

Integrating Ecosystem Services Into Sustainable Forest Management of Public Lands

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ABSTRACT.—Ecosystem services are recognized as a way of framing and describing the broad suite of benefits that people receive from forests. The USDA Forest Service has been exploring use of an ecosystem services framework to describe forest values provided by public lands and to attract and build partnerships with stakeholders to implement projects. In addition to describing ecosystem services provided by forest landscapes, this framework examines the potential tradeoffs among services associated with proposed management activities, while attracting and building partnerships with stakeholders who benefit from particular services these forests provide. Projects that describe objectives and outcomes using an ecosystem services framework could provide an important forest management tool. So, the Forest Service has recently sought place-based applications of the ecosystem services framework to national forest management to better illustrate the concept for policymakers, managers, and forest stakeholders. This paper describes how project scale guidelines can be designed to address commonly recognized products such as timber and water, as well as critical regulating, supporting, and cultural services. We present results from national programs to forest plan assessments to project-scale applications that enhance the provision of ecosystem services and sustainable forest management at broad to local scales.

INTRODUCTION

Ecosystem services have emerged as a way of framing and describing the broad suite of benefits that people receive from nature and the value of these services are now recognized from global to local scales (Costanza et al. 1997, Daily 1997, Farley and Costanza 2010, Kroeger and Casey 2007). The Millennium Ecosystem Assessment (MEA 2005) developed a classification for these services and defined them as provisioning, regulating, cultural, and supporting services. Provisioning services are familiar commodities such as food, fresh water, timber, and fiber for direct human use. Regulating services provide benefits such as flood and disease control, water purification, climate stabilization, and crop pollination. Cultural services include recreational, spiritual, aesthetic, and educational values. Supporting services are the underlying processes that maintain the conditions for life on Earth and include nutrient cycling, soil formation, and primary production.

Forests provide an abundance of ecosystem services. For instance, they have high conservation value for a number of threatened and endangered species, for mitigating pollution, and for flood control. Forests can be managed for the long-term sustainability of wood products, wildlife, and other ecosystem services (Deal et al. 2014). Forests also 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 (FAO 2005, Oliver 2001, Oliver and Deal 2007). Forest carbon is a particularly important ecosystem service to monitor and manage because there is interest in both maintaining current forest carbon stocks and increasing carbon sequestration as a mitigation strategy for reducing atmospheric CO₂

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(FAO 2005, Oliver and Meznik 2005). Forests can serve as carbon sinks in the standing timber, in wood products, and in avoided emissions when wood is used as a substitute for more fossil fuel-consuming structural products such as steel, concrete, and brick (Campbell et al. 2009, Lippke et al. 2004, Mitchell et al. 2009).

Not only can forest products play an important role in carbon sequestration, they have long had a critical role in ensuring that forests function as a vital part of the economy. Hence, sustainable forest management is also crucial. Sustainable forest management is the practice of meeting our current forest resource needs and values without compromising the use of forests by future generations (Deal 2018). Not surprisingly, then, natural resource legislation directs federal land management agencies to include ecosystem services in federal decisionmaking and forest plan revisions (OMB 2015, USDA FS 2012). As an example, the Forest Service's 2012 Forest Planning Rule requires the agency to include ecosystem services in assessments and forest plan revisions (USDA FS 2012). Likewise, a 2015 Presidential memorandum asserts that by incorporating ecosystem services into federal agency planning and decisionmaking, government institutions will be able "to more effectively address challenges facing the Nation and ensure ecosystems are healthy for this and future generations" (OMB 2015, p. 12).

