market prices or general economic conditions. At larger margins (e.g., saving the coastal wetlands of Louisiana), a general equilibrium analysis or ecological–economic modeling analysis would be necessary, as such a large change would have substantial local and national implications. Future research should focus on the scale of change at which partial equilibrium analyses are no longer reasonable for some services.

Basic approaches for assessing the value of changes in ecological services are shown in box 1. Ecological services that have a supportive function (WRI 2005) or that have indirect or less commonly understood effects on individual welfare (biodiversity, nutrient cycling, soil formation, etc.) are problematic for the use of valuation techniques that require direct expressions of value. In these circumstances, it may be necessary to construct values indirectly, by tying services to things people directly value; for example, soil formation values may be measured in terms of increased crop yields and resulting income increases or consumer savings. Replacement-cost methods can be problematic when the cost of replacing a service exceeds its value, as in the case of early wetlands valuations based on the cost of replacing the tertiary wastewater treatment services of wetlands. Very few municipalities used tertiary treatment at the time because it was too costly. However, a reasonable use of replacement cost was in determining the value of preserving and restoring the pristine character of the Catskills watershed, measured by the cost savings to New York City of not having to build a multibillion-dollar water treatment system (Heal 2000).

Avoided-cost methods similarly assume that the costs would actually be incurred in the absence of the service, suggesting the need to understand behavioral responses to changes in service availability.

Economic valuation tools provide monetary measures of service values, reflecting the value of services relative to other things that people spend money on. Nonmonetizing methods do not require a connection between values and money, but still provide information about relative values, equivalencies, or rankings. The equivalencies and relative rankings can be used to weight the changes in ecological services resulting from management decisions.

Some valuation methods are more appropriate for a particular ecosystem service than for others. Table 2 illustrates possible methods for the valuation of different services. For example, gas regulation, such as C sequestration, can be valued on the basis of the costs the economy would incur to remove the same volume of C in the absence of natural sinks (replacement cost), but only if it is reasonable to assume that removal would take place in the absence of the natural service. Nutrient regulation, such as the uptake of nitrogen (N) by streamside vegetation, can be valued for its beneficial impacts on water quality and measured by downstream treatment costs avoided (avoided cost), but only if it is reasonable to assume that polluted water would be treated in the absence of the natural service. Recreationists’ contingent valuations of enhanced fishing opportunities can also be used.

When ecological services or their valuations are interdependent, it may be necessary to jointly value the entire

Box 1. Valuation methods.


Conventional economic valuation

Revealed-preference approaches

- Travel cost: Valuations of site-based amenities are implied by the costs people incur to enjoy them (e.g., cleaner recreational lakes).
- Market methods: Valuations are directly obtained from what people must be willing to pay for the service or good (e.g., timber harvest).
- Hedonic methods: The value of a service is implied by what people will be willing to pay for the service through purchases in related markets, such as housing markets (e.g., open-space amenities).
- Production approaches: Service values are assigned from the impacts of those services on economic outputs (e.g., increased shrimp yields from increased area of wetlands).

Stated-preference approaches

- Contingent valuation: People are directly asked their willingness to pay or accept compensation for some change in ecological service (e.g., willingness to pay for cleaner air).
- Conjoint analysis: People are asked to choose or rank different service scenarios or ecological conditions that differ in the mix of those conditions (e.g., choosing between wetlands scenarios with differing levels of flood protection and fishery yields).

Cost-based approaches

- Replacement cost: The loss of a natural system service is evaluated in terms of what it would cost to replace that service (e.g., tertiary treatment values of wetlands if the cost of replacement is less than the value society places on tertiary treatment).
- Avoidance cost: A service is valued on the basis of costs avoided, or of the extent to which it allows the avoidance of costly averting behaviors, including mitigation (e.g., clean water reduces costly incidents of diarrhea).

Nonmonetizing valuation or assessment

Individual index-based methods, including rating or ranking choice models, expert opinion.

Group-based methods, including voting mechanisms, focus groups, citizen juries (Aldred and Jacobs 2000, Howarth and Wilson 2006), stakeholder analysis (Gregory and Wellman 2001).