



United States Department of Agriculture

Integrating Ecosystem Services Into National Forest Service Policy and Operations



Forest
Service

Pacific Northwest
Research Station

General Technical Report
PNW-GTR-943

January
2017

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.

Technical Editors

Robert Deal is a research forester, Pacific Northwest Research Station, Forestry Sciences Laboratory, 620 SW Main Street, Suite 400, Portland, OR 97205; **Lisa Fong** is a hydrologist, State and Private Forestry–Washington office, Cooperative Forestry, 201 14th St. SW, Washington, DC 20250; **Erin Phelps** is a writer/editor, Coconino National Forest, 5075 N Hwy 89, Flagstaff, AZ 86004.

Authors

Emily Weidner is an ecosystem planning specialist and **Jonas Epstein** is an Oak Ridge Institute for Science and Education, Economic Research Fellow, National Forest System–Watershed, Fish, Wildlife, Air and Rare Plants, 201 14th St. SW, Washington, DC 20250; **Tommie Herbert** is a natural resources specialist and **Mary Snieckus** is the Ecosystem Services and Markets Program Lead, State and Private Forestry–Washington office, Cooperative Forestry, 201 14th St. SW, Washington, DC 20250; **Robert Deal** is a research forester, Pacific Northwest Research Station, Forestry Sciences Laboratory, 620 SW Main Street, Suite 400, Portland, OR 97205; **Nikola Smith** is an ecologist and ecosystem services specialist, Pacific Northwest Region and Pacific Northwest Research Station, 1220 SW 3rd Ave., Portland, OR 97204; **Tania Ellersick** is a biological scientist, Forest Management, 201 14th St. SW, Washington, DC 20250; **Greg Arthaud** is a research social scientist, Research and Development, 201 14th St. SW, Washington, DC 20250.

Cover photo: Aspen leaves changing color on the Coconino National Forest, USDA Forest Service. Photo by Mike Elson.

Abstract

Deal, Robert; Fong, Lisa; Phelps, Erin, tech. eds. 2017. Integrating ecosystem services into national Forest Service policy and operations. Gen. Tech. Rep. PNW-GTR-943. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 87 p.

The ecosystem services concept describes the many benefits people receive from nature. It highlights the importance of managing public and private lands sustainably to ensure these benefits continue into the future, and it closely aligns with the U.S. Forest Service (USFS) mission to “sustain the health, diversity, and productivity of the Nation’s forests and grasslands to meet the needs of present and future generations.” In response to growing interest in ecosystem services, the USFS is identifying needs and opportunities to incorporate an ecosystem services approach into its programs and activities. The National Ecosystem Services Strategy Team was chartered in 2013 to collaboratively develop national strategy and policy around ecosystem services and integrate them into USFS programs and operations. In this report, we identify several focus areas for taking advantage of additional opportunities and needs, and summarize some of the ongoing efforts to integrate ecosystem services into USFS policy and operations.

Keywords: Ecosystem services, decisionmaking, policy, USFS planning rule, public benefits, ecosystem services markets.

Integrating Ecosystem Services Into National Forest Service Policy and Operations

Robert Deal, Lisa Fong, and Erin Phelps
Technical Editors

U.S. Department of Agriculture, Forest Service
Pacific Northwest Research Station
Portland, Oregon
General Technical Report PNW-GTR-943
December 2016

Executive Summary

The term “ecosystem services” refers to the regulating, supporting, cultural, and provisioning benefits people receive from healthy natural systems. The ecosystem services concept describes the many benefits people receive from nature. It helps us connect with people as we carry out the U.S. Forest Service (USFS) mission to sustain the health, diversity, and productivity of the Nation’s forests and grasslands to meet the needs of present and future generations. The ecosystem services discipline uses science, analytical tools, and collaboration to help the agency implement a more transparent and inclusive way of pursuing our mission. It provides the Forest Service a frame through which to reveal and address natural and human-caused changes affecting management decisions. The science of measurement and reporting helps define and articulate the value of forests and grasslands to people. Analytical tools help us discover and understand tradeoffs between decisions on the ground. These elements form the basis for more collaborative and effective relationships with people and communities across the urban and rural continuum, helping us meet the needs of a diverse range of partners while sustaining the health of the land.

This report grew from a grassroots effort by Forest Service practitioners interested in exploring and integrating ecosystem services approaches into agency operations. Their efforts resulted in a focus on ecosystem services in the 2012 National Forest System land management planning rule. The planning rule sets forth processes and content requirements to guide the development, amendment, and revision of land management plans to maintain and restore National Forest System land and resource ecosystems while providing for ecosystem services and multiple uses. As the planning rule developed, practitioners recognized the need to develop information and tools about ecosystem services to share across the agency. In 2012, an “Ecosystem Services Champions Forum” met in Portland, Oregon, with 30 cross-deputy Forest Service participants from the National Forest System, Research and Development, and State and Private Forestry. The objectives of the forum were to (1) identify issues, opportunities, and challenges for integrating ecosystem services approaches into the Forest Service; and (2) develop components of a strategy or framework to improve integration of ecosystem services approaches into the agency. Two recommendations emerged: (1) develop a common language and understanding of the ecosystem services concept and clearly articulate this concept both within the agency and with the public, and (2) develop an ecosystem services framework that serves the USFS and U.S. Department of Agriculture missions. Key elements of this framework are to (1) describe the broad suite of benefits provided by public and private lands, (2) highlight connections between management actions and ecosystem services, (3) provide tools for outcomes-based

performance reporting, (4) support integration across program areas, (5) strengthen collaborative decisionmaking among staff and with stakeholders, and (6) support the development of restoration and conservation incentives for private landowners.

To meet the charge established at the Champions Forum, and in acknowledgment of the increasing importance of ecosystem services thinking for the agency, the Associate Deputy Chiefs chartered the National Ecosystem Services Strategy Team (NESST) in 2013. The NESST was established to collaboratively develop national strategy and policy around ecosystem services and integrate them into Forest Service programs and operations. The long-term goal of the NESST effort is to identify how integration of ecosystem services concepts and tools into Forest Service programs can serve agency goals, and to make recommendations for doing so through collaborative strategy and policy. The NESST was rechartered in 2016 with revised objectives: (1) articulate and demonstrate the relevance of ecosystem services concepts across the agency in fulfilling the Forest Service mission; (2) promote an enabling framework of formal policy and informal guidance to support an ecosystem services approach to manage federal, state, private, and tribal forests and grasslands; (3) build capacity and infrastructure across Forest Service deputy areas to manage or secure forests and grasslands to deliver public ecosystem service benefits; (4) design inventory methodologies and data management solutions to improve reporting of ecosystem service flows, benefits, and—where appropriate—values; and (5) foster two-way communication and learning inside and outside the Forest Service regarding ecosystem services and their values to support management objectives and improve outcomes.

Here, we build on past successes and lessons learned to propose an agencywide shift to design, integrate, and implement ecosystem services science, tools, and communications into Forest Service policy and operations. This approach focuses on three key opportunities: (1) consider a broad suite of services in decisionmaking and priority setting, (2) quantify and communicate in terms of benefits to people in measurement and reporting, and (3) connect providers and beneficiaries of ecosystem services through partnership and investments. Each opportunity offers value to the agency and to society but depends on the condition and supply of key ecosystem services. Ecosystem conditions, often measured by ecological indicators, are the current state of critical ecosystem services found in forest and rangelands. These conditions, in concert with human needs and values, are intrinsic to the supply of key ecosystem services that are measured by benefit-relevant indicators. Resulting societal benefits are measured by benefits assessments. Ecosystem condition, ecosystem services supply, and societal benefits all affect policy decisions and actions (executive summary fig. 1).

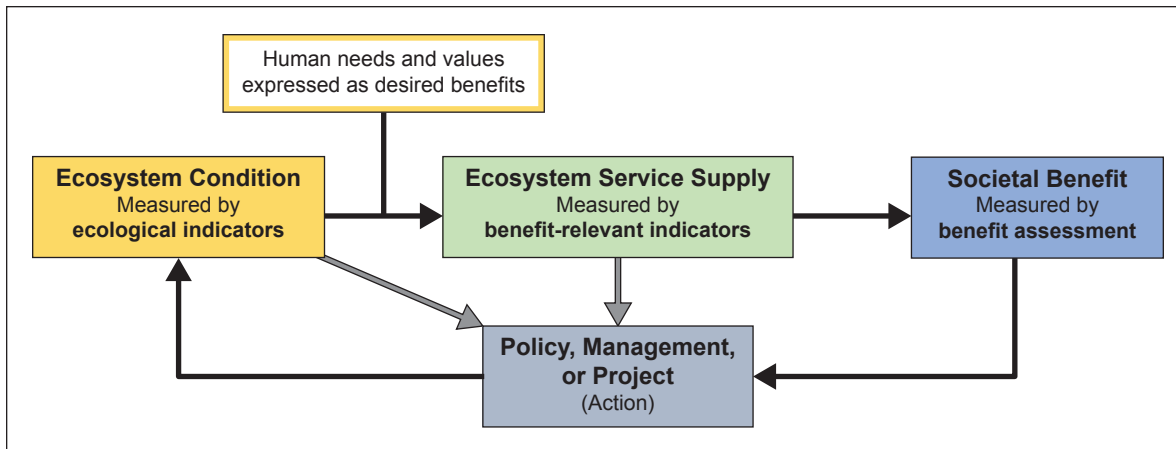


Figure 1—Ecosystems provide ecosystem services, and subsequently societal benefits. The current and desired states of these items inform management actions, which likewise affect the chain of ecological benefits provision. (Modified from Olander et al. 2015.)

We review current examples to identify additional opportunities and needs to be met and provide considerations for ongoing work in integrating ecosystem services into USFS policy and operations. We examine efforts in decisionmaking, priority setting, measuring, reporting, communicating, and investing in ecosystem services. Highlights include the recent support for implementing ecosystem service components of the USFS 2012 National Forest System land management planning rule at the forest level and in collaborations at the project level; incorporation of ecosystem services into the national Inventory, Monitoring, and Assessment framework to examine agency outcomes; and innovation in the development of incentives for increased best management practice implementation on private lands. Our analysis identifies benefits of an ecosystem services approach, including the abilities to leverage partnerships with nongovernmental organizations and private landowners and managers, support private forest conservation and restoration through payments for ecosystem services and markets, enhance connections with the public through a more open discussion on the benefits nature provides, inform more effective decisionmaking, and increase relevancy of the national forests and grasslands to the public.

The Forest Service, as steward of a geographically extensive and ecologically diverse suite of forests and grasslands, is poised to be a leader in the integration of ecosystem services concepts in lands management. This report demonstrates the breadth of opportunity available to the agency. Through the discipline of ecosystem services, NESST is committed to helping the Forest Service pursue its mission to meet the needs of present and future generations of people and natural systems.

Contents

1	Introduction
2	The Ecosystem Services Concept and the Forest Service
2	Development of the Ecosystem Services Concept
5	Potential Added Value to the Forest Service
7	Current Implementation of an Ecosystem Services Approach in the Forest Service
9	Opportunities and Needs
12	Elements of an Ecosystem Services Approach
12	Decisionmaking, Analysis, and Priority Setting
30	Measuring, Reporting, and Communicating
41	Investment in Ecosystem Services
60	Synthesis
60	Overview
62	Common Needs
75	How to Get Involved
77	Acknowledgments
77	References
85	Appendix 1
87	Appendix 2

Introduction

Ecosystem services refers to an internationally recognized concept that describes and frames the comprehensive set of benefits people receive from nature. The prevalence of ecosystem services in natural resource management policy and practice, coupled with recognition of a growing body of related work in the agency, led the U.S. Department of Agriculture (USDA) Forest Service (USFS) to establish the National Ecosystem Services Strategy Team (NESST) to “collaboratively develop national strategy and policy around ecosystem services and to integrate it into Forest Service programs and operations” (NESST 2013). The NESST is composed of USFS employees from State and Private Forestry (S&PF), Research and Development (R&D), and the National Forest System (NFS) deputy areas. In addition to the NESST staff, a broader network of experts from Business Operations, Climate Change, Legislative Affairs, Law Enforcement, USDA partner agencies, and external entities helped develop and refine the content of this strategy document.

The USFS is working to include ecosystem services in planning efforts, develop new metrics for valuing ecosystem services, and support emerging ecosystem services markets. This report is a synthesis document from NESST that illustrates the potential for an ecosystem services approach for the agency. It builds on lessons learned from experimentation and pilot projects, feedback collected from a diverse group of staff, informational interviews with thought leaders and agency program teams, results of facilitated meetings and brainstorming sessions, and desk-based research, along with the knowledge of ecosystem services concepts and USFS policy from NESST staff members. This report is organized into three main sections: “The Ecosystem Services Concept and the Forest Service,” “Elements of an Ecosystem Services Approach,” and “Synthesis.”

The Ecosystem Services Concept and the Forest Service Development of the Ecosystem Services Concept

Over the past several decades, the concept of ecosystem services emerged as a way to frame and describe the comprehensive set of benefits people receive from nature and of recognizing and valuing the underlying ecosystems functions, processes, and structures that provide these benefits (Brown et al. 2007, Costanza et al. 1998, Daily et al. 1997, Kline 2006). Ecologists popularized the term “ecosystem services” as a way to recognize the value natural processes and products provide to society and their intrinsic importance to public welfare. The concept appeared in the 1960s and 1970s, followed by the use of the term by Ehrlich and Ehrlich (1981) to garner support for biodiversity and sustainable development efforts. In 2005, the internationally recognized Millennium Ecosystem Assessment (MEA) further developed

Ecosystem services refers to an internationally recognized concept that describes and frames the comprehensive set of benefits people receive from nature.

and defined ecosystem services as “the benefits people obtain from ecosystems.” The MEA organized these benefits into four service categories: provisioning, regulating, supporting, and cultural (fig. 1) (MEA 2005):

Ecosystem Services	
Supporting Services <ul style="list-style-type: none"> • Nutrient cycling • Soil formation • Primary production 	Provisioning Services <ul style="list-style-type: none"> • Food (crops, livestock, wild foods, etc ...) • Fiber (timber, cotton/hemp/silk, wood fuel) • Genetic resources • Biochemicals, natural medicines, pharmaceuticals • Fresh water
	Regulating Services <ul style="list-style-type: none"> • Air quality regulation • Climate regulation (global, regional, and local) • Water regulation • Erosion regulation • Water purification and waste treatment • Disease regulation • Pest regulation • Pollination • Natural hazard regulation
	Cultural Services <ul style="list-style-type: none"> • Aesthetic values • Spiritual and religious values • Recreation and ecotourism

Figure 1—The Millennium Ecosystem Assessment used a framework that categorized ecosystem services into provisioning, regulating, cultural, and supporting services. (Reprinted from Millennium Ecosystem Assessment 2005.)

- In the USFS 2012 NFS land management planning rule (planning rule) final directives (Forest Service Handbook [FSH] 1909.12 §13.12), ecosystem services are defined as “a product of functioning ecosystems that affect social, cultural, and economic conditions both within the plan area, in the area(s) of influence and the broader landscape” (USDA FS 2015b). The planning rule’s definition of ecosystem services closely matches MEA’s definition of benefits people obtain from ecosystems, including:

- Provisioning services, such as clean air and fresh water, energy, fuel, forage, fiber, and minerals.
- Regulating services, such as long-term storage of carbon; climate regulation; water filtration, purification, and storage; soil stabilization; flood control; and disease regulation.
- Supporting services, such as pollination, seed dispersal, soil formation, and nutrient cycling.
- Cultural services, such as educational, aesthetic, spiritual and cultural heritage values, recreational experiences, and tourism opportunities.

This ecosystem services approach can be useful to identify and value the benefits people receive from nature (Carpenter et al. 2006) and explain those benefits in the context of ecosystem functions and processes (Fisher and Turner 2008). Considering ecosystem services as “natural capital” leads landowners and managers to regard landscapes as natural assets and ensures that the people who rely on natural functions and processes know their value and the cost of losing them (Collins and Larry 2007, Kline 2006). Although many economists and ecologists have trouble agreeing on the appropriate typology or definition of ecosystem services (Boyd and Banzhaf 2007, de Groot et al. 2002), the critical importance of ecosystem services to society is commonly accepted.

While the MEA (2005) focused attention on the importance of ecosystem services, it also presented evidence that many key services are degrading. Subsequently, there is increasing international interest in enhancing conservation to sustain benefits critical for human well-being including clean water and air, food and sustenance, and support for public health (Costanza et al. 1998, Daily et al. 1997). The value of ecosystem services is recognized on local and global scales (Daily et al. 1997, Farley and Costanza 2010, Kroeger and Casey 2007, LaRocco and Deal 2011)—over 50 governments, 86 private companies, and a number of financial institutions support efforts to factor the value of natural assets into business decisionmaking and national accounting (fig. 2) (Patil 2012, Waage and Kester 2014, World Bank 2012).

Incentive programs, like payments for ecosystem services (PES), are widely recognized as playing an important role in the provision and restoration of many ecosystem services throughout the world (Casey et al. 2006, Deal et al. 2014, Farley and Costanza 2010, Muradian et al. 2010). The PES programs typically offer incentives to farmers and landowners in exchange for managing their land to ensure the provision of specific ecosystem services. These programs are important to many countries in Africa, Asia, and South America, and play a critical role in restoring water, wetlands, and habitat to revive degraded services. These programs are becoming an important economic incentive for maintaining and improving critical ecosystem services for many countries, particularly in the developing world (Farley and Costanza 2010).

Although many economists and ecologists have trouble agreeing on the appropriate typology or definition of ecosystem services, the critical importance of ecosystem services to society is commonly accepted.