There is now a need to integrate national policy and programs both for the evaluation of ecosystem services into the national forest planning process and for local project implementation. In particular, forest managers and planners want to demonstrate how an ecosystem services framework can be used in national forest assessments and forest plans revisions, and to address ecosystem services in local projects. To support their efforts, the Forest Service has been evaluating the use of an ecosystem services framework to describe forest values provided by federal lands and to attract and build partnerships with stakeholders and nongovernment organizations to implement projects (Smith et al. 2011). An ecosystem services framework based on sustainable forest management principles could easily be incorporated into stand level silvicultural prescriptions and may be a highly effective way to demonstrate the provision of important ecosystem services included in forest assessments and plans. Forest management plans and stand silvicultural prescriptions could include both common ecosystem services provided such as sustainable timber supply, wildlife habitat, or reduced wildfire risk, and some services that are undervalued or not typically included in forest management plans or stand silvicultural prescriptions such as special forest products, cultural values, and recreation use.

These services are often overlooked or undervalued in typical management plans but including them in a silvicultural prescription would be an innovative way to both address the protection of some key ecosystem services identified in forest assessments and develop management plans that could enhance or preserve these services. Identifying these key services in the desired future condition would be a suitable starting point from which silviculturists could develop specific management plans to ensure these services will be maintained into the future. In this paper, I identify opportunities and needs to integrate ecosystem services into national Forest Service policy and operations and summarize current efforts to address this potential. I further describe how Forest Service national forest plans can use an ecosystem services framework to both meet the requirements of the Forest Service planning rule (USDA FS 2012) and help the agency identify and clarify relationships between the conditions of forest ecosystems and the quality of services they provide. Finally, I provide some examples of how ecosystem services frameworks have been integrated into sustainable forest management at the project scale and how this framework helped the agency meet its mission at the national, forest, and local levels.

ECOSYSTEM SERVICES INTO NATIONAL FOREST SERVICE POLICY AND OPERATIONS

With national forests and grasslands covering over 188 million acres on 155 national forests and grasslands (USDA FS 2008), the Forest Service manages about one-fifth of the forested area in the United States. The Multiple Use Sustained Yield Act (MUSYA 1960), the National Forest Management Act of 1976 (USDA FS 1976), and the National Environmental Policy Act (NEPA 1969) are some of the primary laws and regulations (Table 1) that specified how the Forest Service manages these lands. More recently, the Obama Administration started directing the Forest Service and other federal agencies to incorporate ecosystem services into their decisionmaking processes. A crucial step in operationalizing the new policies regarding ecosystem services into management of Forest Service lands nationwide was the establishment of the 2012 land management planning rule (USDA FS 2012).

Table 1.—Natural resource legislation and response to legislation by the Forest Service (FS) and Bureau of Land Management (BLM).

Natural resource legislation	Intent of legislation	Response by FS and BLM to legislation
Multiple Use Sustained Yield Act (1960)	Promote sustainable management of natural resources to meet the growing needs of an increasing population and expanding economy.	FS and BLM directed to manage timber, range, water, recreation, and wildlife with equal importance.
National Environmental Policy Act (1969)	Encourage harmony between people and the environment, enrich the understanding of the ecological systems and natural resources important to the Nation, and establish a Council on Environmental Quality.	Any federal, state, or local project that involves federal funding, work performed by the federal government, or permits issued by a federal agency must take a multidisciplinary approach to decisionmaking, including consideration of alternatives.
Federal Land Policy and Management Act (1976) National Forest Management Act (1976)	Establish policy of inventory and planning in accordance with the Multiple Use Sustainable Yield Act.	FS and BLM develop land management plans in collaboration with the public to determine appropriate multiple uses, develop strategies for resource management and protection, and establish systems for inventory and monitoring to evaluate the status of resources and management effectiveness.
National Forest System Land Management Planning Rule (2012)	Regulation developed by the FS to implement planning required by the National Forest Management Act.	Rule explicitly requires FS managers to address ecosystem services in planning to ensure that forests have the capacity to provide people and communities with a range of social, economic, and ecological benefits for the present and into the future. Staff across the agency develop and apply tools to address ecosystem services in land management efforts.

