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Comment

# A Framework for Ecosystem Services Valuation

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In the recent article, "Managing Invasive Aquatic Plants in a Changing System: Strategic Consideration of Ecosystem Services," Hershner and Havens (2008) reject the need to manage certain aquatic plant invaders. The authors claim that *Phragmites australis* invasion is acceptable because it provides three ecosystem services: habitat, soil stabilization, and nutrient uptake and retention. We strongly disagree with this conclusion. Without a comprehensive valuation framework, the concept of ecosystem services is of little use to decision makers. The services referenced by Hersher and Havens may be of lesser value than the services lost as a result of *P. australis* invasion. Using *P. australis* invasion as an example, we suggest a framework for ecosystem services valuation that incorporates three important considerations: quality of service, weighting of services, and time frame.

## Quality of the Ecosystem Service

When referring to ecosystem services, a standard measure of quality is lacking, which makes it impossible to determine the value of a service. Hershner and Havens provide evidence for locally similar bird density in *P. australis* patches as compared with surrounding matrix vegetation, stating that "the use of *P. australis* by fauna varies and in some cases equals or exceeds use of other robust, emergent plant communities." This assessment is based on an extremely selective literature (only two studies are cited); it appears that common bird species can be beneficiaries of invasions while rare species or habitat specialists decline (Benoit & Askins 1999). The broader literature suggests that faunal community composition is indeed altered by *P. australis* invasion (e.g., Chambers et al. 1999; Meyerson et al. 2000; Able et al. 2003; Hagan et al. 2007).

The fact that *P. australis* is supporting a certain avian density does not indicate whether *P. australis* is indeed desirable habitat. Hershner and Havens (2008) wrongly assume that "density of bird species" is the only measure of habitat. A more holistic assessment of habitat quality would include measures such as supported taxonomic diversity, suitability for rare species, historic composition of the site, management goals, and the aesthetic preferences of stakeholders. Data would be taken from the full range of best-available knowledge. The quality of the service (in this case, "habitat") would influence the total value of the service provider (in this case, *P. australis*). Hence, before it can be stated that a system provides the service of "habitat," there must exist an agreed-upon definition of habitat that includes measures of quality. The same principle can be extended to other services.

## The Weighting of Ecosystem Services

At present, multiple ecosystem services cannot be considered simultaneously because there is no method of "weighting" services. Hershner and Havens suggest that the ability of *P. australis* to colonize and stabilize disturbed sediments is an ecosystem service. Others, however, suggest that *P. australis* itself disturbs soils (e.g., Rooth & Stevenson 2000; Talley & Levin 2001) and affects biotic communities through allelopathy (Rudrappa et al. 2007) and competition (reviewed in Meyerson et al. [2000] and Mal & Narine [2004]). Ecosystem services based on societal preferences, such as "existence value," are also likely diminished by *P. australis* invasion. Hence, *P. australis*, or any other species, will provide some ecosystem services while not providing or negatively affecting the provision of others. At present, there is no way to weight services—to determine which services are of higher value and therefore of higher management priority. Even if *P. australis* does stabilize soil, its impact on native plant communities may be unacceptable to stakeholders. In this case, the ecosystem service of "native plant communities" would be weighted more than "soil stabilization." Most wetland managers and agencies charged with land management consider invasion by

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introduced *P. australis* detrimental (e.g., Marks et al. 1994) and spend considerable resources on its control, which suggests that the services described by Hershner and Havens are weighted less than services that are negatively affected by invasion.

## The Issue of Time Scale

The value of many ecosystem services depends on the time frame in which they are considered. Hershner and Havens describe the ecosystem service of "nutrient uptake and retention." It is true that water-treatment systems and constructed wetlands that use *P. australis* have been effective in reducing nitrogen, phosphorus, DDT residues, biological oxygen demand, chemical oxygen demand, and suspended solids from water (Mal & Narine 2004). Most compounds, however, are stored in subsurface biomass, making removal virtually impossible (Haberl & Perfler 1991). The inability to remove sequestered nutrients from a location means they will inevitably recycle through the environment; hence, *P. australis* may confer an ecosystem service of "nutrient uptake and retention" on a short-term scale (the lifetime of individual tissues), but not on an ecologically relevant time scale.

Time scale is also important when evaluating other potential ecosystem services. For example, *P. australis* acts as both a source and sink for greenhouse gases. The species assimilates atmospheric carbon dioxide through photosynthesis and through sequestration of organic matter produced in wetland soils. *P. australis* also releases methane into the atmosphere in a two-stage process (Beckett et al. 2001). Wetlands dominated by *P. australis* are a source for greenhouse gases if evaluated on the order of decades, but are a sink for greenhouse gases if evaluated over longer time scales (Brix et al. 2001). Thus, before it can be said that a system provides an ecosystem service, a time frame must be defined.

### Making "Ecosystem Services" a Useful Tool

Hershner and Havens, like many authors, apply the term *ecosystem services* ambiguously. To incorporate the concept of ecosystem services into management regimes, one must first develop a framework for the valuation of services. An ecosystem service does not have a discrete value (its value changes with quality and time frame), and to make managerial decisions, ecosystem services must be weighted against one another. The following equation represents a simplified valuation framework:

$$\mathbf{TV} = \int^{t} x_1 S_1 + y_2 S_2 \ldots . + z_n S_n$$

where **TV** is the total value of a system (such as *P. australis*); $S_1$, $S_2$, and $S_n$ are service functions 1, 2, and $n$, respectively, that include a measure of quality; $x$, $y$, and $z$ are the respective weights of service functions 1, 2, and $n$; and $t$ is the time frame considered. The value and weighting of each service function depend on stakeholder preferences and change over time.

A clear set of management priorities will help direct valuation. Once the total value of a system has been determined, it can be compared with another system. For example, the total value of *P. australis* could be compared with the total value of a native species (e.g., *S. alterniflora*), the total value of the previous wetland community, or the total value of a lack of vegetation. A formalized decision-making process, based on an ecosystem-services valuation framework, could serve as a tool to land managers and agencies. At present, there is no foundation on which to develop fully a robust valuation scheme; thus, the first step is to integrate the literature surrounding ecosystem services with that surrounding land management.

Despite the claims of Hershner and Havens, eradication is rarely the goal of invasive plant management. Complete local eradication of *P. australis* is often impossible, yet it is premature to conclude that acceptance of invasive species is the only answer. Biocontrol and restoration may prove to be a middle ground between absolute control and absolute acceptance. An option for *P. australis* (Tewksbury et al. 2002), and a proven method of control for other species (e.g., Jullien & Griffith 1998), is biocontrol, which may allow for the restoration of some highly valued ecosystem services with less capital investment than other methods. A robust ecosystem-services valuation framework has the potential to inform such decisions.

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