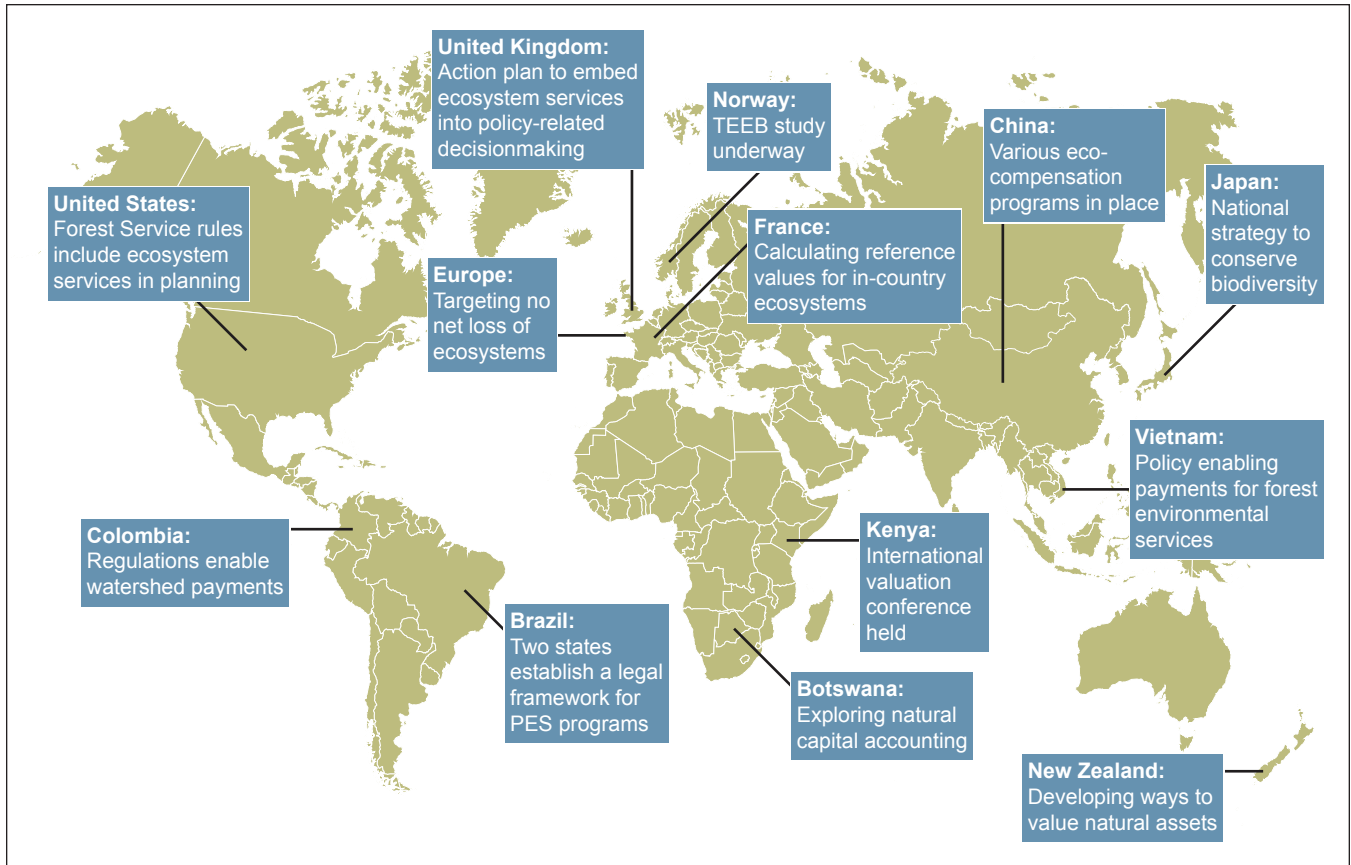


Figure 2—Global public sector activity related to ecosystem services. TEEB = The Economics of Ecosystems and Biodiversity; PES = payments for ecosystem services. (Reprinted from BSR 2014.)

Potential Added Value to the Forest Service

The USFS is in the early stages of applying the ecosystem services concept to operations and management decisions. The concept provides value to the agency in several ways.

Accounting for ecosystem services allows the USFS to value traditional commodities like timber and fresh drinking water as well as services that are more difficult to monetize, such as cultural or aesthetic values.

1. The ecosystem services concept highlights the broad suite of services that national forests provide to the public. It enhances and expands upon multiple-use management by including values from forests and grasslands that are often not captured in traditional forest management accomplishment measures. Accounting for ecosystem services allows the USFS to value traditional commodities like timber and fresh drinking water as well as services that are more difficult to monetize, such as cultural or aesthetic values. Value can include qualitative and quantitative descriptions of public benefits from USFS forests. As this concept becomes more widely understood, its application will improve comprehension of the myriad roles of national forests.

“The promise of an ecosystem service approach is to illustrate the broad suite of public benefits from national forests within the context of multiple scales. An ecosystem services approach gives the Forest Service a compelling rationale for management actions by linking people, nature, and the work we do to maintain and restore healthy ecosystems.”

—*Carl Lucero, USFS Director
Landscape Restoration & Ecosystem Services Research*

2. The ecosystem services concept can help USFS management describe and measure activities as outcomes to complement the output-related targets required by Congress. Agency performance targets and accomplishments are currently reported as readily quantifiable physical outputs, such as board feet of timber sold and acres treated to reduce fuel. Such measures describe management actions without addressing specific objectives such as local jobs created or reducing fire risk for communities. The concept of ecosystem services can help tie output-related targets to the ecological and socioeconomic outcomes meant to be achieved through such targets.

“Where conflicting interests must be reconciled, the question shall always be answered from the standpoint of the greatest good of the greatest number in the long run.”

—*Gifford Pinchot, 1905*

3. An ecosystem services approach can also help agency staff identify and communicate why particular management actions are needed and clarify relationships between the condition of forest ecosystems and the quantity or quality of services they provide. This approach can encourage investigations of the causes of ecosystem degradation or impeded function and help land managers identify where restoration or other actions are most needed and appropriate (Smith et al. 2011).
4. Managing forests and grasslands to sustain ecosystem functions and processes with a focus toward ecosystem services encourages a cross-disciplinary and landscape-scale perspective. This approach can help land managers analyze project impacts across resource areas and boundaries, and consider potential tradeoffs among ecosystem services provided, rather than focusing solely on one objective or working in independent and isolated programs. This will translate into clearer priorities and shared goals across geographic and programmatic boundaries.

The concept of ecosystem services can help tie output-related targets to the ecological and socioeconomic outcomes meant to be achieved through such targets.

An ecosystem services approach can encourage investigations of the causes of ecosystem degradation or impeded function and help land managers identify where restoration or other actions are most needed and appropriate.

Understanding which ecosystem services are valued most highly in a community, and clarifying the rationale for management actions, will help the USFS to develop and implement plans in collaboration with people and communities, and to better manage the resources entrusted to the agency.

5. The ecosystem services approach can help the agency better understand the human values related to natural resources and share information about how ecological conditions relate to those values. Seeking to understand what people value, and why, can help USFS staff prioritize objectives by evaluating tradeoffs to balance needs. Dialogue can be enhanced by highlighting connections between public values, the condition of the land, and management steps that may be needed to sustain landscape functions over time. Identifying and evaluating these values can help to foster collaboration around forest management and increase transparency and trust in agency decisions. Seeking out community values provides the basis for the USFS social license, or “social contract” in the words of Gifford Pinchot, the first Chief of the Forest Service. Understanding which ecosystem services are valued most highly in a community, and clarifying the rationale for management actions, will help the USFS to develop and implement plans in collaboration with people and communities, and to better manage the resources entrusted to the agency.
6. Lastly, an ecosystem services framework, if implemented collaboratively, can strengthen relationships among communities, tribes, private stakeholders, and other organizations by defining common natural resource stewardship objectives. Identifying the services a landscape provides and understanding human use and dependency on those services is inherent in an ecosystem service approach (Collins and Larry 2007). By providing a clear framework for describing these relationships, the ecosystem services concept can enhance collaboration and dialogue among interest groups with shared stewardship goals (Smith et al. 2011). Describing the outcomes of USFS actions as the ecosystem services that various stakeholders value will demonstrate the relevance of the agency and its dual commitment to the land and people.

Current Implementation of an Ecosystem Services Approach in the Forest Service

The NESST works with a wide assemblage of collaborators including participants of the USFS Ecosystem Services Evaluation Framework (ESEF) team, the USDA Office of Environmental Markets, the Natural Resource Conservation Service Ecosystem Services Strategy Development Team, and the early adopter forests for the 2012 planning rule (USDA FS 2012a). Through consultation with federal partners, collaborating universities, and other cooperators, NESST is helping the USFS to develop a number of ecosystem services projects across the agency. With the coordination of NESST, the agency is considering inclusion of ecosystem services in forest planning, inventory and data management, research and development, and collaborative initiatives within and external to the agency.

Through consultation with federal partners, collaborating universities, and other cooperators, NESST is helping the USFS to develop a number of ecosystem services projects across the agency.

Forest planning—

Ecosystem services are now codified in the 2012 planning rule 36 CFR §219 (USDA FS 2012a). This rule requires land management plans to guide national forests toward the provision of ecosystem services and multiple uses to benefit people, both presently and in the future. This approach is consistent with the Multiple-Use Sustained-Yield Act of 1960 (16 U.S.C. 528-531), which is intended to sustain the goods and services forests provide and maintain the long-term productivity of the land (app. 1). The ESEF was created by Ecosystem Management Coordination staff to support implementation of these policies. The ESEF develops resources for managers about how best to incorporate ecosystem services in forest planning and project development. A USFS cross-deputy area working group is developing this framework and assisting national forests that are “early adopters” of the 2012 planning rule. The ESEF led workshops for the Nez Perce-Clearwater, Flathead, and El Yunque National Forests in 2013 and for the Helena and Lewis and Clark National Forests in 2014.

Inventory and data management—

The Inventory, Monitoring, and Assessment program within the NFS is addressing existing data needs and national monitoring questions. Foremost among these needs is a means of measuring and reporting ecosystem services. Furthermore, the Office of Management and Budget (OMB) requested that the USDA, U.S. Department of the Interior, National Oceanic and Atmospheric Administration, and U.S. Environmental Protection Agency (EPA) provide an inventory of current or planned activities that contribute to the identification, assessment, valuation, and use of ecosystem services.

Research and development—

The USFS is actively applying an ecosystem services approach in local urban areas (e.g., Baltimore and New York City), in regional studies (i.e., Southern Forest Futures Project, Forests to Faucets), and in national efforts such as the cross-agency Biodiversity and Ecosystem Services Trends (BEST) assessment. In 2011, the President’s Council of Advisers on Science and Technology (PCAST) called on federal agencies to better integrate natural resources data (PCAST 2011). Forest Service data (e.g., Forest Inventory and Analysis [FIA]) and tools are being incorporated into cross-agency efforts such as EnviroAtlas and the Climate Tools initiative. Collection of this information could be an ongoing effort, which would allow an up-to-date assessment of current and past USFS efforts and opportunities for further collaboration.

Collaborative initiatives—

In addition to partnerships already mentioned, staff from the USFS R&D, S&PF, and NFS deputy areas are participating in national discussions about applications of ecosystem services concepts to land management, including through the 2014 National Ecosystem Services Partnership (NESP). The NESP is an initiative of Duke University's Nicholas Institute for Environmental Policy Solutions. It was developed in collaboration with the EPA and the Moore Foundation to promote dialogue about ecosystem services applications to resource planning and management.

The U.S. Forest Service (USFS) actively works with urban communities on their forests. This work includes determining the ecosystem services (environmental benefits) of urban trees. Research by USFS scientists, including Greg McPherson (Pacific Southwest Research Station) and Greg Nowak (Northern Research Station), has helped to evaluate the benefits of trees for reducing air pollution, urban heat and noise, and road maintenance costs; increasing property values; sequestering carbon; and improving aesthetics. These values are documented in various research publications. Many are also included in the i-Tree software suite, an urban forestry analysis and benefits assessment tool that is used by thousands of communities throughout the world. This work on urban ecosystem services is helping the agency connect the values of trees and forests to a larger population.

Opportunities and Needs

This opportunities-and-needs discussion describes the current state of ecosystem services in analysis, decisionmaking, and priority setting for the agency; and future needs for resource capacity, data integration and management, communication, and policy to implement changes for the agency. The NESST working group is facilitating the pursuit of an agencywide shift to design, integrate, and implement an ecosystem services approach to USFS policy and operations. The NESST reviewed current approaches to ecosystem services within each deputy area (S&PF, R&D, and the NFS) and identified three key elements to integrating ecosystem services into USFS policies and operations:

1. **Consider a broad suite of services in analysis, decisionmaking, and priority setting.** This will involve increasing the integration, transparency, and success of decisionmaking, analysis, and priority setting by linking objectives among the project, forest, program, and national levels.

2. **Quantify and communicate the value of resources and impacts of management actions in terms of benefits to people.** This will involve synchronized measurement, reporting, and communication both internally among USFS management and externally to partners and stakeholders.
3. **Connect providers and beneficiaries of ecosystem services.** This will involve employing available tools to facilitate increased public and private investments in ecosystem services markets, including assessments of benefits provided. Increasing the availability of financing to sustain the supply of human benefits from positive ecological outcomes will create and support synergies between national forests and surrounding communities.

Federal Resources in Management of Ecosystem Services (FRMES):

The Federal Resources in Management of Ecosystem Services (FRMES) guidebook was designed to support ecosystem services assessments among federal agencies. Sponsored by the Duke University Nicholas Institute for Environmental Policy Solutions, the National Ecosystem Services Partnership (NESP) released the FRMES guidebook in January 2015 as part of a coordinated effort to provide a framework in which federal resource agencies could evaluate the ecosystem services of a particular action as part of a robust decisionmaking process. Through a deliberative examination of U.S. Forest Service programs and initiatives, the guidebook has developed credible, scientifically based and peer-reviewed approaches and methods that can be incorporated into existing agency processes and programs.

The assessment framework begins by outlining the critical need for ecosystem services in federal management as a way to describe how agency actions affect the social well-being of people, communities, and economies through their affect

on natural systems functioning. It is intended to be a template that could serve a variety of local- or project-scale decision contexts, from biodiversity management to ecological restoration, risk management, or siting new infrastructure. The guidebook walks the reader through an iterative process from project scoping and development of social indicators to monitoring decision outcomes and weighing tradeoffs through a social impact analysis. It provides visual representations and diagrams, which help land managers assess how a given decision will catalyze multiple outcomes. Additionally, it helps guide planners through quantification and valuation (when appropriate) of marginal changes in key services over time (Urban and Olander 2014).

The framework is generic and intended to align with other decision support methods already in use by academics or consultants. Currently, the authors of the study are working with agency personnel to determine the next steps for providing concrete and agency-specific direction. (See <https://nespguidebook.com/> for more information.)

Consideration of a broad suite of services in analysis, decisionmaking, and priority setting creates opportunities to improve land management practices at the project, forest, state, and national level.

Opportunities—

For each of the three elements listed above, NESST identified specific opportunities to improve the impact and enhance the efficacy of USFS activities by incorporating ecosystem services concepts or tools:

Consideration of a broad suite of services in analysis, decisionmaking, and priority setting creates opportunities to improve land management practices at the project, forest, state, and national level. Identifying the ecosystem services affected by planned activities at each of these scales enables decisionmakers within and external to the USFS to more completely assess the tradeoffs of various management options and target interventions to maximize public benefits. It also helps increase the transparency of national strategies and project activities. Furthermore, considering a broad suite of services at both the state and national levels and ecologically relevant scales (such as ecoregions) could serve to highlight the interconnectivity of landscapes and foster innovative collaboration among beneficiaries and providers.

To actualize this approach to planning and decisionmaking, the USFS first must build internal capacity and leverage capacity of other agencies in quantifying and communicating the value of ecosystem services in terms of benefits to people. The USFS manages 193 million acres of forest and grassland across the United States. Focusing on the benefits to people could allow the agency to better demonstrate the relevance of its programs and resources and illustrate the positive impacts of USFS initiatives on society at large. An understanding of the value USFS management actions deliver to people outside of the NFS boundary could help promote successful outreach to local communities, Congress, and partner organizations. Capturing and depicting this value could also create opportunities for the agency to shift its internal approach to gathering and storing data, measuring performance, and assessing the status and health of the Nation's natural resources. Enhancing data quality could unlock the potential of ecological and economic scenario analysis using predictive geospatially linked models and decision-support tools. Quantifying and communicating this in terms of benefits to people necessitates monitoring outcomes, rather than outputs, from USFS activities. This could help the agency reorient its benchmarking efforts from the "what" toward the "why" of forest and grassland stewardship.

The agency's expertise in land management, combined with the significant influence it brings to bear as a federal agency, makes it uniquely well-positioned to connect providers and beneficiaries of ecosystem services. Connecting providers and beneficiaries through innovative partnerships could allow the agency to generate increased investment in the delivery of ecosystem services to the public. The \$33 million Denver Water Partnership is one example of bringing together USFS landscape stewards and local drinking water providers to invest in proactive watershed management. This kind of partnership could enrich the impact of stewardship contracting and cooperative forestry programs by incentivizing and rewarding the delivery of valuable ecosystem services by land managers. This approach could also slow the loss of ecological values by incorporating ecosystem services into natural resource damage assessments.

Needs—

Each of the three key elements of an ecosystem services approach presents myriad opportunities to bolster the USFS mission through innovation, collaboration, and integration. However, capitalizing on this array of opportunities entails overcoming numerous challenges. Each opportunity requires certain conditions or actions to facilitate success. With this in mind, this report identifies the unique needs that must be addressed to make each of the aforementioned opportunities a reality. Focusing on these needs could enable the USFS to improve implementation of an ecosystem services approach and the development of applicable tools while increasing productivity across the agency. Four categories of needs include:

1. **Resources and capacity for cooperation:** Increasing the availability of resources, capacity of staff, and overall agency infrastructure to support cooperation across deputy areas around an ecosystem services approach.
2. **Data integration and management:** Surveying, testing, and expanding ecosystem services data collection, performance measures. This includes an evaluation of existing analytical tools and methodologies to implement an ecosystem services approach.
3. **Communication:** Promoting consistent communication across all levels of the USFS to articulate a cohesive and compelling mission to USFS staff and the public, potentially reaching new audiences.

The agency's expertise in land management, combined with the significant influence it brings to bear as a federal agency, makes it uniquely well-positioned to connect providers and beneficiaries of ecosystem services.

4. **Policy:** Developing clear and strong guiding language in new and existing policies to create an authorizing environment and, where appropriate, mandates for integrating ecosystem services into USFS operations.

The integration of opportunities and needs for the agency and implementation and coordination across Forest Service deputy areas will be a critical component for success. In particular, coordination of ecosystem services provision and communication across NFS, S&PF, and R&D will be essential. The following sections describe the key elements of an ecosystem services approach for the agency and highlight decisionmaking, priority setting, measuring, reporting, and communicating investments in ecosystem services.

Elements of an Ecosystem Services Approach

Decisionmaking, Analysis, and Priority Setting

Consider a broad suite of services in decisionmaking, analysis, and priority setting—

The USFS is extensively involved in decisionmaking, funding allocations, and priority setting for both public and private forests. An ecosystem services approach can support all of these activities while increasing transparency in the decision-making process. The ecosystem services concept can help explain critical benefits provided by forests, tradeoffs among competing values, and the rationale for management decisions. This can more effectively engage the public in information exchange and enhance adaptive management and monitoring activities after implementation of a strategic course of action.

The 2012 NFS land management planning rule states that revised plans must contain integrated management components to provide for ecosystem services and multiple-use management. The rule requires that forest plans “guide management of [NFS] lands so that they...have the capacity to provide people and communities with ecosystem services and multiple uses that provide a range of social, economic, and ecological benefits for the present and into the future” (USDA FS 2012a). Ecosystem services have become a prominent part of the agency’s work in revising and amending land management plans (described later in this section). Specific examples of forests applying the 2012 rule are mentioned here and in the “Synthesis” section of this report. Other efforts to incorporate ecosystem services into decisionmaking processes include consideration of benefits in project-level National Environmental Policy Act (NEPA) analyses and helping states integrate ecosystem services flows, benefits, and values in their statewide Forest Action Plans. Separate detailed reports and products, including syntheses and guides, are being developed to compile lessons learned from these early efforts and support practitioners with implementation (e.g., Kretchun et al., in press).

This section provides an overview of opportunities for integrating ecosystem services into the following USFS decisionmaking, analysis, and priority-setting processes:

5. **National program (or resource area) priority setting:** Using ecosystem services to inform national program direction, priorities, and funding decisions.
6. **Land management planning:** Developing components in land management plans that provide for management of ecosystem services within the planning area.
7. **Project-level NEPA:** Framing projects in terms of ecosystem service goals and outcomes.
8. **State Forest Action Plans:** Working with states to highlight and conserve public benefits provided by state and privately owned forests.