Regionally, the agency had already taken some steps in the direction of ecosystem service-driven management policies. For example, prior to adoption of the 2012 planning rule, some Forest Service researchers, National Forest System planners, and managers developed an ecosystem services framework on the Deschutes National Forest in central Oregon (Smith et al. 2011). This effort included (1) describing the ecosystem services provided by the forest; (2) investigating how an ecosystem services framework could support an integrated management approach across program areas to sustain ecological functions and processes; (3) assessing the potential tradeoffs among different ecosystem services following specific management actions; (4) using the ecosystem services framework to identify partners and stakeholders to collaboratively plan and implement projects with stakeholder and cooperators; and (5) developing tools and models for managers to assess the potential tradeoffs among ecosystem services following management plans. This effort led to the development of a project-level management plan based on ecosystem services (Smith et al. 2011). Although this framework has not been directly used in assessments and forest plan revisions, it has been used to evaluate smaller scale projects in the Forest Service's Pacific Northwest Region (Marsh and Drink planning areas) described in following sections. This report also enabled managers to explore how an ecosystem services framework can be applied operationally to guide stewardship of national forests and to support restoration of functions and processes characteristic of healthy and resilient forest ecosystems.

The 2012 rule explicitly required the Forest Service to include ecosystem services in the assessment phase of forest planning as mandated by the National Forest Management Act (USDA FS 1976). In this new rule, the term "ecosystem services" was frequently mentioned with "multiple use," a reference to the MUSYA. MUSYA called for national forests and grasslands to be managed for "outdoor recreation, range, timber, watershed, wildlife, and fish purposes" and further defined multiple use as "management of all the various renewable surface resources of the national forests." Although there was substantial overlap between provisioning services and multiple uses as defined by the MUSYA, the addition of ecosystem services in the 2012 planning rule expanded the concept of multiple use through the inclusion of supporting, regulating, and cultural services. For example, the 2012 rule underscored the importance of cultural heritage values and specifically mentions services important for maintaining cultural use, special forest products, and services of particular value for Native American tribes (USDA FS 2012). The 2012 planning rule also expanded public participation in the planning process in several important ways. Specifically, the planning rule states that plans will guide the management of Forest Service land so that they have the capacity to provide people and communities with ecosystem services and multiple uses that offer a range of social, economic, and ecological benefits for the present and into the future (USDA FS 2012).

In 2015, a new Presidential memorandum further required that federal agencies promote consideration of ecosystem services in planning, investments, and regulations (OMB 2015), something that the Forest Service has worked on extensively. However, the Forest Service has struggled to describe, quantify, and value all of the potential ecosystem services that public forestlands provide. To address this challenge, the Planning Rule Final Directives (USDA FS 2015) that guided implementation of the 2012 planning rule directed that forest plan revisions focus on "key" ecosystem services. These key services are important in the broader landscape outside of the plan area and are likely to be influenced by the land management plan (USDA FS 2015). The inclusion of key ecosystem services allows some flexibility and specific focus for individual national forests. Most forest plan assessments include 10–15 key ecosystem services that may vary from common provisioning services (timber, water, fish and wildlife habitat) to highly specific regulating or cultural values (special forest products, endangered species habitats, scenic views, carbon sequestration or flood control, among others).

Another critical effort for incorporating ecosystem services into Forest Service national policy and operations developed from the National Ecosystem Services Strategy Team (NESST). NESST was chartered by the Forest Service leadership (NESST 2013) to collaboratively develop national strategy and policy around ecosystem services and integrate them into Forest Service programs and operations. In particular, there was a need to develop a common understanding of ecosystem services in order to explain the relevance of an ecosystem services framework for the agency and to provide better communication across agency Deputy Areas by formalizing information sharing and reporting mechanisms. Major NESST objectives included articulating and demonstrating the relevance of an ecosystem services framework across the agency; developing formal policy and informal guidance to support an ecosystem services framework for federal, state, private, and tribal forest lands; building capacity and infrastructure across Forest Service Deputy Areas to manage forests for the enhancement of ecosystem service benefits; designing inventory methodologies and data management solutions to improve reporting and evaluating ecosystem service benefits; and fostering two-way communication inside and outside the Forest Service regarding how an ecosystem services framework can better support management objectives and improve outcomes (Deal et al. 2017).

