Forest Ecology and Management 257 (2009) 1637–1646

Contents lists available at ScienceDirect

Forest Ecology and Management

journal homepage: www.elsevier.com/locate/foreco

Ecosystem services: Foundations, opportunities, and challenges for the forest products sector

Trista M. Patterson *, Dana L. Coelho [1]

USDA Forest Service, PNW Research Station, 204 Siginaka Way, Sitka, AK 99835, United States

ARTICLE INFO

Article history:
Received 23 January 2008
Received in revised form 10 November 2008
Accepted 11 November 2008

Keywords:
Ecosystem services
Natural resource management
Forest products

ABSTRACT

The ecosystem service concept has been proposed as a meaningful framework for natural resource management. In theory it holds concomitant benefit and consequence for the forest product sector. However, numerous barriers impede practitioners from developing concrete and enduring responses to emerging ecosystem service markets, policies, and initiatives. Principle among these barriers is that the ecosystem service concept has a complex history, numerous definitions in use, and an astounding diversity in rationale and application. This article provides a conceptual review of ecosystem services and its economic foundations, distinguishes among several current definitions of the term and their relatedness to strategies in practical application, discusses diverse approaches to valuation, and explores potential for future relevance in forest product and other sectors.

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1. Introduction

Ecosystem services can be broadly defined as those processes of ecosystems that support (directly or indirectly) human wellbeing (MEA, 2005). In forest product application, common ecosystem services to be listed are timber, non-timber forest products, wildlife habitat, water quantity and quality, carbon sequestration and storage, and recreation opportunities.[2] Between 1960 and 2000, while the world's population doubled and the global economy increased sixfold, the Millennium Ecosystem Assessment documented a decline in over 60 percent of the world's ecosystem services (MEA, 2005). Future challenges are likely to be more profound, driven in large part by population growth, affluence, and technology (Ehrlich and Ehrlich, 1990; Haberl et al., 2007). Because a large portion of global ecosystem service flows originate within forests, and because the life cycles[3] of forest products affect ecosystem service flows, forest product specialists are important contributors to addressing declines in flows of ecosystem services. At the same time, the valuation of ecosystem services and the development of markets offer opportunities for landowners and investors within the forest products sector to explore alternative revenue streams.

Important opportunities exist to engage new perspectives in provisioning forest ecosystem services, whether through governance (Gibson et al., 2000, 2005), payment systems and markets (Engel et al., 2008; Johnson et al., 2001), adjustments to life cycle processes (Ghertner and Fripp, 2007), or other means. We review concept origins, definitions in current use, and the economic properties of ecosystem services. We focus on three general application strategies relevant to forest product specialists: emerging markets in ecosystem services, managing for ecosystem services on forests as a whole, and raising awareness for ecosystem services through accounting and valuation. The paper concludes with a discussion of futher and potential applications of the ecosystem service concept within the forest products sector.

2. Conceptual review

The modern concept of ecosystem services is a tapestry of accumulated knowledge and perspective stemming from the finite nature of natural resources (Marsh, 1864) and the study of ecosystems (Lindeman, 1942). Multiple disciplines have contributed to the evolution of the term, with ecology and economic lines of reasoning at times appearing more separate than related.

Krutilla's work on the "present and future amenities associated with unspoiled natural environments, for which the market fails to make adequate provision" (Krutilla, 1967, p. 778) stands out as a

* Corresponding author. Tel.: +1 907 7381205.
E-mail addresses: tmpatterson@fs.fed.us (T.M. Patterson), dcoelho@fs.fed.us (D.L. Coelho).
[1] Tel.: +1 907 7474249.
[2] As will be covered later in the article, definitions and scope of ecosystem services differ widely.
[3] The life cycle of a forest product includes everything from planting, to forest treatment applications, harvest, manufacture, sale, consumption, and recycling or disposal; life cycle analysis considers all material and energy inputs and outputs of the production process (Seppälä et al., 1998).

0378-1127/$ – see front matter. Published by Elsevier B.V.
doi:10.1016/j.foreco.2008.11.010

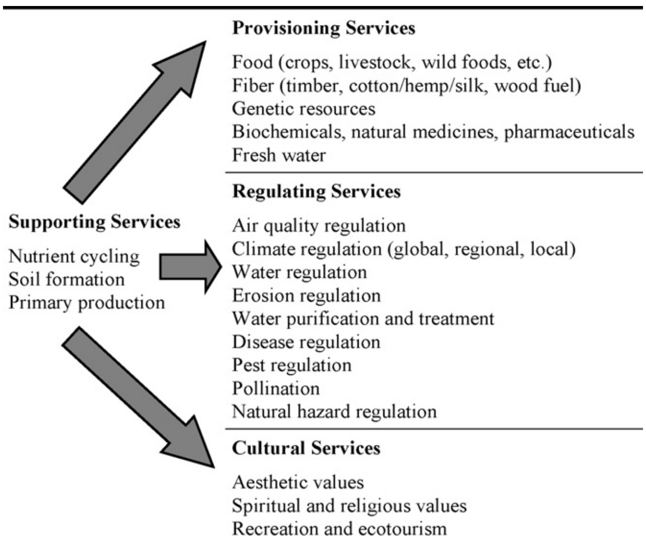

Fig. 1. Broad categories of ecosystem services (adapted from MEA, 2005).

particularly concise, early, and influential characterization of the issue. Meanwhile, an MIT Study of Critical Environmental Problems (SCEP, 1970) was among the first to identify a suite of environmental services that faced decline if ecosystem function were impaired or lost. Specific references to "public-service functions of the global environment"/"global ecosystem", "nature's services", and finally "ecosystem services" (Holdren and Ehrlich, 1974; Ehrlich et al., 1977; Westman, 1977; Ehrlich and Ehrlich, 1981; respectively) soon followed.