National program priority setting—

The ecosystem services concept reflects the Forest Service motto of “caring for the land and serving people” by highlighting relationships between nature and human well-being. Understanding connections between ecological conditions, landscape functions, and public benefits can inform USFS priorities and help the agency better target its actions to achieve ecologically and socially beneficial outcomes. Ecosystem services can be used as a tool to help allocate funding to regions, forests, and projects; prioritize and establish annual goals/targets; assess tradeoffs between proposed activities; and calculate future costs avoided by current interventions. An ecosystem services approach can help program leaders develop strategies across program areas as well as temporal and geographic scales to efficiently achieve interdisciplinary objectives.

Examples—

- **The Hazardous Fuels Prioritization and Allocation System (HFPAS)** is a systematic process for U.S. Department of the Interior agencies and the USFS to allocate hazardous fuels reduction funds to high-priority projects and areas. The HFPAS can use ecosystem services to create a national strategy for targeting regions with high-intensity fire risk that merit immediate treatments. The system can consider the ecosystem service impacts of high-intensity fires such as diminished water quality in municipal drinking supplies, aesthetic damage to viewsheds in recreation areas, degradation of critical habitat, and threats to air quality in local communities (Thorsen 2011). This is a standout example in considering ecosystem services in decisionmaking.
- **The Watershed Condition Framework (WCF)** is a USFS method for improving the health of priority watersheds on national forests and grasslands by implementing integrated restoration activities. The main goals

of the WCF are to provide potential partners and investors with details on watershed restoration needs and to increase public awareness of local watershed conditions. The WCF establishes a consistent and accountable approach for classifying watershed conditions using 12 indicators, “representing underlying ecological, hydrological, and geomorphic functions and processes that affect watershed condition.” Framing these indicators through the associated impacts on ecosystem services can help the USFS communicate with partners and the public regarding the social and economic value of particular watersheds.

The NFS has partnered with the University of Oregon on selected pilot forests to help incorporate social and economic indicators and link WCF restoration efforts with public benefits including job creation, employment, benefits to local businesses, and capacity building. The USFS is in the process of assessing the viability of collecting related data for all forests, as well as how this information could be used to guide restoration decisionmaking. The WCF has helped guide three USFS regions in the Integrated Resource Restoration pilot program that was started in 2012 to help integrate and prioritize landscape-scale restoration and coordinate efforts across program areas.

- **The Forest Legacy Program** provides grants to encourage long-term stewardship of nonindustrial private forest lands through active management of forest resources (USDA FS 2013). Ecosystem services outcomes in priority regions could be used as a framework to evaluate project applications. Proposals could include a description or calculation of the current status of ecosystem services before a project begins, and the projected benefits resulting from project activities in the assessment of need (e.g., Western Environment and Ecology, Inc. 2006). This could allow the USFS to maximize the impact of its financial support for public environmental benefits.
- **The Collaborative Forest Landscape Restoration Program (CFLRP)** is one of several USFS programs highlighting connections between restoration and community benefits. Other programs include the Mokelumne Watershed Avoided Cost Analysis, Forest to Faucets mapping, Forests on the Edge, the Accelerated Restoration initiatives, and municipal watershed investments. These programs can use discrete ecosystem service metrics to characterize human values in watershed risk and restoration. Public benefits and avoided costs resulting from restoration actions can be used to inform priority setting and incentivize partnerships.

- **The S&PF's Urban and Community Forestry program** emphasizes the ecosystem services provided by healthy trees (e.g., clean air, carbon storage, municipal energy savings, etc.) while providing tools and guidance on how to translate these benefits to the broader public.

Envisioning the future—Incorporating consideration of ecosystem services into national programs and priority setting can help the USFS frame its mission in terms of both ecological sustainability and public benefits. This approach has the potential to strengthen connections with the public and encourage integration across program areas and policies. An ecosystem services framework can help the agency integrate multiple USFS national efforts such as national natural resource management goals (WCF, habitat restoration, timber production, and others), the Climate Change Scorecard, the Integrated Resource Restoration program, the Mitigation Policy strategy, the R&D Tribal Engagement Roadmap, and the Woody Biomass Initiative, which link USFS efforts to global efforts (e.g., the Bonn Challenge—see text box). As a first step, the USFS can explore how information within existing program structures can be used to consider ecosystem services and tradeoffs across alternatives for national policy. The agency may also need to develop capacity to articulate connections between biophysical information and ecosystem services—e.g., what benefits does reforestation provide for municipal water utilities? How does soil restoration increase forest productivity, improve habitat, or enhance drinking water quality? How can the use of urban trees improve air quality? Sometimes the USFS can highlight these relationships qualitatively using staff expertise. The agency can also work with partners to develop analytical tools and monitoring systems to track these relationships and help communicate with stakeholders.

The Bonn Challenge

In 2011, a ministerial roundtable established the Bonn Challenge, a call for the restoration of 150 million hectares of lost forests and degraded lands worldwide by 2020. This practical action-oriented platform facilitates the fulfillment of the Millennium Development Goals and the implementation of several existing international commitments that require restoration, including the Convention on Biological Diversity Aichi Targets, the United Nations Framework Convention on Climate Change Reducing Emissions From Deforestation and Forest Degradation goal, and the Rio+20 zero-net land degradation target. The U.S. Forest Service pledged to restore 15 million hectares of degraded forestland, which is the largest countrywide commitment contributing to ecosystem services.

Land management planning—

Land management planning for national forests and grasslands is the principal process used by the Forest Service to determine how these lands will be managed and what uses are permissible. Today all national forests and grasslands (except for those newly established) already have existing land management plans. The focus is on the revision of the existing land management plans with greater understanding of the role of ecosystem services.

Legal background—The Forest and Rangeland Renewable Resources Planning Act of 1974 authorizes long-range planning by the Forest Service to ensure the future supply of forest resources while sustaining the environment. Planning is based on periodic “comprehensive assessment of ... renewable resources through analysis of environmental and economic impacts.” The 1976 National Forest Management Act (NFMA) (16 U.S.C. §1604 (e)(1)) directs that each unit of the NFS shall have land management plans that provide for multiple use and sustained yield of products and services in accordance with the Multiple Use Sustained Yield Act (MUSYA) (16 U.S.C. §528). Permits, contracts, and other instruments for the use and occupancy of NFS lands must be in alignment with land management plans (16 U.S.C. §1604 (i)). The MUSYA calls for national forests and grasslands to be managed for “outdoor recreation, range, timber, watershed, wildlife and fish purposes.” The MUSYA further defines multiple use as “management of all the various renewable surface resources of the NFS.”

There is substantial overlap between provisioning services and the multiple uses identified in the MUSYA. Addressing ecosystem services in forest planning serves the intent of the NFMA and the MUSYA by addressing benefits provided by forests that are not typically associated with multiple uses, particularly supporting, regulating, and cultural services (Kline et al. 2013). Incorporating ecosystem services into consideration of ecological, social, and economic goals can enrich these analyses and strengthen understanding about connections between natural resource management and public benefits. Framing forest management in terms of ecosystem services also highlights how the management of national forests and grasslands contributes to human well-being in a broader landscape.

Planning rule authority—The 2012 NFS land management planning rule (36 C.F.R. §219) is the regulation developed by the USFS to implement planning required by the NFMA. The purpose of the planning rule is:

...to guide the collaborative and science-based development, amendment and revision of land management plans that promote the ecological integrity of national forests and grasslands and other administrative units of the National Forest System (NFS). Plans will guide management of NFS lands

so that they are ecologically sustainable and contribute to social and economic sustainability; consist of ecosystems and watersheds with ecological integrity and diverse plant and animal communities; and have the capacity to provide people and communities with *ecosystem services* [emphasis added] and multiple uses that provide a range of social, economic and ecological benefits for the present and into the future (36 C.F.R. §219.1(c)).

The planning process is defined in this rule as consisting of three major phases:

1. Phase 1: Assessing available information relevant to the plan that is summarized in an assessment report.
2. Phase 2: Developing, revising, or amending the plan itself.
3. Phase 3: Implementing the plan through a set of projects and activities and monitoring the results of this implementation in the area governed by the plan.

Public participation and use of best available scientific information are required throughout all three phases.

The 2012 planning rule defines ecosystem services as

“Benefits people obtain from ecosystems, including:

1. *Provisioning services*, such as clean air and fresh water, energy, fuel, forage, fiber, and minerals;
2. *Regulating services*, such as long-term storage of carbon; climate regulation; water filtration, purification and storage; soil stabilization; flood control; and disease regulation;
3. *Supporting services*, such as pollination, seed dispersal, soil formation, and nutrient cycling; and
4. *Cultural services*, such as educational, aesthetic, spiritual and cultural heritage values, recreational experiences and tourism opportunities (36 C.F.R. §219.19).”

The planning rule requires specific consideration of human benefits obtained from the plan area (ecosystem services) in the assessment (36 C.F.R. §219(b)(7)). Plans revised under the planning rule must contain integrated plan components to provide for ecosystem services and multiple-use management (36 CFR §219.10(a)). Thus the rule provides legal support for ecosystem services as a facilitating approach for collaborative and science-based planning.

Planning directives—The final USFS planning directives to implement the 2012 planning rule consist of the Forest Service Manual (FSM) 1920 and Forest Service Handbook (FSH) 1909.12. They contain the agency’s policy for developing, revising, and amending land management plans, and the content to be included in those plans. Themes related to specific ecosystem services (e.g., recreation or timber) can

The focus on key ecosystem services is intended to prevent the planning process from investing too much time or energy on ecosystem services that are of minimal importance or would not be affected by the plan.

be found throughout the directives, and ecosystem services are specifically discussed in the FSH (assessment in chapter 10, §13.12; and the land management plan in chapter 20, §23.21(b)).

The directives focus the planning process on a set of priorities, or key, ecosystem services to be identified and evaluated for forest plan assessments in individual forests (fig. 3). The assessment phase of planning serves this purpose by identifying the key services that will be addressed by plan components. Key services are also expected to be used in the comparison of alternatives in the environmental impact statement. Key ecosystem services are defined as:

Ecosystem services provided by the plan area that are important in the broader landscape outside of the plan area and are likely to be influenced by the land management plan (FSH 1909.12, zero code chapter, §05).

The focus on key ecosystem services is intended to prevent the planning process from investing too much time or energy on ecosystem services that are of minimal importance or would not be affected by the plan. Engagement with the public is an important process to determine the key services of concern. The directives (FSH 1909.12, chapter 10) indicate that the assessment needs to identify and evaluate available information about each of the key ecosystem services. This information can include the following:

- The conditions and trends of the key ecosystem service.
- The drivers and stressors (§12.3 and 13.13) likely to affect future demand for and availability of the key ecosystem service.



USDA Forest Service

Figure 3—National forests provide a broad suite of key ecosystem services including timber, water, recreation, and cultural values.

- The current conditions and trends of the ecosystems or key characteristics of ecosystems (§12.14) that currently maintain the plan area’s key ecosystem service.
- The influence of lands outside the plan area or other conditions beyond the authority of the Forest Service that influence the plan area’s ability to provide the key ecosystem service.
- The relationship of the key ecosystem service to social, cultural, and economic conditions (§13.12 and 13.23).

The planning rule requires that land management plans include “plan components, including standards or guidelines, for integrated resource management to provide for ecosystem services and multiple uses in the plan area” (36 CFR §219.8 and 219.9). Plan components (desired conditions, objectives, suitable uses, standards, guidelines, and goals) govern subsequent project and activity decisions. The directives’ approach is that the set of plan components provides for the key ecosystem services. This does not necessitate providing unique plan components for every key ecosystem service, but there should be a linkage between each of the key services and the plan components (FSH 1909.12 chapter 20 §23.21b).

The plan must also characterize the distinctive role and contribution of the plan area to the local area, region, and nation (36 C.F.R. §219.2(b)). This distinctive role and contribution can include unique attributes related to uses, values, and products as well as influences on social, economic, and ecological sustainability. Some key ecosystem services may be recognized as part of this distinctive role and contribution.

The final phase of plan revision is development of a monitoring plan, which is intended to track plan effectiveness. Although it is not explicitly required, making connections between monitoring questions, data, and key ecosystem services will serve to evaluate plan efficacy. This need not involve collection of copious data—rather, monitoring can help frame available data to evaluate the contribution of ecosystem services in social and economic as well as ecological terms.

Ecosystem Management Coordination (EMC) is engaged in several efforts to share information with staff about the intent of the planning rule and provide resources for implementation. The ESEF team has developed a variety of tools and advice bulletins regarding selection and quantification of ecosystem services (if desired), examples of economic and ecological indicators for monitoring, and workshops for forests embarking on plan revision. Because EMC does not prescribe a particular approach, these tools can be applied in a variety of ways, and implementation differs. Forest Service staff are also compiling lessons learned at regional levels for use by forests as they begin the revision process (e.g., Kretchun et al., in press).

Land Management Planning Under the 2012 Rule: Early Examples

Seven national forests (NF) were selected in 2012 to be the first to revise their land management plans using the 2012 planning rule: the Nez Perce and Clearwater NFs (Idaho); the Chugach NF (Alaska); the Cibola NF (New Mexico); the Inyo, Sequoia, and Sierra NFs (California); and the El Yunque NF (Puerto Rico). Most of these forests have completed draft assessments and released them to the public. Several of these early adopter forests are developing draft plan components that address ecosystem services, and some are considering strategies to analyze potential changes in ecosystem services and conduct tradeoff analyses. Key participants in these efforts have been U.S. Forest Service staff at individual units, regional offices, and enterprise units (Miller et al. 2014).

The 2012 planning rule does not prescribe precisely how to approach ecosystem services assessments and plan components; therefore, early adopter treatment of the concept differs considerably. Efforts are underway to capture lessons learned as forests embark on plan revision under the rule.

Early Adopter Spotlight: El Yunque National Forest, Puerto Rico

The El Yunque NF offers one of many examples for addressing ecosystem services in plan revision. Colleagues from the urban tropical El Yunque NF, the USFS Southern Research Station, and community leaders from eight neighboring municipalities worked together to identify local stakeholders' perspectives on the benefits the El Yunque provides. The research project (1) assessed stakeholder knowledge of local ecosystem services, (2) documented the geographic distribution of land cover around El Yunque and its effect on the forest's ecosystem services, (3) developed geospatially linked data on priority areas for ecosystem service provision to support planning, and (4) explored the potential role of landowner incentive conservation programs in areas adjacent to the forest. Research project participants also identified change drivers affecting El Yunque's ecosystem services.

Building on this foundation, the Ecosystem Services Evaluation Framework team, members of the National Ecosystem Services Strategy Team, Forest Management Office staff, and the El Yunque Forest Plan Revision Team met in 2013 to identify and assess key ecosystem services. The group selected key services provided by El Yunque and discussed the conditions, trends, and risks for each. Participants selected analytical tools and methods for assessing and evaluating tradeoffs among these services. They demonstrated that simultaneous consideration of processes, functions, benefits, and trends can support better informed planning activities and future project-level decisions (Miller et al. 2014).

Envisioning the future—A forest plan may characterize ecosystem services in qualitative, quantitative, or economic terms, depending on data availability, planning objectives, and context. A critical next step is to determine how existing data and models can be applied to characterize changes in ecosystem services at various scales within a forest planning area. Framing management objectives and effects in terms of ecosystem services provides opportunities for outcomes-based performance monitoring and reporting. However, these processes should build on existing infrastructure and be cost-effective, accessible, and scientifically defensible. Through an iterative and adaptive process, forest managers can use an ecosystem services framework to clearly delineate and demonstrate the value of forest and grassland conservation and management in contributing to a broad spectrum of social, ecological, and economic benefits to communities.

Project-level decisionmaking through the NEPA process—

Legal authority—The National Environmental Policy Act of 1970 (NEPA) (42 U.S.C. §4321) seeks to foster “productive harmony” between humans and nature. The regulation references the “human environment” interpreted “to include the natural and physical environment and the relationship of people with that environment” (40 C.F.R. §1508.14 as quoted by Bear 2014). This relationship is central to the ecosystem services concept. Federal agencies are directed by Congress to “utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences...in planning and decision-making” (42 U.S.C. 4332(A)). The NEPA also requires public participation in environmental analyses of project-level impacts, which highlights the relevancy of relating impacts directly to human well-being.

Current efforts and guidance—The 2012 planning rule (§219.10, §219.10(a)(1), §219.8(b)(3)) requires that a land management plan include components for integrated resource management to provide for ecosystem services and multiple uses. Forest plans provide the context for project-level management. Key services are identified in the Forest Plan Assessment to help establish the purpose and need for revising a forest plan. The USFS does not formally require staff to address ecosystem services at the project level. However, some projects may tier to or reference key services in their rationale for action. National forests using plans developed under the 1982 NFS land and resource management planning rule may find it beneficial to address ecosystem services at the project level, particularly for complex or landscape-level actions.

Individual national forests and ranger districts are exploring various beneficial applications of ecosystem services in the Forest Service NEPA process, represented in figure 4. Ecosystem services can support the proposal development phase of NEPA by making connections between ecological conditions, goods and services, and the

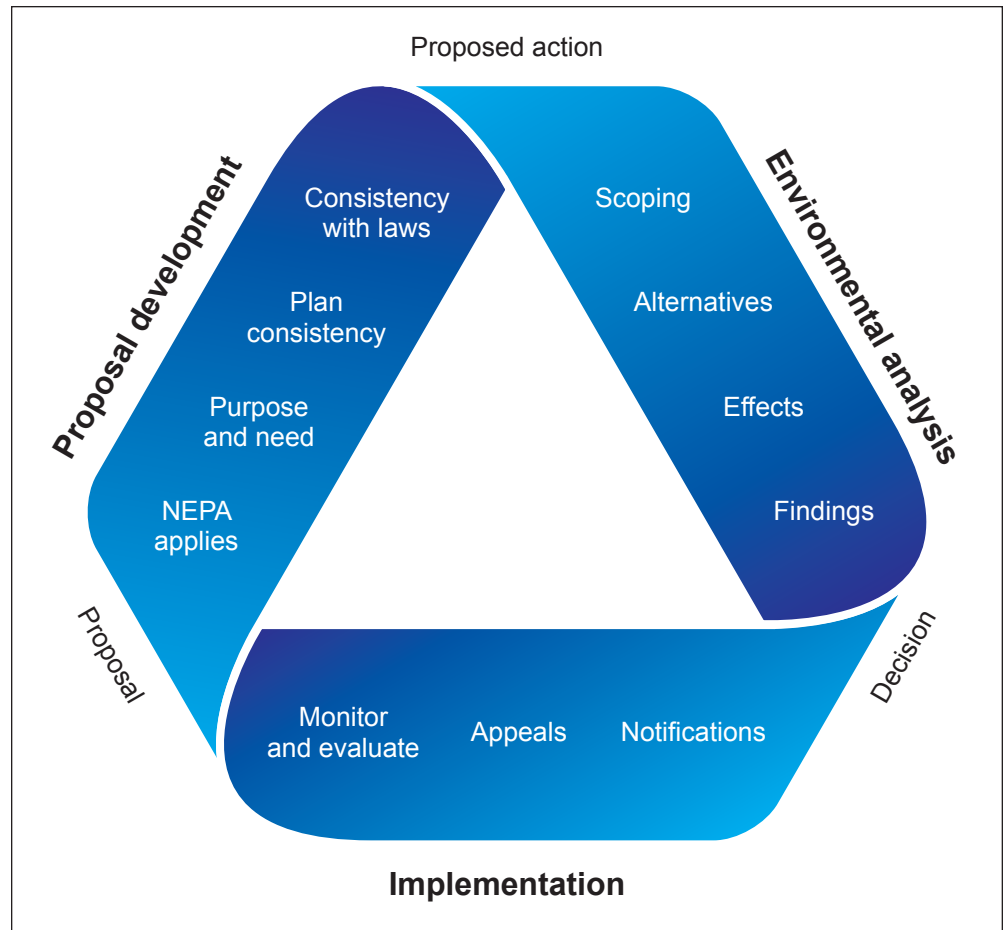


Figure 4—The Forest Service National Environmental Policy Act (NEPA) Planning Model showing different phases of proposed NEPA action: proposal development, environmental analysis, and implementation. Reprinted from the Forest Service Handbook 1909.15.