Nationally, the application of ecosystem services has occurred across all types of lands (public and private) and across different Deputy Areas of the Forest Service (the National Forest System, Research and Development, and State and Private Forestry). Some examples of such efforts include the adoption of the 2012 Planning Rule in forest assessments and for developing new tools to assess ecosystem services provision such as i-Tree (Nowak 2008). However, there is now a need to move from national programs and policy to regional and local scales to assess how an ecosystem services framework can be used in national forest assessments and forest plans, and to implement and evaluate ecosystem system services into projects. The following section describes how forest plans can use this framework to (1) meet planning rule requirements; (2) help the agency identify and communicate why particular management actions are needed; and (3) clarify relationships between the conditions of forest ecosystems and the quality of services they provide.

APPLYING ECOSYSTEM SERVICES AT FOREST AND PROJECT SCALES

Ecosystem services can add particular value at the forest- and project-scale levels of decisionmaking and implementation. Place-based application of the ecosystem service framework highlights the connections between public benefits and ecosystem condition and addresses management challenges by considering the range of services that are affected by projects and the potential tradeoffs that result from particular actions. After all, the project scale is where forest management is applied. To highlight these opportunities, I will assess the use of the ecosystem services framework with three examples of projects in the Pacific Northwest Region.

The Marsh Project

The Marsh planning area on the Deschutes National Forest (Oregon) is a 30,000-acre watershed just south of Crescent Lake that encompasses the Big Marsh and Refrigerator Creek Drainages. The ecology of the area is extremely complex with high biological diversity. The Crescent Ranger District engaged in intensive planning in Big Marsh, one of the most expansive high elevation wetland/marsh complexes in the continental United States. The marsh supports the largest Oregon spotted frog (*Rana pretiosa*) population in the state and



Figure 1.—The Marsh Project planning area is the headwaters of the Deschutes River in central Oregon. It provides dispersed recreation for mountain bikers and canoers as well as habitat for many wildlife species including beaver, river otter, elk, marten, Oregon spotted frog, migratory birds, and rare graminoids. Photo by Carina Rosterolla, USDA Forest Service.

provides habitat for two rare graminoids, *Scirpus subterminalis* and *Carex lasiocarpa*. Other major resource considerations include matsutake mushroom (*Tricholoma matsutake*) habitat (a commercially harvested and culturally significant species), two late successional reserves (LSRs), threatened and endangered species like the great grey (*Strix nebulosa*) and northern spotted owls (*Strix occidentalis caurina*), wild and scenic river values, riparian reserves, big game and fish habitat, and dispersed recreation including mountain biking and canoeing (Fig. 1).

Due to the complexity and uniqueness of this watershed, the Forest Service incorporated an ecosystem services framework into the project analysis as a way to communicate the goods and services supported by sustaining a functioning, resilient landscape. The ecosystem services framework provided a platform for integrating forest management and restoration actions with public benefits such as clean water, cultural values, and wildlife habitat. Although this project-level assessment was not directly related to forest plan revision, it reflects the intent of the 2012 planning rule to support forest restoration and conservation, watershed protection, and wildlife conservation, as well as the sustainable provision of benefits, services, resources, and uses of Forest Service lands, including sustainable recreation (USDA FS 2012). In order to identify the key values associated with the ecological, economic, and social benefits or services of this landscape, Forest Service staff designed workshops with The Nature Conservancy to engage stakeholders, constituents and subject-matter experts in discussions. Public engagement includes dialogue regarding where active management and restoration were needed to sustain ecological function and reduce risks to those values. Once the key ecosystem services were identified, the challenge was to ensure they were clearly linked to the project purpose and need as defined by the National Environmental Policy Act. Metrics were

