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Bundling of ecosystem services to increase forestland value and enhance sustainable forest management

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ABSTRACT

There has been increasing interest in the use of market-based approaches to add value for forestland and to assist with the conservation of natural resources. While markets for ecosystem services show potential for increasing forestland value, there is concern that the lack of an integrated program will simply add to the complexity of these services without generating significant public benefits. If not designed properly, these fragmented programs can result in the restoration of many small sites that lack ecological integrity and are unlikely to provide the benefits from protecting larger and more contiguous areas. An integrated approach that combines or bundles services and provides financial incentives for forest landowners may be more effective to achieving broad conservation goals, including enhancing fish and wildlife habitat, improving watershed health, sequestering carbon to mitigate climate change, and providing other ecosystem services at an ecologically relevant scale. We outline some of the policy and regulatory frameworks for some of the emerging markets for ecosystem services in the United States, and discuss the role that different regulatory agencies play for each of these services. We then assess the potential benefits for bundling different ecosystem services such as water quality, wetlands, species conservation, and carbon and describe an integrated accounting protocol for combining these services.

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1. Introduction

Worldwide, there is increasing interest for enhancing the conservation of clean water and air, healthy foods, and the services provided from functioning ecosystems (Costanza et al., 1997; Daily, 1997; MEA, 2005). In the United States (U.S.), the public is demanding greater environmental protection and conservation of natural resources from its public and private lands (e.g. Clean Water Act and Endangered Species Act, USFWS, 1988). These environmental concerns come at a time when forest lands are rapidly being lost to development and conversion to non forest use (Alig et al., 2003; Butler et al., 2004; Stein et al., 2005). In the 1990s the U.S. lost more than 1000 ha of forest each day, with more forest area being impacted by fragmentation (Alig, 2007). Adding to the conservation challenge, the majority of U.S. forests are privately owned, with about 70% of the forest land being owned by either industrial or nonindustrial private landowners (Smith et al., 2004). Private landowners want to be regarded as good land stewards but they are further challenged by additional regulations and the difficulty in meeting those regulations while providing both forest products and public goods such as fish and wildlife habitat, water resource protection and recreation (Kline et al., 2004; Pouta, 2005; Donnegan, 2007). Public lands in the U.S. also face a dilemma; these lands are no longer managed primarily for wood production and there is a strong need to quantify the value of some of the public goods and services provided from these lands (Kline, 2006; Boyd and Banzhaf, 2007; Collins and Larry, 2008). Emerging markets for ecosystem services present some new opportunities for forest landowners and managers. Besides the economic contributions of timber and other forest products, there is increasing recognition of the importance of ecosystem services and the values (public goods) these services provide (Costanza et al., 1997; Casey et al., 2006; Farley and Costanza, 2010). These emerging markets offer financial incentives for landowners to maintain and manage their forests rather than developing these lands. There is a compelling need to assess some of the different ecosystem services provided from forest lands and the potential role of market-based incentives to maintain these services.

The importance and value of ecosystem services are being recognized from local to global scales (Costanza et al., 1997; Daily, 1997; Kroeger and Casey, 2007; Farley and Costanza, 2010; LaRocco and Deal, 2011). The term "ecosystem services" was popularized by ecologists who recognized the value of natural processes and products, and their intrinsic importance to enhance human well being and ecosystem services were defined as the "biological underpinnings

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essential to economic prosperity and other aspects of our well being" (Daily, 1997). The internationally recognized Millenium Ecosystem Assessment further developed this concept (MEA, 2005) and economists reported the value of the world's ecosystem services to be in the range of US$ 16–54 trillion per year (Costanza et al., 1997). The Millenium Ecosystem Assessment (MEA, 2005) provided a simple definition of ecosystem services as "the benefits people obtain from ecosystems" and this typology highlights the wide-ranging importance and value of these services for both people and the environment. The MEA divided up these services into four categories including provisioning, regulating, supporting and cultural services (Table 1). Provisioning services are a familiar part of the economy that provides goods such as food, freshwater, timber and fiber for direct human use. Regulating services maintain a world in which it is possible for people to live, and provide benefits such as flood and disease control, water purification, climate stabilization and crop pollination. Supporting services are the underlying processes that maintain the conditions for life on Earth and include nutrient cycling, soil formation and primary production for our ecosystems. Cultural services make the world a place where people want to live and include recreational, spiritual, esthetic and cultural values. However, the MEA definition of ecosystem services is excessively broad and includes both supporting ecosystem functions, and goods and services for people. This broad typology creates problems for economists who wish to quantify values from ecosystem services (Boyd and Banzhaf, 2007; Kroeger and Casey, 2007; Farley and Costanza, 2010; Muradian et al., 2010). Boyd and Banzhaf (2007) developed a more quantifiable definition of ecosystem services that focused on final products or services to avoid the potential problem of double counting services. They defined ecosystem services as "components of nature, directly enjoyed, consumed or used to yield human well being." Many economists and ecologists have trouble agreeing on the appropriate typology or definition of ecosystem services (De Groot et al., 2002; Boyd and Banzhaf, 2007), however; the critical importance of ecosystem services is widely recognized.