Ecosystem services should be seen as a tool to support management decisions, rather than adding burdensome analyses. Addressing ecosystem services in the “pre-NEPA” phase can support proposal development and contribute to a project’s success by communicating relevance and engaging the public.

purpose and need for action. In other words, ecosystem services can help “tell the story” of what’s occurring on the landscape and why management is needed in meaningful terms. Several Forest Service units are engaging the public earlier in planning processes to strengthen participation in project design. Ecosystem services can be applied in these efforts to underscore connections between the land and peoples’ values, and demonstrate how USFS management actions relate to those values.

Most Forest Service decisions are Categorical Exclusions or Environmental Assessments, which do not require economic and social impact analysis. Many staff are working to streamline the NEPA process, rather than add unnecessary process. With this in mind, ecosystem services should be seen as a tool to **support** management decisions, rather than adding burdensome analyses. Addressing ecosystem services in the “pre-NEPA” phase can support proposal development and contribute to a project’s success by communicating relevance and engaging the public.

The USFS is involved in collaborative efforts with other federal partners to explore methodologies and lessons learned for supporting the intent of NEPA through ecosystem service applications. Chartered as a partnership between the EPA and Duke University’s Nicholas Institute for Environmental Policy Solutions (NESP), the NESP connects directly with public agencies and private sector experts to strengthen coordination of policy, market implementation, and research in the field of ecosystem services. Most recently, NESP focused its attention on creating a federal guidebook (Federal Resource Management and Ecosystem Services Guidebook) to “develop credible approaches for incorporating ecosystem services into natural resource planning and management” (NESP 2014). The guidebook was developed in close collaboration with the USFS, which contributed several case studies and peer review. This resource explores opportunities and existing ecosystem service planning developments within federal land management agencies at various scales, identifies data and modeling infrastructure necessary for a fully integrated framework, and lays out a methodological approach for ecosystem service evaluation and analysis at a project- or landscape-specific level, from scoping through decision-support and

Deschutes National Forest: Early Applications

“Using an ecosystem services perspective is like moving from black and white to full-spectrum color, in terms of the richness of analysis and the ability to communicate it to the public.”

—*John Allen, Supervisor, Deschutes NF*

In 2009, the Deschutes National Forest in Oregon partnered with the Pacific Northwest Research Station to establish a management framework that could address the full suite of ecosystem services provided by the forest. Staff identified several potential benefits of applying ecosystem services to planning at various levels, including:

- Highlighting a diverse set of benefits
- Supporting integration across disciplines
- Understanding tradeoffs
- Attracting and building partnerships
- Strengthening public engagement

In 2011, the Crescent Ranger District launched a pilot to test the use of ecosystem services in National Environmental Policy Act (NEPA) project planning. The Marsh Project was completed in four phases: education and outreach about the ecosystem services concept (see fig. 6, p. 31), discussion

of prioritized value perceptions, drawing connections between values and ecological conditions, and development of an organizational framework to translate values into discrete NEPA-proposed actions. This project is exploring how an ecosystem services strategy can shift the Forest Service management process—instead of “bringing a proposed NEPA action to the public and asking for comments, the agency is asking the public for input in designing the proposed action” (Foley et al. 2014).

This approach emphasizes early information exchanges with the public, and among staff, to increase transparency and highlight the rationale for action to achieve interdisciplinary objectives. Rather than starting with a primary management objective or action (such as a fuels treatment to reduce fire risk) and mitigating potential impacts of that action, staff took a more proactive vision across resource areas to address a range of goals. Interactions among services, such as soil conditions, site productivity, hydrology, habitat, cultural uses, and forest products, were emphasized to support integrated planning. Staff gained a better understanding of other disciplines, and the relationships between ecological conditions and public benefits. Possible management actions were presented in terms of positive, negative, and neutral interactions with sets of services to tell a cohesive story about management needs and possible outcomes.



T. Ellersick

Figure 5—U.S. Forest Service employees discuss the broad suite of services provided in the Marsh Project planning area, Crescent Ranger District, Deschutes National Forest, Oregon, in 2013.

Willamette National Forest: All-Lands Approach

The South Santiam watershed on the Willamette National Forest's Sweet Home Ranger District has a checkerboard U.S. Forest Service (USFS)/private ownership pattern. Representatives from the USFS (regional office, State and Private Forestry, and Pacific Northwest Research Station), local watershed councils, and private land managers engaged in a collaborative process to (1) determine the inherent capacity of the "Cool Soda" planning area (including Soda Fork) to produce a variety of ecosystem services based on its ecological characteristics; (2) understand changes to that capacity based on historical land uses and existing conditions; and (3) develop a restoration plan to restore these services at a level that is ecologically sustainable, economically viable, and socially acceptable.

The team produced a restoration proposal that includes project recommendations and potential ecosystem services outcomes. Proposed restoration actions were tied to projected ecosystem services provided in addition to target accomplishments (Smith 2012). This planning approach helped leverage funds for the district and the community, including a \$460,000 grant awarded to the city of Sweet Home from The Conservation Fund's Livability Initiative, which emphasizes the integration of economic and environmental goals.

Traditional Ecological Knowledge

The ecosystem services approach facilitates open discussion and incorporation of cultural values, including "traditional ecological knowledge" into national forest management actions. Traditional ecological knowledge is defined by Jim Ransom, Director of Tehotiiennawakon, Mohawk Council of Akwesasne as: "a science rooted in our relationship with creation and based on living in peace and harmony with the natural world."

Indigenous populations throughout the United States are particularly vulnerable to climate-change impacts, confronting disproportionate risks to their culture and economies (Lynn et al. 2011). These tribes and indigenous groups have centuries of locally relevant experience managing natural resources that can be more effectively integrated into collaborative natural resource planning under an ecosystem services framework. Traditional ecological knowledge can provide insights into how our Nation's forests and grasslands respond to human interventions and changing climate conditions. It can suggest new strategies to manage these areas for a variety of ecological goods and services, social and cultural uses, and economic benefits.

analysis (Bear 2014). These efforts could enhance the NEPA process by highlighting potential decision-support tools that illustrate stakeholder values and priorities, establish linkages with those values and ecological conditions, and help translate public priorities into actionable and quantifiable management decisions.

Envisioning the future—Distilling the lessons learned from these early pilot projects into digestible guidance will help NFS units consider options for applying ecosystem services to planning processes. Because USFS decisions differ in scope, scale, context, and data availability, a diverse toolbox will serve the agency well. Understanding and adopting an ecosystem service approach is an evolving process, so this guidance should be reevaluated and updated as more experience is gained.

Consideration of a range of metrics including monetary, nonmonetary, quantitative, and qualitative measures can increase the scope of benefits that are considered, including cultural values that are difficult or inappropriate to monetize.

The collaborative process of understanding landscapes and the benefits they provide can be informative and iterative, with potential applications to a range of decisionmaking priorities, including wilderness management, fire-risk reduction, and sustainable harvesting of timber and nontimber products. Consideration of a range of metrics including monetary, nonmonetary, quantitative, and qualitative measures can increase the scope of benefits that are considered, including cultural values that are difficult or inappropriate to monetize. Taking a more comprehensive interdisciplinary approach to landscape analysis can inform the agency’s understanding of tradeoffs and the potential outcomes of actions, potentially leading to more effective management decisions. Where appropriate, field- and forest-level decisionmaking and planning can be supplemented with the use of existing decision-support methods and tools. These instruments are capable of comparing management scenarios to determine avoided costs of management actions. These types of tradeoff and effectiveness analyses may help inform comparisons of the environmental effects across alternatives in the NEPA process. However, applying ecosystem services to decisionmaking processes does not require complex assessments, and caution should be taken against “analysis paralysis” that doesn’t serve a decision or support communication with the public. Additional guidance or advice is needed to determine if and how existing ecosystem service tools and models can be feasibly applied, in a defensible manner, to support USFS decisionmaking under NEPA, and to understand existing data and modeling gaps that the agency could help fill to tell meaningful stories about management outcomes. This guidance should include direction on situations in which these tools and models are most effectively applied.

Effective public engagement and meaningful articulation of management outcomes are important components of the agency’s future. The ecosystem services approach is a powerful tool for strengthening our connections with constituents

and communicating the relevance of forests and forest management. While this may involve more time allocated to the proposal-development phase of planning, this investment has the potential to payoff later in the NEPA process by engaging stakeholders early, increasing trust and thereby decreasing the amount of time spent resolving objections and litigations. Enhancing engagement and mutual understanding may increase the likelihood of project implementation.

Applications of ecosystem services to NEPA in the USFS should prioritize efficiency—namely leveraging existing information and expertise in innovative ways to tackle challenges and sources of conflict, and working with partners to fill gaps in information and capacity. Ecosystem services applications should be seen as a tool to address needs rather than create challenges. Articulating management rationales using the ecosystem services concept can enhance communication regarding the relationship between strategic decisions and ecological conditions, and subsequent benefits to the public.

State Forest Action Plans—

The USFS has a directive to not only manage national forests for the benefit of the public in perpetuity, but to collaborate with state foresters and private landowners to provide financial, educational, and technical assistance to maintain and conserve our nation’s forest-based resources. State and private forest land encompasses about 56 percent of America’s total forest cover (USDA FS 2008b). These forests are critical contributors to the health of our nation’s social, economic, and ecological systems, providing multiple public ecosystem services benefits such as clean air, forest products, recreation, and wildlife habitat. State foresters have the responsibility to assist municipal governments and “nearly ten million family forest landowners [who] manage and protect state and private forests” (NASF 2014). The S&PF deputy area can work with state foresters to promote an ecosystem services approach to state and private forest management. Stewardship of these resources is critical to sustaining ecosystem services across public and privately owned landscapes.

Legal authority—

In 2008, the Food, Conservation, and Energy Act, also known as the U.S. Farm Bill, established updated direction regarding forest management goals on state and private lands. The landmark bill requires each state to complete a statewide forest resource assessment and strategy no less than every five years (Cerretani and Jones 2011). These assessments, called forest action plans, include analyses of current forest conditions and trends, assessments of overall forest health, delineations of priority forest landscape areas, and long-term strategies to focus resources on addressing

threats and opportunities. Together, the forest action plans provide a comprehensive assessment of U.S. forest land (public and private) and illustrate potential next steps to conserve, protect, and enhance forest resources (NASF 2014). Recommendations are state specific and incorporate public input and local expertise. Forest action plans and the statewide forest resource assessments that produce them represent a major avenue for taking a coordinated ecosystem services approach in state-level natural resource inventories and long-term planning on conservation and economic development. Statewide assessments are guided by three important objectives:

- Preserve working forest lands.
- Protect forests from harm.
- Enhance public benefits from trees and forests.

This last objective establishes the legal authority and requirement for state forest action plans to take an ecosystem services approach to guide forest management on state and private lands (NASF 2014).

Early examples—

Most states completed their forest resource assessments and forest action plans in response to the U.S. Farm Bill in June 2010. Southern states were particularly successful at addressing ecosystem services in their plans. Their work presents very clear data establishing the important role of state and private forests in the Southern United States for the provision of significant public benefits:

- Florida’s assessment highlighted that hunting, fishing, and wildlife viewing supported about 120,000 jobs in 2007.
- Tennessee’s urban FIA project estimates the value of its urban forests for removing pollutants from the atmosphere is over \$203 million annually.
- Georgia’s state forestry assessment found that its forest industry employs 128,000 people at an estimated economic benefit to the state of nearly \$29 billion.
- Texas conducted a statewide ecosystem services valuation published in 2013, and discovered that its forests provide \$92.9 billion annually in public ecosystem services benefits (Simpson et al. 2013).

The USFS Southern Region is leading state and private forest planning through meaningful followup on these assessments and forest action plans:

- The USFS Southern Region developed a summary analysis of state results. A common theme was a need to better communicate and enhance the ecosystem services and social benefits of forestry. In particular, state agencies highlighted the need to steward forests for provision of high-quality water

supplies, especially in the face of forest fragmentation threats owing to development and increased demand for clean water from urbanization and agriculture (Cerretani and Jones 2011).

- The USFS is collaborating with the Southern Group of State Foresters to develop procedures and methodologies for standardizing ecosystem service valuation in the south. The goal of the project is to provide individual states with guidelines that better enable them to quantify and value ecosystem services provided by forests.
- The USFS Southern Region capitalized on the research conducted for the state forest action plans to establish the Southern Forest Futures Project, an effort to forecast probable changes in southern forests between 2010 and 2060.

Envisioning the future—State forest resource assessments and forest action plans present critical opportunities to inventory ecosystem services benefits from state forests, create state-level priorities for ecosystem service outcomes from public and private forest management, and establish strategies to dedicate finances to address threats to ecosystem service provision. State foresters have identified numerous data gaps that presented challenges in assessing forest resources across all lands (NASF 2014). Gaps were predominantly related to the completeness, availability, scale, and accuracy of data. The USFS can dedicate staff and resources to filling data gaps in preparation for anticipated forest action plan development. If the USFS lacks adequate data on the broader landscape, this underscores the importance of state agencies in filling that information gap in the “all-lands” management approach. Following the example of the Southern Region, the USFS S&PF staff in the Washington office can help regional offices guide state foresters to develop action plans with an ecosystem services perspective. Regional offices can also collaborate with state foresters to help link national and regional ecosystem services priorities.

The National Association of State Foresters and USFS share an interest in using ecosystem services concepts, metrics, and methods to develop outcomes-based performance measures for management actions and expenditures. The National Association of State Foresters (NASF) has requested S&PF assistance to improve measures used to assess and report on the outcomes of state, federal, and nongovernmental investments in improving the health of nonfederal forests. This effort involves USFS representation on a NASF Subject Matter Expert Committee to enhance available data systems, current reporting, and program accomplishments. This effort will be mutually beneficial and will inform opportunities for developing more meaningful outcomes-based measures for USFS programs on NFS lands.

Quantify and communicate the value of resources and impacts of management actions in terms of benefits to people.

Measuring, Reporting, and Communicating

Quantify, and communicating the value of resources and impacts of management actions in terms of benefits to people—

The ecosystem services approach offers tremendous potential for quantifying and communicating the importance of healthy forests and grasslands and articulating their value to people and communities. To demonstrate how agency management decisions and program expenditures correlate to human well-being, the biophysical metrics collected by the USFS must be translated into terms of services provided to society. This information can be centrally stored for more direct access and analyzed in national assessments to give larger scale overviews of the condition and contributions of our public resources. Ecosystem services offer a way to translate typical USFS outputs into social outcomes and benefits. For example, the number of forest acres thinned for fire risk reduction would affect the amount of carbon sequestered. Quantification of ecosystem services facilitates adaptive management by measuring marginal changes in ecological and economic conditions—by delineating how a particular action affects resource flows, managers can alter and evaluate their plans accordingly in an iterative process. As discussed in the previous section, quantification also fosters more defensible and informed land management decisions. Additionally, assessment of total economic value and baseline flows of goods and services can convey the importance of forests and communicate the relevance of agency actions to Congress and the public.

A strong effort is underway to account for a more comprehensive range of indicators in performance measurement and program evaluation at the USFS. The agency is thinking more broadly about the effectiveness of its programs in meeting goals attached to appropriations. Ecosystem services concepts can be meaningful tools for the agency to actively monitor progress and performance while reinforcing the connection between land and people. For example:

- In November 2012, the USFS Sustainable Landscape Management Board of Directors was tasked to work with the Strategic Planning and Budget Analysis Office to improve agencywide performance measures to better capture the outcomes and impacts of agency activities.
- The agencywide inventory, monitoring and assessment (IMA) team is redrafting national management questions to assess progress toward national objectives based on data availability. The IMA framework incorporates ecological integrity and ecosystem services concepts.