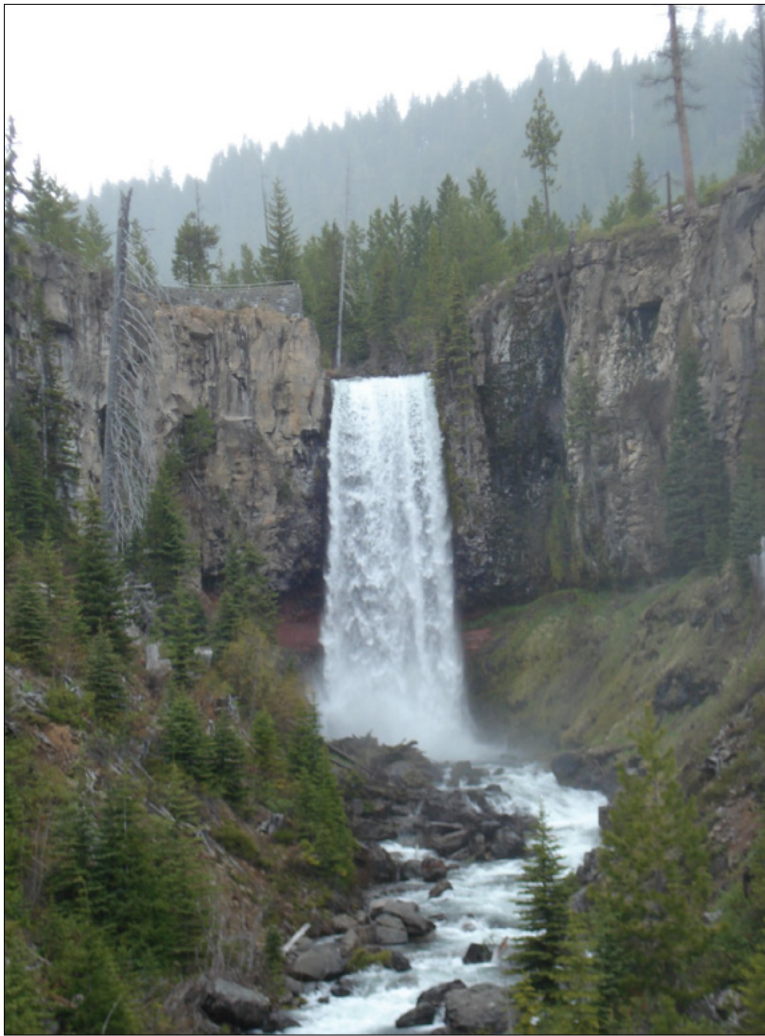


Figure 2.—The water supply for the city of Bend, Oregon, originates on the Drink Project planning area of the Deschutes National Forest. The forest is valued for water supply, recreation, wildlife habitat, timber, and scenery such as this view of Tumalo Falls. Photo by Svetlana Kushsch Schroder, Hancock Forest Management, used with permission.

developed to quantify differences between management alternatives and monitor outcomes. The ecosystem services framework provided a more comprehensive understanding of the benefits of active forest management, potentially enhancing collaborative partnerships and supporting restoration activities.

The Drink Project

The Drink planning area (also on the Deschutes National Forest) is a 17,000-acre area located on the eastern slopes of the Cascade Range and provides a number of key ecosystem services including drinking water for the city of Bend, Oregon (Fig. 2), habitat for a threatened wildlife species (northern spotted owl), and a number of important recreational services (Smith et al. 2011). This project analyzed the effects of fuel treatments designed to reduce fire hazard on ecosystem services that were identified as the most important values of this study area. Tradeoffs between the provision of the ecosystem services of water quality, northern spotted owl habitat protection, and fire hazard reduction were assessed using mathematical models that integrated all these values. Study results in this project area (Kushch-Shroder et al. 2016) showed that management activities planned in areas of high ecological importance, such as northern spotted owl habitat and municipal watersheds, affect the important ecosystem services these areas provide. In the short term, fire hazard reduction led to increases in sedimentation and reduced water quality and some loss of potential northern spotted owl

habitat. However, over the longer term, analysis showed that the loss of water quality and northern spotted owl habitat caused by wildfire would be 30–50 percent less than without any treatments to reduce wildfire hazard. These results provide alternative strategies where various objectives are prioritized differently; thus, they present a wide range of choices to meet different requirements and public demands. The knowledge of forest managers can further refine the suggested management plans, creating well informed and effective management strategies.

