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# Exploring operational ecosystem service definitions: The case of boreal forests

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ABSTRACT

Despite the widespread use of the concept of ecosystem services, there is still much uncertainty over the precise understanding of basic terms such as 'ecosystem services', 'benefits' and 'values'. This paper examines alternative ways of defining and classifying ecosystem services by using the specific example of boreal forests in Finland. We find the notion of final ecosystem goods and services (FEGS) operable, and suggest using it in economic valuation and other priority setting contexts, as well as in the selection of indicators. However, in the context of awareness raising it might be more effective to retain the well-established terminology of the Millennium Ecosystem Assessment. Our analysis shows that the cascade model (Potschin and Haines-Young, 2011. Progress in Physical Geography 35(5), 575–594) is helpful in distinguishing between ecosystem structures, processes, services, benefits and values by making the sequence of links visible. Johnston and Russell's (2011. Ecological Economics 70(12), 2243–2249) operational mechanism for determining FEGSs proves also instrumental in separating intermediate (e.g. carbon sequestration) and final ecosystem services (e.g. reduction of atmospheric carbon). However, we find their definition of importance, which is based on willingness to pay, too narrow. Furthermore, we favour the CICES approach, which defines ecosystem services as the direct contributions that ecosystems – whether natural or semi-natural – make to human well-being.



## 1. Introduction

The concept of ecosystem services has been received enthusiastically by the research community and recently also by policy makers (e.g. Primmer and Furman, 2012; Hauck et al., 2013). Despite the definitions provided by the Millennium Ecosystem Assessment (MA [Millennium Ecosystem Assessment], 2005) and other studies (e.g. Fisher et al., 2009; Harrington et al., 2010), there is still much uncertainty over the precise understanding of what is meant by ecosystem services, and the basic terms such as 'ecosystem services', 'functions', 'benefits' and 'values' are often used with different meanings from one study to another (Ojea et al., 2012; Chan et al., 2012). Some researchers argue that ecosystem services are ecosystem attributes such as clean water, which lead to benefits such as angling or other recreational activities (e.g. Fisher et al., 2009; Nahlik et al., 2012; Johnston and Russell, 2011), while others equate ecosystem services to the benefits, e.g. recreational activities, that humans derive from ecosystems (e.g. MA [Millennium Ecosystem Assessment], 2005; Tallis et al., 2012; Bateman et al., 2011). Yet for other authors, ecosystem services are the ecological processes or functions such as nitrogen removal from surface water (MA [Millennium Ecosystem Assessment], 2005; Tallis and Polasky, 2011; Maes et al., 2012), which contribute to clean water. Due to these inconsistencies, researchers often measure and map different biophysical outcomes and different benefits as ecosystem services. Lacking clarity also makes communication of the importance of "ecosystem services" to managers and the public more difficult. Making the concept practicable for researchers, as well as understandable for the public, decision-makers and managers, requires a clear and

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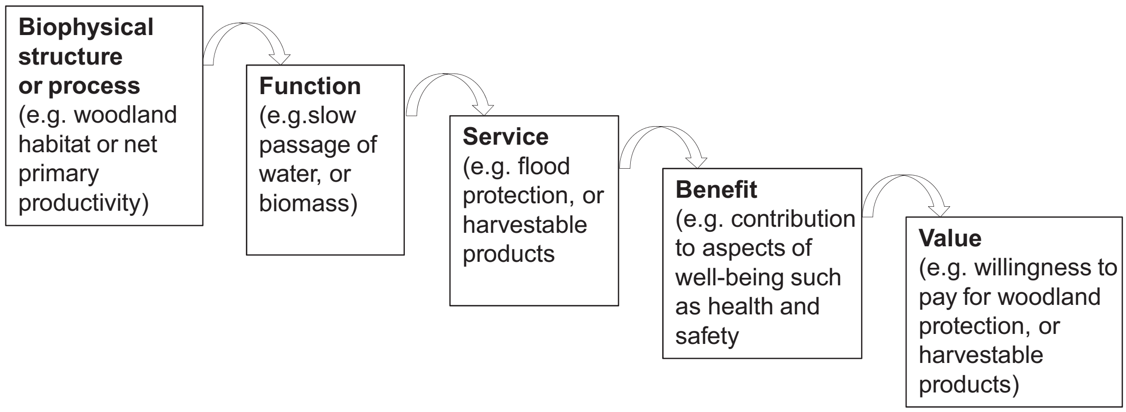


**Fig. 1.** The ecosystem service cascade model (Potschin and Haines-Young, 2011).

precise way of naming and categorizing ecosystem services and linking them to underpinning ecological structures and processes (Tallis and Polasky, 2011; Lamarque et al., 2011).