The USFS can use existing data to quantify and measure ecological integrity through an ecosystem services approach and report outcomes as benefits

to society (fig. 6). National management questions can track these impacts accordingly. This type of reporting framework is meant to be an iterative process—one that has the flexibility to both evaluate the efficacy of national program and management activities, as well as monitor and track trends as changes to human condition over time as a result of specified activities. This section outlines promising opportunities for the USFS to quantify and communicate about forests grasslands, and their management in terms of how they can affect people and communities. Of particular focus are:

- **National assessments:** Reporting big-picture national trends in forest and grassland conditions in terms of benefits to people to inform decisionmakers
- **Inventory monitoring and assessment:** Collecting data of USFS management outcomes to communicate progress toward objectives
- **Performance measurement:** Creating standardized ecosystem services metrics, integrative valuation models and decision-support tools to illustrate and enhance USFS benefits to people

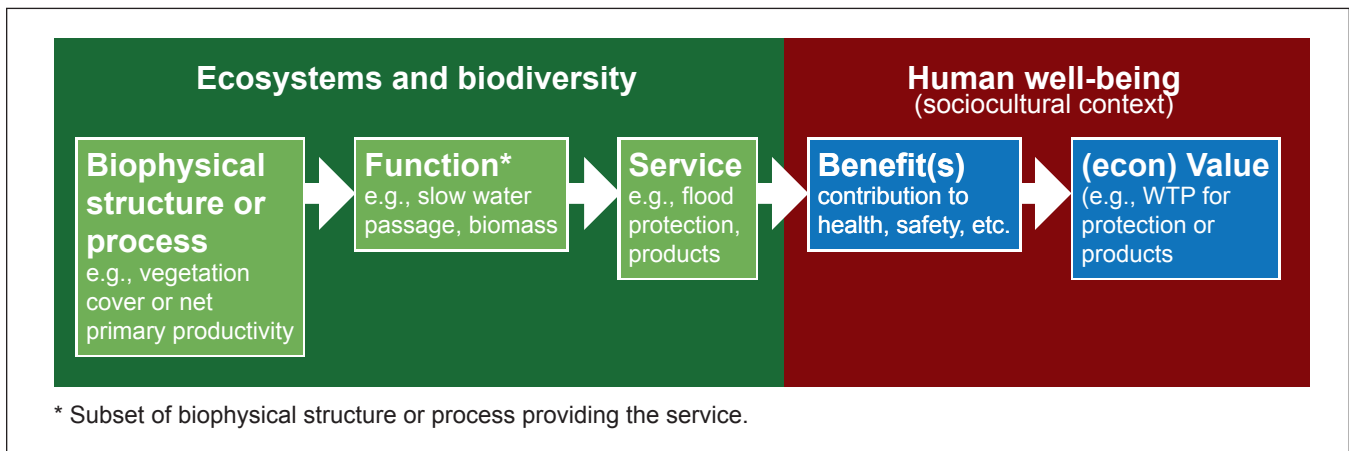
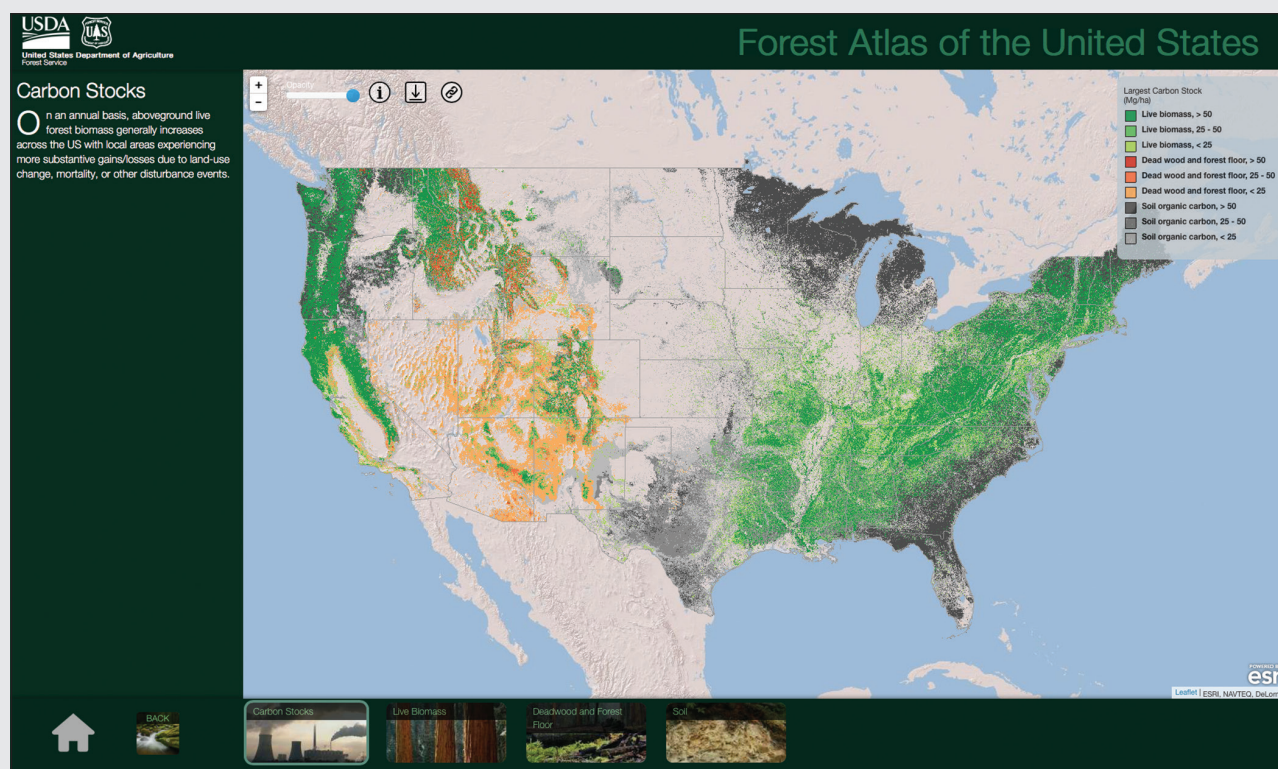


Figure 6—The U.S. Forest Service can join efforts to translate existing data about natural processes to human benefits via an ecosystem services approach. WTP = willingness to pay. (Adapted from Haines-Young and Potschin 2010.)

National assessments—National assessment reports address trends in forest and grassland conditions and impacts to communities and people. Many of these assessments now implicitly require reporting on ecosystem services. Reports on items including forest health, fire risk, climate change, and resource production inform decisionmakers, the general public, and external stakeholders about how agency work provides real value to social and economic stability. This broad macro-level analysis necessitates comprehensive reporting indicators.

The U.S. Forest Service's **Forest Atlas of the United States** combines state-of-the-art inventory and monitoring information with tree pollen counts, mill surveys, ownership records, bird observations, and more to tell stories about the value of our nation's forests and the challenges they face.



Legal authority—The Forest and Rangeland Renewable Resources Planning Act of 1974 (16 U.S.C. §1642) requires the USFS to develop and review national assessments. The authority supplements the agency's mission to manage forests for multiple uses and full productive capacity. It explicitly outlines that assessments of forests and grasslands contain elements of inventory, measurement, and prediction of how changing conditions and ecological stressors might affect future renewable resource production and ecosystem functionality. The report currently uses ecological process modeling from FIA data to directly project ecosystem service provisioning trends for renewable resources. The Forest and Rangeland Renewable Resources Planning Act of 1974 states that managing renewable resources involves the agency "evaluating opportunities for improving their yield of tangible and intangible goods and services, along with estimates of investment costs and direct and indirect returns to the Federal Government" (16 U.S.C §1600). This language emphasizes the

importance of measuring and reporting ecological conditions on the national scale while linking their implications to economic value, both direct and indirect.

In 2011, the President’s Council of Advisers on Science and Technology (PCAST) released a report entitled “Sustaining Human Capital; Protecting Society and the Economy” (PCAST 2011). This report pointed to the need for a quadrennial ecosystem services trends assessment to provide a synthesis of information about the impacts of climate change on ecosystem services and the challenges presented for sustaining those services. The report focuses on biodiversity and ecological integrity as a key underlying tenet of “environmental capital,” and directed the Biodiversity and Ecosystem Services Trends (BEST) assessment as a subcomponent to analyze how policy decisions affect ecosystem services and whether the federal government possesses the resource capacity to sustain them.

Envisioning the future—National assessments are critical for demonstrating the human benefits inherent in healthy forests, and the role of the USFS in delivering these values. They are also important tools for tracking agency progress toward management goals. When they become publically available, the reports promote partnerships and collaboration with other government and nongovernment agencies by highlighting shared objectives. As the agency continues with national assessments of forests and grasslands resources, consideration of ecosystem services will make these reports more relevant by illustrating the important connections between sustaining our natural resources and human well-being.

Enhancing integrated and transparent information sharing is essential to creating greater opportunities for collaborative management, progress monitoring, and public communication. Sharing data in a way that supports collective decisionmaking necessitates an understanding of where it is stored, where it comes from, and what it implies.

- **Where it is stored:** Explicitly monitoring ecosystem services at such a broad level will require guidance to dictate which agency or department will house the appropriate information. Currently, there is a lack of clarity on the location of certain datasets. The BEST assessment reported no gaps in data gathered at the national level; however, it did not specify where the data were being collected.
- **Where it comes from:** National assessment reports on renewable energy could incorporate ecosystem services geospatial monitoring into existing production functions. This level of monitoring would help illuminate opportunities for watershed partnerships, biodiversity, and conservation banking, and carbon mitigation strategies in the face of rapidly changing land development and climate change patterns.

National assessments are critical for demonstrating the human benefits inherent in healthy forests, and the role of the USFS in delivering these values.

- **What it implies:** An opportunity exists to use the BEST report to design and test indicators, selection criteria, and monitoring techniques to provide a consistent approach to ecosystem services analysis. Working with partner agencies to make the best use of national assessments and develop market and nonmarket valuation tools for translating and quantifying these services as social and economic impacts is another important step. Forthcoming valuation models have a high degree of potential for integration into existing economic functions and ecological simulations to report on the flows of vital services.
- **How to enhance:** Models could be applied to existing national reports to demonstrate the efficacy (or lack thereof) of forest management activities in terms of losses avoided. While all models are imperfect and economics cannot paint the whole picture, this would certainly help frame the agency’s work as valuable to ensuring sustainable development, both environmentally and economically.

USFS Inventory, monitoring, and assessment—

The IMA process presents a prime opportunity to improve the way the agency monitors, stores, and shares ecological data and better inform planning and management activities. There is momentum within the USFS toward coordinated information sharing and targeted inventories, which promote successful reporting on management results. The holistic inclusion of ecosystem services into the IMA reporting process would help the USFS accurately monitor ecological changes in real time and adjust agency priorities to enhance community benefit. The IMA team is currently restructuring management questions.

“Many natural resources don’t have a market value until they’re gone.”

—Janet Ranganathan,
Vice President for Science & Research,
World Resources Institute

Legal authority—The Forest Service Manual 1900 Chapter 1940—Inventory, Monitoring, and Assessment Activities (2009) states “The objectives for managing inventory, monitoring, and assessment activities are to...support an adaptive land management process that includes social, economic, and ecological evaluations.” It also states that “Inventory, monitoring, and assessment activities shall: 1. Be coordinated

through a national integrated program planning process that addresses information needs related to all agency business requirements.” The IMA directives are intended to guide agency planning through an iterative and adaptive process that directs decisions to promote desired future states given existing environmental conditions.

IMA and ecosystem services—The IMA effort to restructure management questions provides a prime opportunity to build a consistent national framework for ecosystem services monitoring and management. Currently, land managers inventory vegetation, monitor water quality, and assess social and economic conditions near national forests and grasslands. The information serves the purposes of some USFS organizational units but is frequently gathered inconsistently across other agency units. This inhibits the agency’s ability to analyze trends and compare management methods. The IMA team has the challenging task of creating assessment questions that include generalizable criteria relevant for reporting at the national level while being specialized enough to reflect local ecological complexity.

This restructuring is intended to increase the USFS land stewards’ ability to respond to environmental stressors and trends while establishing a consistent method for internal data management that is linked laterally and vertically across jurisdictions and management scales. The IMA team’s most recent draft framework considers ecosystem services in five key components: biological diversity, ecosystem health and productivity, soil and water resources, infrastructure, and social and economic factors. The latter emphasizes the interrelated nature of ecological integrity and social and economic resilience. The ability to monitor and articulate ecosystem services is fundamental to making a shift in management to sustain these benefits.

Envisioning the future—Currently, the IMA process addresses ecosystem services with a discrete set of questions. For the IMA national management questions to fully adopt an ecosystem services approach, questions should be integrated throughout the key components. Furthermore, the questions should be altered to address how biophysical inputs get converted to social or economic impacts, who benefits, and how impacts are distributed. An ecosystem services approach to IMA questions can integrate stakeholder values into management decisions, quantify the impacts of these decisions on stakeholders, synthesize data from a variety of sources, and provide indicators to gauge performance and efficacy. The process can be used to promote outcome-oriented performance measures and improve alignment between objectives, accomplishments, and resource accountability. Results can be evaluated retroactively to determine which past decisions were most effective. The IMA could be refined in a way that aligns project or programmatic objectives with ecological and socioeconomic sustainability over time.

An ecosystem services approach to performance measurement can help the USFS make progress toward clearly defined success indicators. More interdisciplinary, outcome-based performance metrics can also incentivize cooperative decisionmaking across resource programs.

Performance measurement—

Performance measures are important for all federal agencies to justify budget allocations. The USFS uses performance measures to assess progress toward its mission “to sustain the health, diversity, and productivity of the Nation’s forests and grasslands to meet the needs of present and future generations.” An ecosystem services approach to performance measurement can enhance the scope and appropriateness of metrics and help the USFS discern whether agency activities deliver verifiable benefits to human health and well-being or measurable improvements to land conditions. An ecosystem services approach to performance measurement can help the USFS make progress toward clearly defined success indicators. More interdisciplinary, outcome-based performance metrics can also incentivize cooperative decisionmaking across resource programs. The legislation quoted below creates tremendous opportunities for applying ecosystem services to establish more economically indicative performance metrics.

Legal authority—The Government Performance and Results Modernization Act of 2010 (GPRA 2011) requires the following three elements:

1. Agencies are required to develop 5-year strategic plans that must contain a mission statement for the agency as well as “general goals and objectives, including outcome-oriented goals, for the major functions and operations of the agency.”
2. Agencies are required to prepare annual performance plans that establish “objective, quantifiable, and measureable” performance goals, and a set of “performance indicators to be used in measuring or assessing progress toward each performance goal including, as appropriate, customer service, efficiency, output, and outcome indicators” for the applicable fiscal year, a brief description of how these goals are to be met, and a description of how these performance goals can be verified.
3. Agencies must prepare annual performance reports that review the agency’s success or failures in meeting its targeted performance goals. While the aforementioned agency (as pertains to the USFS) is the USDA, the USFS must report their accomplishments via standardized performance indicators up from the agency to the department level.

The Geospatial Accomplishment Reporting Project (GARP) Charter, July 2012 (Wheldon and Hubbard 2013) emphasizes employing an integrated data warehouse to facilitate easy data updates at the field, district, forest, or regional level.

The GARP strategy “utilizes existing resources and will develop low impact processes that support consolidating program management reporting and official geospatial accomplishment reporting in the Enterprise Data Warehouse.” This storage mechanism is intended to facilitate quick access through a user-friendly interface with an emphasis on geospatial reporting on accomplishments. There is now direct attention within the GARP strategy on indicators to illustrate the spatial distribution of impacts on stakeholders affected by forest management decisions. Connecting these indicators with standardized metrics will ensure that ecosystem services are reflected in GARP reporting.

Chapter 1410—Management Reviews—of the FSM (USDA FS 2007) clearly articulates the need for comprehensive performance measures and accomplishment reporting at deputy and program levels to be evaluated by deputy chiefs and national program directors. The FSM 1410 expresses the need for deputy areas and corresponding programs to implement performance measures to monitor accomplishments. It also explicitly requires national program directors to respond when objectives are not fully achieved. Forest Service programs can ensure ecosystem services delivery by providing accurate and appropriate metrics to assess program achievements against objectives. The manual reads: “Deputy Chiefs must ensure that...coordination occurs within their staff area to ensure consistent interpretation, collection, and reporting of accomplishment data and performance measures...Washington Office staff directors are responsible for monitoring program performance, conducting reviews to evaluate whether accomplishment data meets performance measure definitions, system of record standards, and reporting protocols...and proposing adjustments to the Deputy Chief where oversight reviews suggest that national performance measures are hindering program delivery and attainment of their agency mission.”

Performance Metrics on the Tongass National Forest: a Closer Look

Southeast Alaska salmon and trout populations contribute to over \$986 million of regional economic activity and 10 percent of regional jobs (commercial, recreational, personal) (TCW Economics 2010). Tying these provisioning ecosystem services to more broadly reflect economic opportunities could help justify conserving habitats and restoring affected streams and riparian areas while managing to minimize climate change impacts.

USFS-wide performance measurement and reporting—

National reporting—The USFS has always recognized the significance of national performance measures as a critical way of evaluating the agency’s progress toward reaching accomplishments. This process demonstrates accountability while highlighting key successes and challenges. A U.S. General Accounting Office testimony before the House Appropriations Committee (Hill 2000) identified the USFS as an agency in need of more accountability with appropriated funds. Of particular note was the need to link budget allocation criteria, forest plans, and performance measures to strategic objectives. Two major changes resulted from this insight: (1) the USFS consolidated its budget structure to form key objectives and integrate goals with strategies (such as promoting ecosystem services), and (2) the USFS decided to justify future fiscal budgets on the basis of performance measures linked to strategies and outcomes rather than measures linked to specific resources.

Additionally, the OMB is interested in linking outcome-oriented metrics to performance and accountability through a more consistent and explicit ecosystem services-based economic analysis for all federal agencies, and its efforts to guide these agencies has resulted in a number of new assessment frameworks. It lays out a method for more robust cost-benefit analysis taking into account environmental impacts on public health and social well-being in a memorandum revising Executive Order 12866 “Regulatory Planning and Review” (OMB 2003). Consistency among these frameworks will be essential in creating an effective, standardized system for evaluating efficiencies in budgetary allocations—if the Forest Service

President’s Council on Environmental Quality Delivers Final Principles, Requirements, and Guidelines (PRG) for All Federal Natural Resource Management Agencies

The updated 2015 PRG will require the U.S. Department of Agriculture to develop a consistent departmentwide analysis for water-resource development projects over \$20 million. Since 1983, a narrow economic cost-benefit assessment was required for evaluating and selecting all major Army Corps of Engineers and Natural Resources Conservation Services water projects, from navigation to storm resilience, wetland restoration, and flood prevention. That assessment has been broadened to all federal natural resource management agencies and must meet the following federal objectives:

As the 2012 planning rule already meets these general objectives, application of the PRG is expected to be limited to mostly third-party infrastructure projects above the financial threshold on National Forest System land.

wishes to retain the resources necessary to implement its key strategies to achieve desirable outcomes, it must quantify and communicate programmatic success in a way that will resonate with program evaluators charged with a diverse portfolio of expenditures.

National performance measures are currently embedded within the agency's 2015–2020 strategic plan. The plan features specific objectives such as strengthening communities, conserving open space, and exchanging natural resource expertise. Strategic components embedded in the fiscal year 2016 budget include furnishing abundant clean water; resisting damage from fire, insects, and disease; and sustaining a strong productive capacity. The agency explicitly identifies the need to “deliver all the social, economic and ecological values and benefits that Americans want and need, both now and for generations to come” (USDA FS 2015a).

Deputy areas and program-level reporting—Under national directives, USFS deputy areas began to align their own performance measures to meet overarching agencywide strategies. Specifically, the 2008 U.S. Farm Bill provided new language on how the S&PF deputy area would identify priority areas for multi-partner investments designed to incorporate integrated national, regional, and state forest management goals (defined as national S&PF objectives) in responding to prioritized landscape- and outcome-based planning.¹ These three objective areas (conserving and managing forests for multiple values, protecting forests from threats, and enhancing public benefits from trees) all implicitly emphasize ecosystem services as a justification and standard to which accomplishments could be tracked. Within the NFS, performance is evaluated through ecological indicators entered into agencywide monitoring systems (e.g., watershed improvement tracking).

There is an opportunity for each program area to work with the Strategic Planning and Budget Analysis Office to update performance measures to focus on the impact or result, and ecosystem service outcomes, benefits, and values of activities rather than outputs (e.g., volume timber, acres treated). Currently, S&PF programs (i.e., Forest Stewardship, Forest Legacy, Community Forestry, Urban and Community Forestry) and NFS programs (i.e., Collaborative Forest Landscape Restoration) are tasked with monitoring and reporting outcomes focused on improved social and economic conditions. Metrics include numbers of stakeholders engaged, the performance of conservation activities on private lands, and spatial or tabular

¹The U.S. Farm Bill was recently reauthorized in 2014, and builds on the original bill empowering actions to “enable USDA to further expand markets for agricultural products at home and abroad, strengthen conservation efforts, create new opportunities for local and regional food systems and grow the bio-based economy” (USDA 2015b).

tracking of ecological improvements via the Stewardship Mapping and Reporting Tool. Applying new metrics through an ecosystem services lens (e.g., carbon sequestered, phosphorus load avoidance) could increase market values for contracts and encourage stewardship of private lands. Additionally, more reflective geospatial reporting of ecological and economic outcomes could inform where future dollars could be invested for the greatest net returns.

Forest and project-level reporting—Through an annual monitoring and evaluation report, every national forest must evaluate and report on forest plan accomplishments on a statewide basis. Reports are tailored to specific state needs and contain quantitative and qualitative data garnered through IMA management questions. At the national forest level, forest stakeholders and regional land managers are beginning to revise performance measures to reflect the economic impacts of activities.