The Cool Soda Project

Located on the westside of the Cascade Range of Oregon, the Cool Soda area has a fire regime with a combination of mixed severity and stand replacement. This project area included an approximately 10,000-acre “checkerboard” of Forest Service and private land where universities, tribal members, and a number of government agencies collaboratively engaged in an all-lands framework to assess the broad suite of ecosystem services provided by the landscape (Furtwangler et al. 2012). The intent was to improve management of Forest Service land to achieve ecosystem resiliency, while providing direct socioeconomic benefits to local communities and stakeholders. Several key services were addressed in the planning process, including changes in the volume and quality of timber sold, changes in water quality, sustainable recreation, the provision of special forest products including beargrass (*Xerophyllum tenax*) and huckleberry (*Vaccinium* spp.) valued by tribes, and restoration of fish and wildlife habitat. This project was an outstanding example of cross jurisdictional, public-private management with consultation by tribal governments to sustain cultural resources and has been cited as one of the best examples of an all-lands management approach to provide multiple ecosystem services for diverse stakeholders and partners (Furtwangler et al. 2012).

Sustainable Forest Management is the practice of meeting the forest resource needs and values of the present without compromising the similar capability of future generations (Deal 2018). An ecosystem services framework based on sustainable forest management principles could easily be incorporated into stand-level silvicultural prescriptions and may be a highly effective way to demonstrate the provision of important ecosystem services included in forest assessments and plans. Forest management plans and stand silvicultural prescriptions could include both common ecosystem services provided such as sustainable timber supply, wildlife habitat, or reduced wildfire risk but could also include some services that are undervalued or not typically included in forest management plans or stand silvicultural prescriptions, such as special forest products, cultural values, and recreation use. These services are often overlooked or undervalued in typical management plans, but including them in a silvicultural prescription would be an innovative way to both address the protection of some key ecosystem services identified in forest assessments and develop management plans that could enhance or preserve these services. Identifying these key services in the desired future condition would be a suitable starting point from which silviculturists could develop specific management plans to ensure these services will be maintained into the future.

CONCLUSIONS

Ecosystem services frameworks have emerged as a way of framing and describing the comprehensive set of benefits that people receive from nature including commonly recognized goods like timber and fresh water, as well as processes like climate regulation, water purification, and cultural and aesthetic benefits. In the United States, recent regulations such as the Forest Service 2012 Forest Planning Rule now require the agency to include ecosystem services in assessments and forest plan revisions. The Forest Service has been

exploring the use of an ecosystem services framework to describe forest values provided by federal lands and to attract and build partnerships with stakeholders to implement projects. This framework includes describing the ecosystem services provided by forest landscapes; examining the potential tradeoffs among services associated with proposed management activities; and attracting and building partnerships with stakeholders who benefit from particular services the forest provides.

An ecosystem services framework should not only help transform the agency into a more effective and relevant organization, but it should also bolster external relationships by strengthening the public's investment in Forest Service activities and articulating a management vision in terms of social values. The Forest Service has sought placed-based applications of the ecosystem services framework to national forest management to better illustrate the concept for policy makers, managers, and forest stakeholders. In particular, forest managers and planners want to demonstrate how the ecosystem services concept can be used in national forest assessments and plan revisions, and to implement ecosystem services in local projects. In summarizing applications of an ecosystem services framework to forest- and project-scale implementations, I hope to demonstrate how modifying stand silvicultural prescriptions to include key ecosystem services should be a central part of forest plans and assessments.

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