The most influential attempt to create an ecosystem service typology is by the MA [Millennium Ecosystem Assessment] (2005), which classified ecosystem services as supporting, regulating, provisioning and cultural services. The MA has been highly effective in stimulating discussion on ecosystem services and bringing the concept into broader environmental planning and policy making arenas. However, the MA categories of ecosystem services are not operable as such because they do not distinguish between intermediate ecosystem processes and the services that are directly consumed or enjoyed by people (Boyd and Banzhaf, 2007; Fisher and Turner, 2008). For instance, if we calculate the value of the regulating service 'nitrogen removal' on the basis of the value of clean drinking water, and sum it up with the value of the provisioning service 'drinking water', we double-count the contribution of the nitrogen removal service.

In order to provide an analytic distinction between intermediate and final services, Boyd and Banzhaf (2007) have introduced the notion of Final Ecosystem Goods and Services (FEGS) defined as "components of nature, directly enjoyed, consumed, or used to yield human well-being". These are thus ecosystem services proper [sensu strictu]. The notion of FEGS is adopted by Fisher et al. (2009), Nahlik et al. (2012) and the Common International Classification of Ecosystem Services (CICES; see www.cices.eu), which defines final ecosystem services as the contributions that ecosystems make to human well-being: "These services are final in that they are the outputs of ecosystems (whether natural, semi-natural or highly modified) that most directly affect the well-being of people. A fundamental characteristic is that they retain a connection to the underlying ecosystem functions, processes and structures that generate them (Haines-Young and Potschin, 2013)". Benefits are defined by CICES as final outputs from ecosystems that have been turned into products or experiences that are not functionally connected to the systems from which they were derived (Haines-Young and Potschin, 2013).

A further attempt to define final ecosystem services is Johnston's and Russell's (2011) operational mechanism for determining whether a biophysical feature, quantity, or quality represents a final ecosystem service for beneficiaries. Their set of rules to distinguish final services stipulates that for a biophysical outcome to serve as an ecosystem service, a beneficiary should be willing to pay for an increase in the outcome, assuming that all ecosystem outputs and conditions are held constant. Johnston and Russell (2011) illustrate these conditions with an example of nutrient removal in a riparian buffer that leads to an increase in water clarity in a neighboring lake. Nutrient removal is not a final ecosystem service for lakeside homeowners because it does not influence their welfare if other ecosystem conditions, including water clarity, remain the same. The final service is water clarity because homeowners are willing to pay for increased water clarity, even with no other changes in ecosystem condition. Johnston and Russell (2011) also maintain that biophysical outcomes that count as ecosystem services must represent the output of an ecological system prior to any combination with human labour, capital or technology, and that in cases where an ecosystem outcome simultaneously represents both a final service to a beneficiary and an intermediate service to another beneficiary, only the benefits of final services should be counted and aggregated. In the above example, water clarity can be a final service for lakeside homeowners and an intermediate service for recreational anglers, assuming that it increases the catch. In this case we should calculate both the benefits for lakeside owners as well as the benefits for anglers.

To illustrate the ways in which underlying ecological structures, processes and functions – the intermediate services – are linked to ecosystem services, Potschin and Haines-Young (2011) have introduced the cascade model (Fig. 1), which has also been adopted in The Economics of Ecosystems and Biodiversity (TEEB) study (2010, 2011). The cascade model seeks to articulate the 'production chain' that underlies ecosystem services and emphasizes the fact that services exist only in relation to people's needs; the benefits from ecosystem services and their value to different beneficiaries depend on the social contexts in which the services are used. The ecological structures in the cascade model refer to the composition and distribution of the system's components; the processes refer to any change or reaction which occurs within ecosystems, either physical, chemical or biological, and functions denote the capacity of an ecosystem to provide services (Potschin and Haines-Young (2011)Potschin and Haines-Young 2011)[1] .

Chan et al. (2012) have tackled the problem of conflation of services, benefits and values in ecosystem service frameworks particularly in the context of cultural ecosystem services. They view benefits as valued goods and experiences at the level at which people can most easily relate ecosystems to themselves, and services as the ecosystem processes underpinning benefits, at the level at which ecosystem properties and dynamics might be considered in planning and management. They also provide a detailed typology of different types of values including e.g.

[1] While the term "functions" is used in several different meanings within the environmental sciences in general and in the context of ecosystem services specifically (see Jax, 2005), Potschin and Haines-Young (2011) as well as several other authors (e.g. de Groot et al., 2002) define "functions" as the capacity of an ecosystem to provide services or sometimes as "the subset of interactions between biophysical structures, biodiversity and ecosystem processes that underpin the capacity of an ecosystem to provide services" (TEEB, 2010, p. xxxiii).

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