Case Study

The state of Florida’s annual monitoring and evaluation report includes a component entitled “Sustainable Multiple Forest and Range Benefits.” Within this category, monitoring questions regarding recreation site accessibility, trail maintenance, wilderness protection, forest product harvest, and socioeconomic contribution are addressed to gauge the effectiveness of national forests in meeting this goal. Ecosystem services could extend beyond recreation and provisioning to include regulating and supporting services such as carbon sequestration and water-quality benefits.

Envisioning the future—The USFS has an opportunity to integrate ecosystem services goals throughout the agency through targeted inventories, transparent and accessible data management, and performance measurement. The USFS can monitor national objectives using performance metrics that characterize ecosystem services outcomes beyond species delisted or habitat acres restored. This will help the agency demonstrate progress toward its mission, justify how budget allocations to the USFS promote human well-being, and communicate the economic value of the agency to the public. Additionally, quantifying and demonstrating the ecosystem service benefits delivered through cooperative assistance programs or stewardship contracts can encourage greater participation by private landowners. Use of newly developing spatial databases, decision-support tools, and models linking ecological process to economic valuation data (via transfer values and production

functions) will prove essential in quantifying and reporting outcomes and progress toward goals. Quantification and communication of the foundational environmental benefits necessary to support communities—clean water, clean air, processing of material, and buffering of natural catastrophic disasters—are essential to telling the story of how NFS lands can serve people, thereby emphasizing the relevance of the agency. This concept has added value in challenging program leaders to reconsider how objectives might be reprioritized. These achievements will be essential in communicating the value associated with the agency’s increasing emphasis on budget consolidation (e.g., integrated resource restoration).

Investment in Ecosystem Services

Connect providers and beneficiaries of ecosystem services—

The cross-boundary nature of ecosystem services delivery processes makes connecting providers and beneficiaries of these services a challenge. Political and geographic boundaries can create artificial barriers that hinder consideration of ecosystem service benefits in land management and land use decisions. Benefits provided by green infrastructure and sustainable natural resource management practices are often poorly understood or not captured in market values. There are many ways to overcome these barriers, from informal communications/collaboration to investment partnerships, environmental markets, or other incentive-based approaches.

This section highlights opportunities for the USFS to build relationships between providers and beneficiaries and encourage full or partial financial investment from the beneficiaries. Specifically, this section covers the USFS’s approach to connecting providers and beneficiaries of ecosystem services through incentives, damage mitigation, investment partnerships, and environmental markets.

Incentives: The USFS provides incentives for ecosystem service delivery from private landowners through grants, financial assistance, and stewardship agreements.

Damage mitigation: The USFS provides ecosystem services for public benefit. Damages to USFS land and property affects the ability of the USFS to provide ecosystem services. The agency quantifies and values these damages to ecosystem services.

Investment partnerships: The USFS facilitates connections between actors with shared risks and benefits by building partnerships where beneficiaries can invest in natural resource management for sustained ecosystem services.

Environmental markets: The USFS facilitates markets for ecosystem services by developing infrastructure for enabling transactions between ecosystem services providers and beneficiaries.

Quantification and communication of the foundational environmental benefits necessary to support communities—clean water, clean air, processing of material, and buffering of natural catastrophic disasters—are essential to telling the story of how NFS lands can serve people, thereby emphasizing the relevance of the agency.

The U.S. Forest Service (USFS) Connects Providers and Beneficiaries of Ecosystem Services

- The USFS and the Denver Water Board signed a memorandum of understanding in which each committed \$16 million for improved forest restoration work in Denver’s municipal watershed to avoid damage to water quality caused by large wildfires.
- In 2012, the city of Flagstaff, Arizona, passed a bond measure committing \$10 million for use on the Coconino National Forest, Arizona state lands, and city parcels for forest thinning treatments to reduce severe wildfire and subsequent flooding risk in Flagstaff.
- The USFS engages in a collaborative effort with the Eugene Water and Electric Board to design a voluntary payment incentive program that protects high-quality riparian areas on private lands to benefit the drinking water supply in Eugene, Oregon.
- In 2013 alone, the USFS closed 350 damage assessment claims cases for over \$146 million. Over \$100 million of this total was generated from fire damages; \$60 million of which was returned directly to national forests for resource damage mitigation. There were nine large settlements in 2013 related to fire mitigation ranging from \$1.25 to \$45 million in recovered costs.

Incentives—

Cooperative assistance—The Cooperative Forestry Assistance Act of 1978 (16 USC 41), as amended by the Food, Conservation, and Energy Act of 2008 (Public Law 110-246), authorizes the USFS to provide financial, technical, educational, and related assistance to state foresters, extension agents, public agencies, private landowners, forest resource operators, vendors, tribal organizations, and other managers. This assistance is provided in exchange for the protection and maintenance of forest land and forested wildlife habitat and “the multiple values and uses that depend on such lands.” Included in this authority is the ability to offer private landowners financial incentives for stewardship actions (table 1). These incentives promote the voluntary delivery of ecosystem services from private lands for public benefits. Clearly articulating the ecosystem services benefits provided by these incentives could encourage increases in dedicated funding and future impact for these programs.

Table 1—Examples of financial incentive programs for stewardship actions

Program	Description	Ecosystem services language
Forest Stewardship Program (FSP)	Financial and technical incentives to nonindustrial private landowners for long-term stewardship and active management.	The FSP invests in practices that maintain and enhance the productivity of the full suite of forest resources. The FSP ensures that financed activities, “meet future public demand for all forest resources and the environmental benefits that result.”
Forest Legacy Program	Purchasing easements on forests with significant environmental values threatened by conversion.	Environmental values include, “scenic, cultural, fish, wildlife, and recreational resources, riparian areas, and other ecological values.” Easements allow recreation and forest management.
Community Forestry and Open Space Conservation	Grants for fee-simple acquisition of threatened private forests to provide community benefits.	Acquisitions provide “economic benefits through sustainable forest management; environmental benefits, including clean water and wildlife habitat;” and benefits from education and recreation.
National Urban and Community Forestry Assistance	Financial assistance through matching grants for urban and community forestry projects.	Projects include tree planting, wood utilization, open space programs, energy conservation for air quality benefits, and demonstration projects to illustrate the benefits of urban forest cover.

Other potential opportunities for USFS to use an ecosystem services approach to leverage cooperative assistance include:

- Using an assessment of ecosystem services to inform the selection of target areas and estimation of the potential values of individual projects. This would require national- and project-scale modeling as well as local discussions regarding priority ecosystem values.
- Incorporating ecosystem services values into USFS appraisal and acquisition standards and procedures. This could make fair market value estimates more representative of social and ecological values beyond highest and best use for development purposes. Increased property value appraisals would further incentivize the sale of conservation easements and fee-simple parcels.

Stewardship contracts—Stewardship contracts leverage community relationships to help the USFS meet restoration goals and carry out ecosystem management projects. In current policy, stewardship contracts allow the trade of goods for services in an integrated resource contract (IRC). Here, a local operator is compensated for completing ecological restoration activities on NFS land by capitalizing on the value of forest products extracted from the treated areas (Roessing et al. 2014). The financial cost of these services is offset by the value of products removed. Services can include thinning, removing brush, watershed and habitat maintenance, weed

control, soil productivity, and prescribed fire. The USFS evaluates which operator (federal, municipal, private, or nonprofit) will deliver the “best value” in terms of final ecosystem outcomes rather than by bid price for forest products (fig. 7) (USDA FS 2014b). The quality of a proposal, expertise and past performance of the contractor, and price are also factors (USDA FS 2009).

Section 323 of the Consolidated Appropriations Resolution of 2003 (16 U.S.C. §2104) established the authority to implement stewardship contracts for land management and community outreach. The authority expired in 2013 and was renewed by the 2014 U.S. Farm Bill that permanently authorized USFS stewardship contracting (FSM 2400; FSH 2409.19). The 2014 authorization does not place a restriction on the number of acres that can be included in a stewardship contract. Stewardship contracts quickly and efficiently connect the USFS to communities through shared work and investment. Communities receive ecosystem service benefits from USFS and contractor activities, often in the form of job creation and employment stability. Stewardship contracting represents a significant opportunity for the USFS to highlight ecosystem services and community outcomes from activities on NFS lands. The agency could use stewardship projects as case studies for developing ecosystem services metrics and creating best practices for community collaboration.

In fiscal year 2013, the U.S. Forest Service awarded 195 stewardship contracts and agreements covering 171,767 acres of forest and grassland. Accomplishments include:

- 3,391 acres of established forest vegetation
- 44 miles of enhanced stream habitat
- 1,346,470 CCF* of timber sold
- 72,578 acres of restored or improved wildlife habitat

Expressing the outcomes of these contracts in terms of ecosystem services would enhance our understanding about project impacts.

* CCF = 100 cubic feet.

Damage mitigation on USFS lands—

The USFS provides ecosystem services to public beneficiaries through management of agency resources. When these resources are negatively affected, their ability to function and deliver benefits also suffers. Damage assessments are evaluations of impacts to property or resources on NFS lands resulting from natural or human-caused disasters and unlawful activity. They provide an opportunity to account for impacts on ecosystem services delivered from USFS land to public beneficiaries.

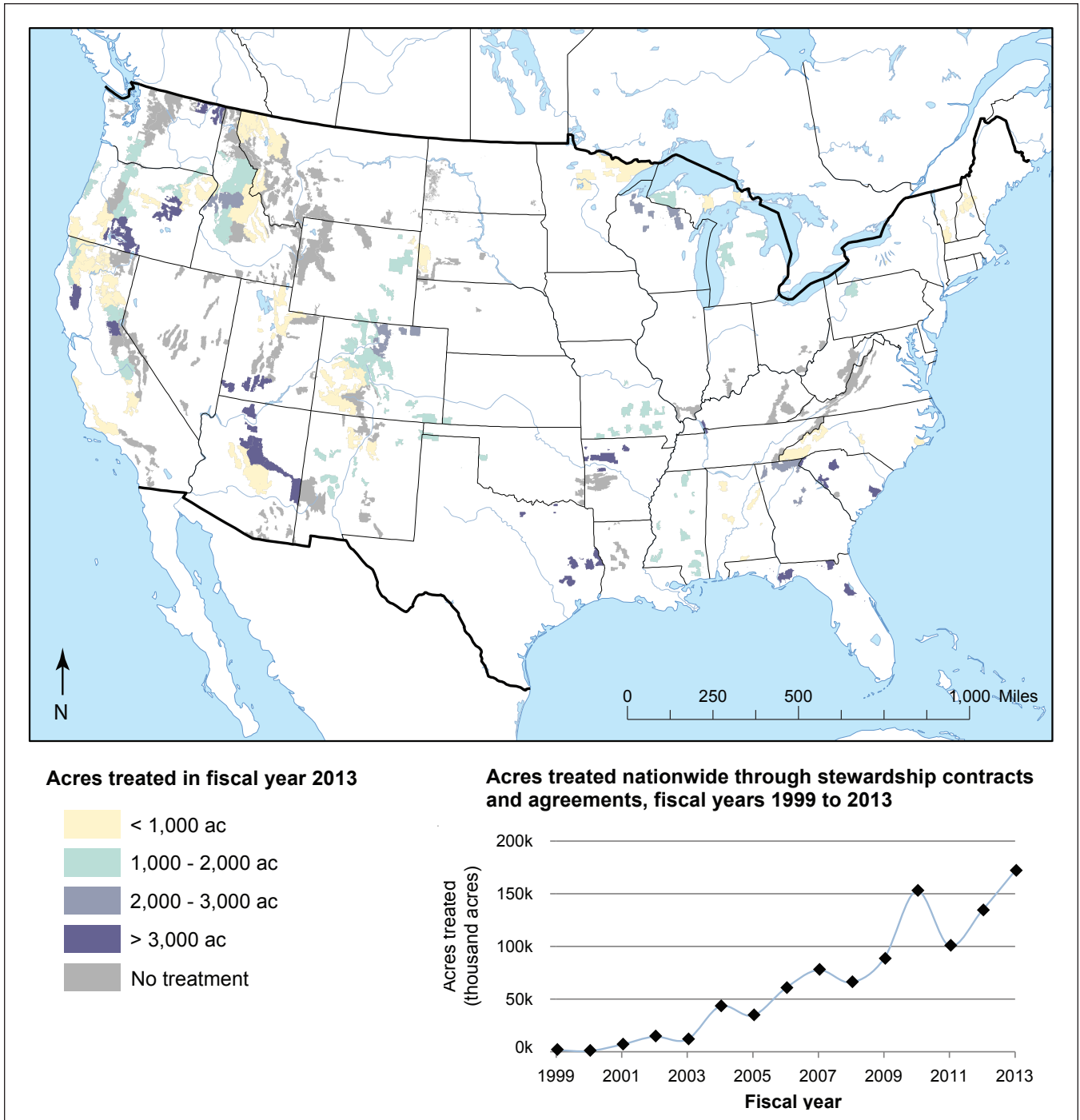


Figure 7—Acres treated in 2013 through U.S. Forest Service stewardship contracts.

The USFS can use them to assess damages to agency resources from management decisions or the actions of outside entities. The USFS can also be held accountable to other parties for impacts of agency activities on resources outside NFS boundaries. Damage assessments can also be conducted without assigning fault (see the damage assessment example text box on p. 47).

USFS damage assessments—There are several circumstances for which damage assessments are conducted by the USFS, including:

- Development impacts: Natural resource impacts from construction or development (e.g., sedimentation/erosion control, nutrient leaching, interrupted scenic views)
- Property impacts: Theft, depredation, or damage of USFS property, facilities, or infrastructure (e.g., railroad fires, timber theft, growing of illegal crops, arson, timber sale accidents, vehicle theft, power line damage, camp-fire damages)
- Cultural impacts: Damages to archeological or cultural resources, sites, or property

Damage assessments can result in claims after an accident, restoration recommendations after a natural disaster, or criminal charges after theft or arson. Damages are typically assessed using a combination of methods, including accounting for the appraised value of resource rehabilitation, and the lost value of the standing resource (based on resale value or “cost price”). These standing resources typically include costs incurred by the USFS and market value for timber, infrastructure, vehicles or property, and other established vegetation.

Legal authority—At the federal level, damage assessments are conducted using Natural Resource Damage (NRD) liability provisions guided by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Oil Pollution Act (OPA), and the National Marine Sanctuaries Act (NMSA). Liability calculations in a NRD assessment include costs of restoring the resource to baseline conditions, compensation for “interim losses” pending full restoration, and the reasonable cost of the damage assessments itself (Scarlett and Boyd 2011). Through these three approaches, OPA, CERCLA, and NMSA provide a framework for valuation beyond market value and resource development. The NRD framework provides an opportunity for USFS to account for the values of nonmarket ecosystem services.

Certain authorities allow the USFS to assess damages occurring on or affecting the NFS (table 2). Although calculating damage costs according to impacts on ecosystem services values and ecological function is not expressly authorized or

Damage Assessment Example

The Arapaho and Roosevelt National Forests and the Pawnee National Grassland completed a flood impact assessment report to determine natural resource, infrastructure, recreation, and economic damages from heavy and sustained rain over multiple days in September 2013. The report revealed that over 600,000 acres were affected. After the heavy rain, the forest supervisor established a flood impact assessment team to rapidly assess damage and imminent risk to facilities and infrastructure caused by the flooding. Preliminary estimated total costs for infrastructure and facilities:

Roads	\$10,609,025
Bridges	\$2,784,954
Trail	\$425,693
Facilities	\$3,025,031
Estimated total costs	\$16,844,703

These estimates could be enhanced by addressing impacts to habitat, scenic views, recreation/tourism, hydrologic function, water quality, and other ecosystem services.

prohibited, using an ecosystem services approach in damage assessments can help the USFS gain a more accurate and complete picture of natural resource impacts from planned or implemented management activities. Damage assessments could then account for a broader suite of values, such as habitat, water filtration, carbon sequestration, disaster mitigation, aesthetics, and recreational values.

Early examples—Although most damage assessments do not fully account for the value of ecosystem services delivered from the impacted resource, a few landmark examples set precedent for an ecosystem services approach to damage assessment claims:

1. *U.S. vs. Scarry (unpublished, 9th cir. 1989)*: Under a criminal violation for timber theft, the USFS may apply the fair market value of the stolen timber at point of delivery and the resource damages value. The authority to charge for resource damages is in Title 18, U.S Code 1361. The court ruled that resource damages caused by the violation would include “damages to visual, silvicultural, wildlife, archaeological, soils, hydraulic, and recreational resources, and so forth.... These values may be based on the ‘value of the live trees in terms of their contribution to the forest ecosystem’” (18 USC 641; 18 USC 1361).

Table 2—Legal partnership tools

Instruments	Authorization	Limitations/guidelines
Participating agreements can be used for partnerships involving shared costs/benefits related to pollution abatement, job training, publication of forest history materials, interpretive associations, forest protection, prescribed fire, watershed restoration and enhancement (public or private lands), and resource advisory committees.	Cooperative Funds and Deposits Act of December 12, 1975 Wyden Amendment	Does not apply to other federal agencies. Total resources from the partner must be at least 20 percent of what is required. Must benefit natural or cultural resources within a watershed on National Forest System lands. Project can involve public or private lands.
Challenge cost share agreements apply to partnerships with shared costs/benefits when U.S. Forest Service (USFS) and its cooperator agree to develop and execute a project that enhances existing USFS activities.	Interior and Related Appropriations Act of 1992	Partners must receive equal qualitative benefit from the project and contribute at least 20 percent of project resources. Funds cannot be sourced from other federal agencies.
Collection agreements are implemented by the USFS to perform a service or provide goods for a cooperator that is not a federal agency. These allow the USFS to accept money from a nonfederal party to carry out a purpose authorized by law.	Cooperative Funds Act of June 30, 1914 Granger-Thye Act of April 24, 1950	Contributions must be voluntary and can cover all or part of the cost of the work. Work must benefit an existing USFS program. Acceptance of funds must not be conditional upon endorsement. Some public benefit must result from accomplishing the work. Agreements must not be initiated to supplement USFS crews or equipment. The USFS cannot accept services as payment and cannot provide endorsements.
Interagency agreements clarify the expenditures or services exchanged when the USFS performs a service or provides a good for a federal agency partner.	The Economy Act of June 30, 1932 The Service First Authority	The transaction must be in the best interest of the U.S. public, and the agency must not be able to procure the goods or services at a similar cost or effort from a commercial enterprise. An Economy Act determination and finding letter is required. USFS, Bureau of Land Management, National Park Service, and Fish and Wildlife Service can share facilities, services, and employees to improve customer services and enhance work accomplished between federal agencies.

2. **The Storrie Fire:** In August of 2000, the 52,000-acre Storrie Fire was started by Union Pacific Railroad crews working on a rail line, who failed to take fire prevention precautions. The fire spread through 22,000 acres of USFS land on the Plumas National Forest and generated \$22 million in suppression costs. The fire destroyed wildlife habitat including old-growth forests and designated wilderness areas. Union Pacific was found responsible for the full costs of restoration, suppression, lost timber value, and “the loss of public scenery and recreation and habitat and wildlife.” This \$102 million settlement includes compensation above and beyond the fair market value of destroyed timber or other tangible resources. It includes compensation for unique aspects of the forest and restoration of ecological balance.