Healthy, functioning ecosystems have an important role for mitigating pollution, maintaining biodiversity and improving overall global health. Forests play a major role in the global carbon cycle through the ability of trees to withdraw or sequester carbon, and forests serve as a terrestrial carbon sink during most stages of forest development. Forests also have high conservation value for a number of threatened and endangered species, for mitigating pollution, for flood control and for other ecosystem services. Direct government payments for ecosystem services and mitigation markets based on regulations are two common examples of financial incentives for the provision of ecosystem services, and market-based mechanisms for ecosystem services may have an important role to play in ecosystem protection (Kroeger and Casey, 2007; Muradian et al., 2010; Broughton and Pirard, 2011). These markets can generate financial resources by providing new revenue streams for landowners, and create incentives for investment by increasing the involvement of the private business sector in environmental management (Boyd, 2004; Heal et al., 2005). The concept of providing incentives, through market mechanisms, has helped stimulate interest in market-based programs for ecosystem services. Although other public policies such as regulations and zoning, tax credits, conservation easements and other incentive payments have important policy roles for ecosystem protection, the recent emergence of market-based incentives for carbon, water, wetlands and biodiversity has enlisted a broad suite of new stakeholders. Ecosystem services when considered as "natural capital" leads land owners and managers to regard landscapes as natural assets that requires accounting for different ecosystem services and ensuring the people who rely on these services know their value and the cost of losing them (Kline, 2006; Collins and Larry, 2008).

Markets for ecosystem services are increasingly recognized as having an important role to play in ecosystem protection. Combining or "bundling" of ecosystem services may also provide a more administratively efficient process for integrating different ecosystem services (water, wetlands and endangered species for example) that are managed by different regulatory agencies (Chan et al., 2006; LaRocco and Deal, 2011). However, reducing transaction costs and streamlining the regulatory and policy constraints of these emerging markets is critical to develop functioning markets for these services (Chan et al., 2006; Kline et al., 2009). These new financial incentives expand opportunities for forest landowners to gain revenue from their lands while also providing public goods to society. The objectives of this paper include: 1) describe the policy and regulatory frameworks of emerging markets for ecosystem services in the U.S. and assess the role of market incentives for maintaining these services, 2) evaluate the potential benefits of bundling ecosystem services and/or stacking credits as an incentive to keep forestlands in forests, 3) describe a case study in Oregon using an accounting protocol to integrate different services into a multi-ecosystem service marketplace. Lastly, we will evaluate some of the opportunities and challenges related to bundling of ecosystem services and their potential to enhance sustainable forest management and help maintain a broad suite of ecosystem benefits.

Table 1
Typology of ecosystem services provided by nature. Modified from the Millenium Ecosystem Assessment (MEA, 2005).

Ecosystem services	
	Provisioning Services
	Food (crops, livestock, wild foods, etc.…)
	Fiber (timber, cotton/hemp/silk, wood fuel)
	Genetic resources
	Biochemicals, natural medicines, pharmaceuticals
	Fresh water
Supporting Service	**Regulating Services**
Nutrient cycling	Air quality regulation
Soil formation	Climate regulation (global, regional, and local)
Primary production	Water regulation
	Erosion regulation
	Water purification and waste treatment
	Disease regulation
	Pest regulation
	Pollination
	Natural hazard regulation
Cultural Services	**Cultural Services**
	Esthetic values
	Spiritual and religious values
	Recreation and ecotourism

2. Markets for ecosystem services

Land use policy and regulations have an important role for establishing markets for ecosystem services, and market-based programs have developed in response to regulations for wetlands, water, and endangered species. Examples of regulation-driven markets for ecosystem services include wetland mitigation banking and water quality trading (Gaddie and Regens, 2000; Brauman et al., 2007) authorized under the Clean Water Act (33 U.S.C. 1344), and species conservation banking (USFWS, 1988; Carroll et al., 2007) implemented under the Endangered Species Act (33 U.S.C. 1344). Cap-and-trade programs are also being successfully applied in several important U.S. programs to reduce pollution, including the effort to control acid rain by limiting SO_2 emissions (Stavins, 1998, 2005). For example, fossil fuel electric power plants are issued permits by the U.S. Environmental Protection Agency for a certain amount of SO_2 emissions. However, these different ecosystem services are regulated and controlled by several different federal and state agencies with their own sets of policies and regulatory frameworks. For instance, at the

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