Schumacher (1973) and Daly (1977, 1991, 1996) drew attention to the increasing likeliness of ecosystem service declines, pointing out that the world's growing "man made economy" would one day bump up against immutable laws of physics,[4] as economic growth consumed and affected the "biosphere". Thus, today's ecological economists are not only addressing the value of ecosystems as life support (Folke et al., 1991; Deutsch et al., 2003), but are asking questions such as to how ecosystem services relate to quality of life (Collados and Duane, 1999; Bridgewater, 2002; Daily, 1997), whether we are over-weighting those resources which have market value in decision making (Costanza et al., 1997), whether current rates of energy and resource use exceed the planet's ability to replenish itself (Wackernagel and Rees, 1996; Wackernagel et al., 2002). Other lines of inquiry question whether social resource use is excessive (Ehrlich and Goulder, 2007), if social–ecological relationships are less than resilient (Holling, 2001; Folke et al., 2002) and what role social institutions play if any of these is the case (Ostrom, 1990; Dietz et al., 2003).

These lines of research have come together in an ecosystem service concept that broadly recognizes ecosystems as a fundamental basis of production. Consequently, economists are increasingly using ecosystems as the organizing structure of the benefits people receive, while ecologists are becoming more versed in explaining management choices in terms of benefit tradeoffs (Kline et al., 2008). These tradeoffs have both a spatial and temporal variation. Ecosystem services originate from, and extend to users at, different scales—from local to global. They are often described using four broad categories: provisioning (direct), cultural (direct), regulating (indirect), and supporting services (indirect) which create a foundation for the first three (Fig. 1) (MEA, 2005).

This broad definition arose from and remains in the company of various, more specific definitions, as covered in the next section. We use this information later in the article in discussing the appropriateness of market-based tools (according to economic properties of the ecosystem services at hand) and three methods of applying the ecosystem service concept within the forest products sector.

3. Definitions currently in use

Considering the long history of the ecosystem service concept and its now frequent appearance in the literature, the diversity in definitions may be surprising (see for review, de Groot et al., 2002; Kline, 2007; Costanza, 2008; Fisher and Turner, 2008). The broadest interpretations are often used to raise awareness of the pervasive yet often intangible benefits that people receive from healthy ecosystems (MEA, 2005; Daily, 1997; Collins and Larry, 2007). Other, more specific definitions are intended to relate ecosystem function to social activities, or estimate replacement cost of lost ecosystem services (Costanza et al., 1997; US EPA, 2006). Others employ more narrow definitions for specific accounting and decision making (Boyd and Banzhaf, 2007) (Fig. 2). Each definition varies in its emphasis on supply- and/or demand-side issues, recognition of market and non-market values, consideration of temporal and spatial scale, units of measurement, and the tracking of services from origin to user.

The decision of how to define ecosystem services for a given ecosystem service project places important bounds on it. Assumptions that cooperators already share agreement on definition can undermine the ability of those cooperators to be as specific as may be needed to produce tangible project outcomes. Should the project deal with multiple services, or just one? Should it deal with markets only, non-marketable services only, or a mix of both? On one hand, as research and practice strive for greater specificity, the need for empirical data increases. The need for quantification may lead to assessments which intentionally exclude non-market values and qualitative data. On the other hand, a more inclusive definition may be chosen to intentionally facilitate consideration of supporting, regulating, and cultural ecosystem services which would otherwise not be counted.

More general references are generally regarded as more appropriate for education and raising awareness, stakeholder discussions, and broadening the scope of existing studies or projects. Allowing for both quantitative and qualitative information from a full spectrum of ecosystem services can provide the basis for a more culturally inclusive and complex system description. More narrow definitions of ecosystem services may be the most practical way to avoid issues of joint production and double counting, to distinguish ecological structure from function, or to estimate a discrete service or multiple services within a geographically limited area (Brown et al., 2007; Boyd and Banzhaf, 2007). A more refined definition will be warranted for any study involving quantification of flows of ecosystem services or the use of data in models and other decision tools. Estimates of market value will require great attention to definition, as that will determine the structure of calculations and resulting values (Boyd and Banzhaf, 2007), appropriateness for wider application (Costanza, 2008), and whether or not markets can support the ecosystem service under consideration (Johnson et al., 2001).

Defining the scope of a project is also important to understanding the complex perspectives encompassed when using the term 'valuation'. If an ecosystem service valuation project has publicized a dollar value for ecosystem services, an individual land owner seeking payment for ecosystem services may be surprised when even the most effective payment for ecosystem service program is not expected to deliver this in returns. The difference is

[4] Nicolis and Prigogine (1977) established the thermodynamic basis for these limits and was awarded the Nobel Prize in Chemistry for dissipative structures, complex systems, and irreversibility.