“It’s an important development. . .to have courts saying decisions aren’t limited to the value of timber. A calculation is now allowed to look at the value of wildlife and the ecosystem. It seems to me that’s the correct view, otherwise it’s like saying there’s no consequence to someone burning land that didn’t have salable timber.”

—Sean Hecht, *Executive Director*
UCLA Environmental Law Center

3. **The PG&E Fire:** The USFS reached a settlement with Pacific Gas & Electric Co. (PG&E) for \$14.75 million over a 1999 fire in California. The fire burned 11,725 acres, including 3,866 acres of NFS lands. The fire, caused by a ponderosa pine on PG&E land falling on a PG&E power line, resulted in extensive damage to ecological habitat and timber value on NFS land. The funds were directed to the Plumas and Tahoe National Forests, and included \$4.2 million for fire suppression costs and \$10.55 million to fund natural resource restoration.

Envisioning the future—Incorporating the public value of ecosystem services benefits into damage assessments from impacts to USFS resources is a financial and standard-setting opportunity for the agency. Policy and methodology shifts will allow financial compensation from damages to support restoration of the Forest Service’s ability to provide ecosystem services to beneficiaries. For example, when scientists measured the “loss of passive values arising from injuries to natural resources,” caused by the 1989 Exxon Valdez oil spill in Alaska using a contingent valuation method, they calculated a minimum of \$2.8 billion in additional compensation owed to the state of

Alaska (Carson et al. 2003). Incorporating ecosystem services values into appraisal and acquisition standards and procedures would increase the fair market value of parcels and further incentivize easements. Mitigation strategies, NRD assessments, and environmental penalties can steer funds within a particular ecosystem into a common pool for investment in priority ecosystem services protection and restoration.

Investment partnerships—

This section focuses on partnerships that involve an exchange of financial resources between providers and beneficiaries of ecosystem services. This subset of partnerships represents the most specific opportunity to promote investments for the USFS to serve people and ecosystems. In many of the partnerships presented in this section, the USFS and collaborating entities both serve as providers and beneficiaries of ecosystem services.

Legal authority—A combination of legislative authorities and leadership guidance communicates the agency’s intention to facilitate collaborative ecosystem services transactions that connect providers and beneficiaries. One guidance directive is the 2011 Public-Private Partnership (PPP) strategy. The PPP invites partners to share directly in the care and benefits delivered from healthy landscapes; they illustrate how the USFS can expand public appreciation for ecosystem services benefit.

The USFS is working to clarify policies and align internal structures to encourage institutional partnerships. Many USFS partnerships have evolved beyond traditional nonprofit organizations to include entities such as private companies and local governments. When sharing responsibilities, financial resources are often exchanged to accomplish work. There are existing authorities for the USFS to exchange funds and services with private entities (table 2). These authorities establish instruments for the USFS to accept money from partners or share investments. These instruments include participating agreements, challenge cost-share agreements, collection agreements, and interagency agreements (USDA FS 2012b). However, direct relationships with industry and for-profit organizations if not handled appropriately may raise endorsement concerns and can cause uncertainty, hindering partnership development and project timelines. For instance, the agency developed guidance that dictates it does not accept “directed” funds from private partners. The agency is currently developing more explicit ethical guidance and building on existing instruments for collaboration to address potential concerns and uncertainties from PPPs (Bedell-Loucks 2014). While USFS is not specifically prohibited by partnership authorities from receiving private funds, working through nonprofit intermediary partners can often expedite projects and avoid endorsement concerns.

The agency works with multiple nonprofit organizations whose missions are aligned with agency objectives. National-level partners such as the National Fish and Wildlife Federation (NFWF), the Nature Conservancy, the Arbor Day Foundation, the American Forest Foundation, the Pinchot Institute, the National Environmental Education Foundation (NEEF), and the National Forest Foundation (NFF) are integral to the agency’s ability to leverage private funds and accomplish goals. The NFF, NFWF, and NEEF can accept funds for direct investment in USFS work. The NFF has specific congressional authority to do so (NFF and USDA FS 2005). For instance, The Carbon Capital Fund is managed by the NFF and financed by corporations to support restoration projects on national forests in exchange for carbon offsets.

Early examples—The USFS partnerships benefit the public interest by providing ecosystem services from collaborative management or outreach activities. There are multiple ways to organize partnerships that connect providers and beneficiaries of ecosystem services. Table 3 presents examples of partnership structures where USFS facilitates investments by beneficiaries of ecosystem services to providers of those services for continued delivery.

Table 3—U.S. Forest Service (USFS) ecosystem services partnership opportunities and examples

Who pays	Motivation	Funding tools	Work funded	Example
Utilities	Cost avoidance Risk mitigation	<ul style="list-style-type: none"> • Cooperative investments and projects 	<ul style="list-style-type: none"> • Vegetation management adjacent to transmission rights of way • Utility infrastructure upkeep • Reduce hazardous fuels • Joint planning and research 	USFS and Western utilities group
City residents municipal water users	Clean and consistent drinking water supply	<ul style="list-style-type: none"> • Voluntary bond vote • Mandatory water rate changes • Partner contributions to nonprofit managed community fund 	<ul style="list-style-type: none"> • Targeted land conservation • Sustainable forest management activities • Habitat restoration • Watershed reforestation 	Watershed Investment Partnerships in Santa Fe, NM; Denver, CO; and Flagstaff, AZ
Companies Nonprofit partners	Corporate Sustainability Mission-related investing	<ul style="list-style-type: none"> • Partner contributions to nonprofit managed community fund 	<ul style="list-style-type: none"> • Healthy fish and wildlife habitat • Sediment detention basin construction • Rehabilitate alluvial fans • Filling deep gullies 	Coca-Cola® and National Forest Foundation National Watershed Replenishment Initiative
Consumers Tourists	Regional resilience and community development	<ul style="list-style-type: none"> • Voluntary point of sale donations coordinated by industry 	<ul style="list-style-type: none"> • Forest conservation • Forest restoration • Invasive species removal • Trail maintenance 	The Ski Conservation Fund

Note: Use of a trade or firm name in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service.

Source: USDA FS 2014a, 2016.

Our nation’s rivers, forests, grasslands, mountains, and wetlands provide a network of natural resources that benefit people.

Envisioning the future—Many of the collaborations highlighted in table 3 were started by partner organizations. Corporations, utility companies, citizens, and community organizations are accustomed to institutional collaboration. One approach for facilitating connections between providers and beneficiaries of ecosystem services is to define and pursue additional model partnerships. The USFS has an opportunity to proactively pursue shared work agreements for ecosystem service provision to deliver shared ecosystem services values. Continued engagement and strengthening relationships with partners across all levels of the agency will be instrumental in developing a shared vision of land and resource stewardship.

Environmental markets—

Our nation’s rivers, forests, grasslands, mountains, and wetlands provide a network of natural resources that benefit people. However, the values of the ecosystem services they provide, such as water filtration, pollutant sequestration, and weather protection, are infrequently incorporated into natural resource management decisions. Because it is challenging to quantify and assign monetary values to these services, these services are consistently undervalued. This results in the overuse of and stress on our natural infrastructure. Environmental markets can incentivize the preservation of these ecosystems and the continued delivery of benefit to people (Duraiappah 2006).

*Introduction to environmental markets*²—The USDA Office of Environmental Markets presents environmental markets as, “an innovative policy approach to increasing funding for environmental conservation and... a complement to traditional conservation programs” (USDA 2015a). In an ecosystem services market, transactions occur between actors interested in purchasing an ecosystem service and actors with dominion over the improved condition of an ecosystem service. There are currently pilot market programs and active established markets for carbon and other greenhouse gasses, water quality, wetlands, and habitats. These markets are designed to provide a cost-effective approach to improved natural resource management and increased options for conservation actions on private lands.

² Formal markets with open trading between buyers and sellers are either (1) under a regulatory cap or floor on the level of ecosystem services to be provided or (2) voluntary. Regulatory ecosystem markets are established through legislation that creates demand for a particular ecosystem service by setting a “cap” on the damage to, or investment in, an ecosystem service. The users of the service, or at least the people who are responsible for diminishing that service, respond either by complying directly or trading with others who are able to meet the regulation at lower cost. Buyers are defined by legislation, but are usually private-sector companies or other institutions. Sellers may also be companies or other entities that legislation allows to be seller and who are going beyond regulatory requirements. Voluntary markets also exist, as in the case of most carbon emission trading in the United States. For example, companies or organizations seeking to reduce their carbon footprints can be motivated to engage in the voluntary market to enhance their brands, to anticipate emerging regulation, or in response to stakeholder pressure. Voluntary exchanges are also a category of private payments (Forest Trends et al. 2008).

The Pacific Northwest Region is working with the Willamette Partnership and Defenders of Wildlife to develop the **Counting on the Environment** project, which established an integrated, functions-based protocol for calculating biodiversity ecosystem services provided by the restoration of wetlands, salmonid habitat, and prairie. With habitat metric development on private farm and forested lands finalized in 2009, this protocol is being used as a national model for ecosystem services markets.

Greenhouse gas markets—In carbon markets, supply and demand forces establish a price for tons of carbon emissions. Markets are regulated by emission trading schemes, which set rules that govern market transactions. Cap-and-trade is a common trading scheme for carbon and other greenhouse gasses (Gledhill et al. 2008). Similar to water quality markets, a regulator sets a cap on emissions from a set group of emitting agents. The regulator then assigns a certain number of allowances across the group of emitters. The emitters, or market participants, can then flexibly meet their targets through internal emissions reductions or through purchasing allowances in the market. Project-based offsets is another common trading tool. Here, third-party project developers can generate "offset" credits through proactive activities to sequester or mitigate greenhouse gasses below a baseline target. The emissions reductions below the target baseline can be sold in the regulated markets or in voluntary transactions.

Water quality markets—In watersheds across the United States, markets for nutrients, temperature, and sediment load reductions are developing to meet regional water quality goals. In a typical water quality trading market, a regulatory agency will create demand for water quality credits by imposing a maximum limit or "cap" on annual discharge of various pollutants in a watershed (Willamette Partnership et al. 2012). Discharge allowances equal to the cap are allocated among regulated discharging firms operating in the watershed. If a firm's discharge exceeds its annual allowance, it can pay a fine, reduce its discharges, or purchase allowances from another firm to offset this amount. Firms discharging less than their allowance can sell their polluting allowances as water quality credits (Ribaudo et al. 2008). The market enables allowances to be traded for a cost-efficient approach to regulating pollutants at a landscape scale (Willamette Partnership et al. 2015).

Wetland mitigation markets—Mitigation banks are a tool that incentivize maintenance of functioning coastal or freshwater wetlands and streams. Wetland mitigation banking markets were established to aid compliance with Section 404 of

the Clean Water Act, which requires compensatory mitigation for unavoidable impacts to aquatic resources. A mitigation bank is an aquatic resource area that has been restored, established, enhanced, or preserved to provide compensation for those impacts to aquatic resources permitted under Section 404 or a similar state or local regulation (USEPA 2015). A mitigation bank may be created through formal agreement between a regulatory agency and a government agency, corporation, nonprofit organization, or other entity. The quantity of compensatory mitigation credits generated by activities determines the value of a mitigation bank (U.S. Army Corps of Engineers and EPA 2008). Credits are measures of restored, established, enhanced, or preserved ecological function. The mitigation banks can use the credits to mitigate for internal impacts, or sell credits to external agents responsible for unavoidable impacts to aquatic resources. Mitigation banks are, “a form of ‘third-party’ compensatory mitigation, in which the responsibility for compensatory mitigation implementation and success is assumed by a party other than the permittee” (USEPA 2015).

Habitat markets—The Endangered Species Act (16 U.S.C. §1531—1544) incentivizes landowners and managers to improve ecosystem services on their lands by providing habitat for endangered and threatened species conservation. In habitat markets, landowners can provide natural resource values by conserving or managing parcels of land (conservation banks) in perpetuity for the benefit of a specified listed species whose habitat has been affected on another site (Jones 2003). Conservation banks deliver habitat of equal or greater value as impacts occurring in other sites to the same habitat types. Those who impact the habitat of the listed species can mitigate this impact by purchasing credits from a conservation bank. A conservation bank can be created by purchasing habitat, protecting habitat, restoring or enhancing disturbed habitat, creating new habitat, or managing habitat for additional values (USFWS 2012).

These markets can help achieve conservation goals when implemented in conjunction with other complementary approaches to sustainable natural resource management. Other tools such as subsidies, protection programs, public lands management, eco-labeling, and tax incentives are equally critical to solving environmental challenges (Ecosystem Marketplace 2013). Markets can also help incentivize conservation actions by those capable of providing the most ecosystem services at the most efficient cost. Environmental markets are designed for beneficiaries of ecosystem services to remunerate providers of ecosystem services to maintain a sustainable and healthy balance of conservation and impact.

USFS and environmental markets—Each deputy area of the USFS supports market approaches to sustainable forest management primarily by facilitating infrastructure for market transactions, and connecting providers and beneficiaries of forest-based ecosystem services.

- **State and Private Forestry:** As a provider of **technical and financial assistance** to states, tribes, communities, and nonindustrial private landowners, the USFS supports the creation of a flexible but secure market-enabling infrastructure. The agency generates demand for ecosystem services by offering incentives for conservation actions on private lands. The agency can also consider allowing landowners enrolled in USFS conservation protection programs to leverage federal funding to reduce barriers to market entry.
- **Research and development:** The USFS plays a role in **demonstrating sound science for market metrics and methodologies** through pilot projects and research on forest land. For the USFS to effectively support market development, the agency can look at essential ecosystem service market components and explore opportunities to provide market clarity and scientific guidance.
- **National Forest System:** It is possible for the USFS to consider a role as a buyer of ecosystem services in environmental markets. Environmental markets can allow the USFS to efficiently **compensate for environmental impacts the agency brings to the landscape**. In addition to providing ecosystem services from positive land management on NFS units, USFS management also generates impacts to ecosystem services and could seek to mitigate these impacts through credit or offset purchase. The USFS can also consider an internal ecosystem services market to meet agency goals. Ecosystem services generated on federal land can allow the agency to meet national goals (e.g., compensatory mitigation strategy).

More on mitigation—The USFS is working to develop a more systematic approach to avoiding, minimizing, and compensating for adverse impacts on natural resources and the ecosystem services they provide. This mitigation hierarchy establishes compensatory mitigation as the final step in a sequence of actions to offset unavoidable adverse impacts to natural resources (Brown 2010, U.S. Army Corps of Engineers and EPA 2008). Concerning mitigation, the main types of authorities the USFS has are:

- Allow rights-of-way on NFS lands.
- Manage NFS lands in a manner that might necessitate mitigation.
- Work with other agencies as interagency efforts on mitigation emerge.

The USFS is working to develop a more systematic approach to avoiding, minimizing, and compensating for adverse impacts on natural resources and the ecosystem services they provide.

Compensatory Mitigation and Ecosystem Services

Mitigation is a planning tool used to balance conservation and development on a landscape scale. It addresses adverse impacts (e.g., of development projects) on natural resources through three hierarchical steps:

1. Avoidance: Use onsite planning to avoid ecological impacts.
2. Minimization/reduction: Minimize onsite unavoidable impacts and their effect on future ecological and social values within and external to the project area.
3. Compensation: Compensate for unavoidable residual impacts through the provision of positive or additional resources on- or offsite. Compensatory mitigation preserves, enhances, restores, or establishes ecological resources to compensate for or offset unavoidable resource impacts.

The U.S. Forest Service (USFS) policies and procedures require avoidance and minimization of development impacts on a case-by-case basis. The agency is working through a cross-deputy area initiative to provide a comprehensive national mitigation framework. This could allow the USFS to participate in mitigation at the landscape, regional, or watershed scales, both internally and in partnership with other agencies and private actors. It will build from lessons learned from compensatory mitigation on National Forest System units and by other agencies.

In a recent example of USFS compensatory mitigation activity, the Francis Marion and Sumter National Forests in South Carolina signed a conservation land use agreement in 2013 with the U.S. Army Corps of Engineers (USACE) Charleston District that established a framework for compensatory mitigation. Under this framework, permittees and developers can meet USACE mitigation requirements, as dictated by the Clean Water Act §404, by restoring or enhancing aquatic resources on the national forest, or by transferring suitable lands to the appropriate National Forest System units. Through this framework, Boeing purchased 4,000 acres of land adjacent to the Francis Marion National Forest for \$12 million in 2014 to be transferred to the national forest as compensation for unavoidable ecological impacts in a nearby development project site.

The National Ecosystem Services Strategy Team collaborates with the leaders of the USFS compensatory mitigation cross-deputy team. There is an opportunity for the USFS compensatory mitigation framework to consider a full suite of ecosystem services in impact calculation methodologies, and offset requirements so that solutions in landscape-scale scenarios better fit the impact or range of impacts. An ecosystem services approach can help to identify priority areas for compensatory mitigation. Preservation and enhancement success can be determined by assessing ecosystem services benefit delivery. Nonmonetary valuation methods from the ecosystem services approach can help the agency consider how to address impacts to environmental, cultural, spiritual, educational, economic, and recreational resources in the compensatory mitigation framework. Also, work on damage assessments can potentially inform the agency's final strategy.

Legal authority—The USDA Office of Environmental Markets and the USFS Ecosystem Services and Markets program are two entities in the USDA that partner with stakeholders to develop the infrastructure, capacity, and tools necessary to support transactions in environmental markets. Section 2709 of the 2008 U.S. Farm Bill focused on environmental services markets and officially established the Office of Environmental Markets under the department secretary. As an agency of the department, the USFS acts in tandem with the Office of Environmental Markets (Lucero 2014). The mandate for the office is to design science-based methods to measure, report, and maintain ecosystem services from the land management activities of farmers, ranchers, and forest landowners. The 2008 U.S. Farm Bill, which was renewed in 2013, is a guide for the department’s vision of public involvement in, and support of, environmental markets.

The S&PF Redesign Implementation Council approved new national objectives for the deputy area in 2008, including to maintain and enhance the economic benefits and values of trees and forests; connect people to trees and forests and engage them in environmental stewardship activities; and manage trees and forests to mitigate and adapt to global climate change (USDA FS 2008a). These national objectives indicate that the USFS is also prioritizing opportunities to advance economically viable conservation activities and stimulate markets and payments for ecosystem services on public and private forest land. For more details on policy guidance and initiatives related to environmental markets, see appendix 1.

Opportunities for USFS involvement in environmental markets—There is no specific federal authority that authorizes the USFS to be a participant in environmental markets, nor does the agency’s mission clearly lead to an active role in market transactions beyond forest products. Development of the opportunities below for market participation is contingent upon policy clarity and defined strategic agency direction. Specific opportunities for markets include:

- **Carbon:** In July 2007, the Forest Service and the NFF entered into a memorandum of understanding to develop three demonstration projects supported by the NFF’s Carbon Capital Fund (CCF). The projects reforested areas of NFS land to generate carbon offsets for the corporations financing the CCF. Participating companies retired the credits from the carbon marketplace and used the offsets generated for corporate social responsibility claims. The projects were completed in conjunction with NFS carbon mitigation and management goals, and continue to demonstrate the role of forest management in climate change mitigation. The USFS is researching opportunities to produce additional carbon offsets to either be retired or traded in the voluntary market (Ryan et al. 2010).

