The ecology of ecosystem services: introduction to the special issue

Throughout history, humankind has enjoyed a love-hate relationship with Nature, praising its bounty, fearing catastrophe, or challenging and conquering wilderness and sea. Regardless of our sense of distance from Nature, humans are nonetheless one species out of millions of others on Earth, one with an exceptional ability to harness a vast spectrum of energy sources, materials, and organisms for our welfare. As we exit the second millennium, we enter a world in which our impacts on the environment no longer can be ignored on global scales. In the coming century, our species, numbering roughly 10–12 billion, will be squeezing many natural resources to and in excess of their limits. We will also continue to affect profoundly biogeochemical and hydrological processes that occur at scales ranging from microbial to global-atmospheric.

How did we get here? By doing what all organisms do: we use resources to survive and we reproduce successfully. As highly social creatures, we have been effective at organizing and developing infrastructure and mores that sequester resources and protect us from the environmental adversities of weather, disease, starvation, etc. The development of civilization and culture has blinded many to the fact that humans are irrevocably tied to the natural world, a blindness exacerbated during the fossil-fuel era. Many societies have become philosophically and mentally ‘disembedded’ from the biophysical milieu (see Borgström-Hansson and Wackernagel, this issue), despite the fact that socio-economic development ultimately depends on the dynamic capacity of ecosystems to support it.

Although ecologists and other environmental scientists have long understood the strong coupling between humans and the rest of Nature, many choose to ignore this relationship and instead derive knowledge about the natural world by studying ‘pristine’ situations. Today, increasing numbers of these scientists are re-examining the Man-Nature links and attempting to make these clear to the public as well as to their colleagues. For example, Wilson (1992) drew attention to the importance of biodiversity, and to the emerging crisis of massive species extinction due to human alterations of ecosystems. Vitousek et al. (1986) estimated that humans today garner roughly 40% of the entire, annual, global primary production, an almost incomprehensible share. Ehrlich and Ehrlich (1990) and Cohen (1995) contemplate how many humans can be supported by the Earth’s resources, and at what level of welfare.

Today, few people question the human dominance of the planet (Boulding, 1966; Lubchenco,
De Groot (1992) identified the critical role of ‘environmental functions’ for human well-being. More recently, an edited volume (Daily, 1997) explicitly documented many of ‘Nature’s services’ in a series of thoughtful, quantitative essays. Here, ‘ecosystem services’ were defined as ecological processes that produce, directly or indirectly, goods and services from which humans benefit. These may be as apparent as the production of fertile soils, forests, and fish, or as invisible (to many) as the global maintenance of an atmospheric gas balance amicable to humans and other land-dwelling creatures. Controversial debate was sparked when Costanza et al. (1997) attempted to set a dollar value on 17 of these ecosystem services, evaluated worldwide.

As noted by Costanza et al. (1997), there are no absolute ‘right ways’ to evaluate the environment. What is now clear is that evaluation does not fall solely in the domain of the economist, nor is money the only appropriate metric. In this spirit, we convened a doctoral course in the autumn of 1997 to examine in detail the ecology underlying ecosystem services. We invited the participants to engage in the current debate and write papers on topics of their choice.

This special issue, consisting of eight papers, reflects the diversity of backgrounds and interests from which the authors approach the subject. We begin with two essays. Norberg introduces several areas of ecological theory and suggests how these support our understanding of ecosystem service generation. Borgström-Hansson and Wackernagel next examine society’s disconnect with Nature, and advocate a combination of bioregionalism and ‘ecological footprint analysis’ as a means to show explicitly humanity’s dependence on ecosystems.

Four of the remaining six papers review and explore a number of systems and their generation of services. Two deal with natural systems: coral reefs and their functional diversity (Moberg and Folke), and the role of mangrove forests for capture fisheries and aquaculture (Rönnbäck). Two examine human dominated systems: changes in services provided by the agricultural landscape (Björklund et al.) and ecosystem services within urbanized areas (Bolund and Hunhammar). Holmlund and Hammer discuss how fish populations generate services in a wide variety of ways and how they, by virtue of moving across and using multiple habitats, connect different systems. Finally, Gössling considers how an increasing awareness of ecosystem services can be captured by ecotourism and used as a conservation measure.

We believe that sustainable management of welfare-supporting ecosystem services cannot be achieved unless the diversity and dynamics of ecosystems that generate such services are understood (even if not necessarily explained completely). Hence, awareness of the existence of a particular plant or animal or service is not sufficient. The dynamics of the ecosystem(s) generating and sustaining a good or service, along with links to other systems, to energy, biogeochemical, and hydrological flows, and to human activities have to be addressed.

There are many ecosystem services that meet the criteria of having economic value (they contribute to well-being and are scarce), but that go unrecognized by people in general. In an ecologically illiterate world, humans do not always perceive their indirect dependence on critical ecosystem services and support. Even if they do, they may not value it: preferences are not necessarily linked to biophysical needs. Therefore, economic valuation based on an aggregation of preferences may only capture a part of the ecological prerequisites for social and economic development (Costanza and Folke, 1997). There is a risk that environmental decision-making, based on cost/benefit analysis taken out of an ecological and social context, will lead to undesirable outcomes.

Institutions are critical in this context, as they provide the framework, norms, and rules for individuals (North, 1990; Bromley, 1991). Of particular importance are institutions with response systems that are flexible and adaptive (Norgaard, 1994; Berkes and Folke, 1998). Conventional re-
source management structures have been successful in producing yields and economic growth in the short term, but have not been very successful in safeguarding the dynamic capacity of ecosystems to generate services, or in managing ecological and social systems for long-term well-being (Levin et al., 1998). For example, agricultural output could display a rising trend even when soil quality and quantity declines. Soil erosion, masked by increasing input of fertilizers, irrigation, or machinery, may lead to sudden disruptions in the flow of services (threshold effects) from an agricultural system (Dasgupta et al., 1994). Social traps of resource extraction policies like maximum sustainable yield (MSY) and other static carrying capacity measures are now well known (Ludwig et al., 1993; Gunderson et al., 1995).

Clearly, conventional approaches will not suffice to cope with a spectrum of potentially catastrophic and irreversible environmental problems. Levin et al. (1998) suggest that these problems are characterized by: (1) unpredictability; (2) the potential importance of threshold effects in ecosystems with multiple stable states; (3) difficulty in detecting change early enough to allow effective solutions, or even develop scientific consensus on a time scale rapid enough to allow effective solution; and (4) the likelihood that the signal of change, even when detected, will be displaced in space and time from the source, so that motivation for action is small.

Societies need a variety of ways to assess the changing state of ecosystems, not only at a local scale as is routinely done via environmental impact assessment. Rather, information at numerous scales and across systems needs to be gathered and interpreted to enhance resilience in what we recognize now as the linked ecological-social-economic system. A major purpose of this special issue is to illuminate ‘the mentally hidden’ ecology underlying our environmental resource base. Building knowledge and understanding of the range and dynamical complexity of natural systems into policy is key for effective management of ecosystem services.

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References


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