Special Highlight: USFS and Wood Innovation Markets

Markets for wood-based biomass are driven by national, regional, and local climate change reduction and renewable energy goals. The U.S. Forest Service's (USFS) internal driver for increasing demand for wood-based fuel is also related to the cost of fire suppression on national forests and the need for restoration through biomass removal to promote resilient forests and healthy watersheds. In the past 3 years, the USFS biomass program has worked to leverage these drivers to create demand for wood energy from small-diameter timber. Owing to a legacy of overstocking, the USFS has a large supply of small-diameter timber to meet these demands. Transitioning national forests from pile-and-burn operations to increased woody biomass utilization can bring significant benefits for local employment, reduced greenhouse gas emissions, sustainable fuel supply, and avoided costs in fire suppression.

The USFS is exploring opportunities to help incentivize biomass removal and develop and support markets for small-diameter timber from National Forest System and adjacent land. The USFS biomass program goals include:

- Create market demand for biomass energy derived from wood utilization.
- Work with partners on proof of concept for carbon offset credits from woody biomass utilization and solid wood cross-laminated timber (CLT) made from small biomass to replace carbon-intensive steel and cement in large construction.
- Integrate biomass utilization for wood energy to existing watershed investment partnerships.
- Continue to explore opportunities to layer financing to reduce barriers to entry and increase viability of a wood-based energy economy.

The USFS can generate additional demand for biomass utilization by building public interest in, and understanding of, wood-based energy. Communication and outreach is critical to address perceived negative impacts of wood burning. The USFS can also use staff expertise and grant programs to research and pilot approaches to accurately account for sequestered and emitted carbon in wood utilization. The agency will benefit from additional staff at the Forest Products Laboratory assessing ecosystem services resulting from the full life cycle of biomass products including small-diameter timber harvesting, biomass pellets or CLT generation, and burning or construction. These supply chains confront challenges in carbon offset jurisdiction, community-based production distribution, access to finance for pilot projects, and local capacity for harvesting techniques. The Forest Service has an opportunity to address these challenges through training programs, partnerships with investors and bankers, grants to promote local wood energy infrastructure, and research to support metric development and clarity on environmental impacts of woody energy and construction.

- **Wetlands and biodiversity:** The USFS can collaborate with the U.S. Fish and Wildlife Service and the U.S. Army Corps of Engineers to clarify policy requirements regarding compensatory wetland and species mitigation credits from public land to trade and transfer in the domestic market. The Forest Service can also conduct its own wetland or species mitigation projects when USFS activities affect these threatened ecological systems. This opportunity will require the Forest Service to develop capacity for monitoring ecosystem services outcomes from specific forest treatments and restoration activities.
- **Water:** The USFS is a leading participant in water quality and quantity payments for ecosystem services. The USFS initiatives such as watershed investment partnerships and corporate partnerships for forest restoration are discrete transactions that can inform development of future market-driven projects. For instance, the Coca-Cola Company is funding forest restoration on USFS land in watersheds where the company operates through partnerships with NFF, NFWF, and local entities. Land management actions funded by Coca-Cola include construction of sediment detention basins, rehabilitation of alluvial fans, filling of deep gullies, and other projects to provide ample and clean water supplies for surrounding communities. Coca-Cola is not financing these projects in response to a specific market-based demand, but to meet its internal long-term water replenishment goals. These types of projects build USFS experience in generating defined units of ecosystem services benefits that will increase the agency's ability to enter formal markets for water quality and quantity as they develop.
- **Other:** The USFS certifies that forest products from the national forest were derived using sustainable approaches to management and harvesting under standards of the Sustainable Forestry Initiative and sometimes the Forest Stewardship Council. Certification is a market-based tool to incentivize forest stewardship. Ecosystem services are not officially measured and quantified under these certification systems, but certification often grants access to markets and sometimes price premiums for sustainably produced forest products.

Envisioning the future—The Forest Service's opportunity to serve as a participant, designer, and facilitator of markets will be nuanced and challenging; however, the agency is well positioned to shape markets so they best steward the ecosystems whose services they monetize. The USFS can continue to connect providers and beneficiaries of ecosystem services by facilitating environmental markets. The agency has an opportunity to contribute to further innovation in environmental markets by developing tools to support private landowner engagement in markets, generating proof of concept from scientific research and pilot projects on national forests, engaging in partnerships that embrace market-based tools, and establishing national strategy around mitigation of impacts to natural resources.

The USFS can continue to connect providers and beneficiaries of ecosystem services by facilitating environmental markets.

Synthesis

Overview

An ecosystem services approach will not only help transform the agency into a more effective and relevant organization, it will bolster external relationships by strengthening investment in restoration outcomes and articulating a management vision in terms of values. It will help the agency illustrate its rationale for management decisions and rebuild trust between national forests and their surrounding communities. Adoption of an agencywide ecosystem services framework will significantly help the USFS to care for the land and serve people.

The opportunity to adopt an ecosystem services approach throughout the USFS could significantly improve the agency's ability to make strategic management decisions, create adaptive policies, quantify and communicate the value of forests, build partnerships, and enable private landowners to engage in environmental markets. This paper presents 11 core opportunities to integrate ecosystem services into agency policy and operations (table 4), but many more may be explored through the engagement of staff and partners.

The USFS is in a prime position to set the standard for integration of ecosystem services as a central and unifying concept in federal land management. The agency's mission, strong research and development capacity, and focus on partnerships make it uniquely suited to promote innovation. Many USFS resource programs, research offices, national forests, or state and private partners are already using ecosystem services concepts to frame the objectives of their programs and monitor success. Building on and learning from their experiences will allow the USFS to work expediently toward actualizing the opportunities presented in this paper.

Although the USFS has demonstrated leadership in the field by successfully integrating ecosystem services into specific agency policies and operations, this work is not adequately coordinated. There is a need for national policy to articulate the value of considering ecosystem services in all aspects of the USFS work and to clarify executive leadership's intent for program staff to do so. Staff capacity can be strengthened by providing training resources and creating support structures to help employees incorporate ecosystem services analyses into their daily responsibilities. The agency would also benefit from more cohesive data collection and storage systems that can help tell the story of why forests matter—in ecological, social, and economic terms, at various scales, and in diverse contexts.

The challenges of implementing an ecosystem services approach are numerous, but not insurmountable. To realize the vast potential of ecosystem services to enhance the agency's relevance and effectiveness, it is critical that the agency continue to focus on collaboration. Increased communication through collaborative

Table 4—Core opportunities and needs for ecosystem services integration into U.S. Forest Service policy and operations

Opportunities	Needs											
	Resources and cooperation		Data			Communication			Policy			
	Staff capacity	Reference materials	Align funding, priorities	Metrics, performance, data	Valuation and mapping tools	Research strategy	Collaboration, partnerships	Communication strategy	Leadership signals	Strengthen policy	Clarify policy	Policy gaps
Consider ecosystem services approaches as a means to improve the transparency and success of analysis, decisionmaking, and priority setting.												
Forest planning	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Project-level NEPA	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Program area priority setting	✓	✓	✓	✓	✓				✓			✓
State forest action plans	✓		✓	✓	✓				✓			
Quantify and communicate in terms of benefit to people through measuring, reporting, and outreach.												
National assessments		✓	✓	✓	✓	✓	✓	✓	✓			
Inventory monitoring and assessment	✓	✓	✓	✓	✓	✓	✓		✓			
Performance measurement	✓		✓	✓	✓	✓	✓	✓	✓			
Connecting providers and beneficiaries of environmental benefits and values through investments in ecosystem services.												
Incentives	✓		✓	✓	✓	✓	✓	✓	✓		✓	
Damage mitigation	✓	✓		✓	✓	✓	✓		✓	✓	✓	
Investment partnerships	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Environmental markets	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

NEPA = National Environmental Policy Act.

relationships can improve internal and external information sharing about the benefits of national forests and grasslands (particularly to the general public and congressional appropriators), support the exchange of lessons learned from case studies and success stories, and highlight incentives for partnerships. To better integrate ecosystem services into agency operations, staff at all levels should engage in robust discussions around priorities and the next steps toward accomplishing this. Programs and deputy areas without a history of shared goals can find seats at the same table to address their common needs.

Common Needs

Each of the opportunities identified in this paper has unique potential value to the agency, and a unique set of needs the agency must address to capitalize on that value. These needs fall into four broad categories: resources cooperation and infrastructure, data integration and management, communication, and policy. Beyond this, there are discrete subsets of needs within each broad category that, if addressed, will help the agency meet their objectives. These common, or cross-cutting, needs are described in detail below.

Resources, cooperation, and infrastructure—

Build staff capacity for the concept and application of ecosystem services—

To effectively integrate an ecosystem services approach into policies and operations, the USFS must cultivate understanding and dialogue at all levels regarding the concept, vocabulary, and benefits of addressing ecosystem services in resource management decisions. Ecosystem services considerations should be integrated into existing programs and serve key management objectives rather than being “add-ons.” Communication about the ecosystem services concept should be a two-way exchange—i.e., staff can share key challenges and opportunities, and management can share strategies for addressing those key needs through an ecosystem services approach. Ecosystem services applications to management challenges can encourage integration across disciplines and deputy areas. The effort can use multidirectional communication (e.g., district level to national, national to district, cross-regional) to ensure policymakers understand realities on the ground, and forest managers understand broader agency goals.

The USFS can establish a network of champions to provide training and engage all forest supervisors and regional planners in this effort, which conserves agency resources and empowers existing leaders. These champions can then go on to motivate and educate within their spheres of influence. Training programs could also be developed to establish a cadre of individuals who can be called on to facilitate ecosystem services discussions and implementation, when the need arises.

The USFS can use webinars, workshops, conferences, rotational training teams, forest-level learning groups, and other innovative information-sharing mechanisms to promote a collective understanding of the ecosystem services concept and to apply it across the USFS management context.

The USFS benefits from collaboration with other federal agencies and partners that are developing capacity for addressing ecosystem services in natural resource management. The U.S. Geological Survey and the EPA are among our federal partners in this endeavor. Efforts like the NESP promote sharing of methods and resources across the federal government. The USFS also supports infrastructure development for payment programs and markets. These tools and protocols can be tested and adapted on NFS lands to increase understanding and articulation of management outcomes.

Create and publish USFS ecosystem services resource and reference materials in a centrally available location—To successfully apply ecosystem services to USFS programs and operations, information and guidance resources need to be readily available and accessible to agency personnel. The desired outcomes for ecosystem services applications (e.g., strengthening collaboration and program integration, clarifying management rationales, communicating management outcomes in meaningful terms, targeting actions to maximize effectiveness) can be accomplished using tools that are adaptable for application in diverse ecological and social settings. Guidelines, handbooks, templates, lessons learned memos, and step-by-step manuals that allow for flexibility and creativity at the local level can accompany ecosystem services policies and facilitate implementation. These materials should be centrally stored and maintained to reduce redundancy, maintain currency, flag best practices or tools, and make stewardship of the information easier. Some resources that could be developed to fill existing needs include:

- **Cross-deputy area website and knowledge base:** A website and knowledge base could host all of the materials mentioned below and be maintained by a cross-deputy area staff. The website can include relevant ecosystem services policies, archived webinars from a variety of sources, links to existing publications, workshop materials, training materials, manuals, podcasts, and an informal forum to source guidance from geographically dispersed staff. Maintenance of web and knowledge base services would require dedicated staff.
- **Forest Service ecosystem services primer:** The USFS can create an Ecosystem Services Manual that contains USFS-accepted ecosystem services definitions and synthesizes the science of ecosystem services on forests and rangelands.

The USFS benefits from collaboration with other federal agencies and partners that are developing capacity for addressing ecosystem services in natural resource management.

- **Technical guidance:** In certain instances, direct technical support should be available to provide clear and agreed-upon guidance on best practices developed through research and application with regard to specific ecosystem services protocols. Technical guidance can be in the form of handbooks, templates, and how-to guides for incorporating ecosystem services into various agency practices and procedures for specific types of decisionmaking and activities. Applicable analytical tools and models could be cross-referenced.
- **Case studies:** Case studies of USFS ecosystem services project experimentation and collaboration may help inspire new partnerships or the replication of past successes. Pilot projects for environmental markets or new payment mechanisms for ecosystem service delivery provide a testing ground for new approaches and metric development, and establish proof of concept for private partners.
- **Lessons learned memos:** Beyond case studies, creating lessons-learned memos would help (1) coordinate USFS teams innovating around similar challenges, (2) highlight shared successes and challenges, (3) create opportunities for more efficient design, and (4) decrease the time and funding required to replicate projects or partnerships. Having a toolkit of digestible materials would also help communicate the concept with the public.

Align agency staffing, funding, and program structures with ecosystem services priorities—Each opportunity presented in this report would benefit from an established USFS financial and employment infrastructure to support collaboration around an integrated ecosystem services approach. To fill this need, the Forest Service may consider allocating dedicated funding for ecosystem services across each deputy area. Agency leadership may consider using ecosystem services as an organizing principle for research and regional staff groups. The USFS would also benefit from recruiting a high-level leader to help drive integration of ecosystem services throughout agency policy and operations. To support implementation, the USFS can build capacity for addressing sustainability, ecosystem services, social sciences, and communication through development of existing employees and acquisition of new talent to serve as ecosystem service facilitators, technical assistance providers, or coordinators. An ecosystem services network could be modeled after the sustainable operations structure of regional experts. Because the ecosystem services mandate cuts across staff areas, the agency should identify and communicate the responsibilities of each job within various deputy areas and staff levels to articulate a diversity of contributions to an ecosystem services approach.

Data integration and management—

Within the agency, data are inconsistently aggregated owing to the vast diversity of criteria, monitoring techniques, and regional and landscape-level intricacies in social, economic, and ecological conditions. Different databases may house similar if not identical information, which can hamper efforts to locate specific information and retrieve data. The compendium of various interfaces, data warehouses, and viewing tools may make data accessibility and information sharing across program areas or regions onerous. Information queries are also limited in scope and cannot pull integrated information from multiple databases in the manner necessary to examine ecosystem service provisioning and benefits across a landscape or watershed. The increasingly collaborative process of ecosystem services tracking and metric development requires clear guidance on where data are housed, both internally and among other public land management agencies. The complex and holistic ecosystem services approach to informing management decisions, reporting accomplishments, and developing environmental metrics for emerging markets cannot be fully achieved without actively engaging data resource program areas and leveraging research to develop more refined tools for assessing multiple ecosystem service tradeoffs across landscapes.

Identify inventory metrics, define outcome-based performance indicators, organize and link data—The PCAST and BEST studies and data reporting suggest that the federal natural resource management agencies already have the collective capacity to produce the broad array of information necessary to evaluate and account for the provisioning and flow of ecosystem services in monitoring and assessments (PCAST 2011). A recent integrated business environment study detailed many of the data management issues facing the agency and provided recommendations for streamlining information and warehouse processing systems internally. The report found that efforts to monitor, report, and quantify ecosystem services at a broad scale were plagued by suspect data quality, inconsistent data cleansing, the lack of a functional and standardized data-retrieval process, and the collection of too much unwieldy data with too little direction. Underlying many of these challenges is a strong tendency for groups within the agency to assess data myopically to support specific business needs, causing reporting redundancies. The team conducting the study emphasized the need for robust system architecture, alignment of data collection processes and resources, establishment of an authoritative standardized data source, metadata registry and standards, consolidation, tracked information delivery, and timely updates across program areas. Realizing this goal will require a coordinated effort to identify, define, organize, and link data. An agencywide policy framework should be accompanied by credible and responsive data handling,

Ecosystem services metrics can help program managers and forest planners communicate the social value of their activities and conditions on their forests.

delivery, and storage procedures to serve ecosystem services objectives. Data storage systems that are compatible across resource programs can facilitate information sharing and enable integrated assessments and decisions.

Ecosystem services are assuming a more prominent role in the performance reporting process for executive branch agencies. The USFS needs a more meaningful and consistent process for reporting the outcomes of agency efforts both internally and externally. Performance objectives need to address the importance of forests to the American public and delineate economic contribution with ecosystem functionality. Because regional biophysical data are difficult to process and aggregate if overly specific, the economic and social impacts of activities should complement reporting and monitoring as a means to more uniformly or consistently describe the impacts of management. Ecosystem services metrics can help program managers and forest planners communicate the social value of their activities and conditions on their forests. The challenge is to develop measures that are broad enough to be applied consistently on a national level while reflecting and ensuring sensitivity to local ecological, social, and economic conditions (i.e., forests or regions may have more refined or varied metrics to facilitate communications and decisionmaking). Additionally, perception of ecosystem goods and services varies by sociopolitical and environmental landscape. The agency could benefit from a flexible, tiered approach to data management to serve a variety of purposes, where regional offices are afforded full discretion in collecting information and designing metrics that fulfill the more broadly defined objectives and standards set by the Washington office.

Once the agency has identified national metrics for various ecosystem services, and performance indicators for outcomes, data managers can coordinate and communicate with each other to develop a single data storage system that facilitates single-stream data retrieval to support integrated ecosystem services-based decision-making. Accurate and accessible data are critical for use in economic models for ecosystem services valuation as well as in nonmonetary assessments. A strong emphasis on increased information sharing with other federal agencies is also warranted.

Potential next steps to address these inventory, performance, and data needs include:

- Establishing a reference website of USFS ecosystem services datasets and tools.
- Identifying list of key ecosystem services to measure, and relevant metrics for biophysical, social, and economic data.
- Coordinating with metrics applied in relevant settings, such as those used by utilities to assess the cost-benefit of watershed investments.

- Defining ecosystem service performance targets that are outcome-based and capture the value of healthy resources at the national level.
- Identifying examples or templates of ecosystem services desired conditions that can apply at regional or forest levels.
- Coordinating inventory efforts to reduce data overlap.
- Consolidating data storage and retrieval into transparent and user-accessible databases through a library or catalogue that helps categorize and cross-reference information, projects, and models.
- Collaborating with other federal agencies to leverage existing know-how when data are required beyond NFS boundaries.
- Establishing a long-term common framework and transparent governance of data systems to improve agency ability to collect and use data.

Value and map ecosystem services using current tools and methodologies—

Credible tools and replicable techniques for quantifying and valuing ecosystem services are needed to support decisionmaking. These tools and methodologies could help the USFS communicate changes in ecosystem services delivery in a variety of terms, including biophysical units and social and economic outcomes. Existing agency tools and resources should be leveraged to characterize ecosystem services benefits provided by forests and grasslands. However, many of these tools do not adequately reflect regulating or supporting services and rarely consider the values of these services, which limits the agency's ability to communicate these values and consider tradeoffs across management alternatives. To best inform decisionmaking processes, models and tools should be capable of illuminating linkages between land management shifts and ecosystem services delivery. Appropriate and robust methods to value (monetized or nonmonetized) ecosystem services based on market and nonmarket cost should be highlighted and explored for wide-scale applicability to ecological services of interest. For example, avoided cost analysis could be

Avoided Costs

A partnership with California utilities centers on restoring forests to avoid costs related to wildfire threats, such as damage to infrastructure and impaired water quality. The White House has continually communicated that inaction on climate change implies high future costs for citizens and corporations. John Podesta, advisor to President Obama, stated: "The cost of inaction on wildfires and climate change is too high a price for Americans to pay, particularly when we have a chance to address this right now."

applied to determine the ecological value-added of natural regulating or supporting services based on the estimated amount of economic damage resulting in the absence of selected services or ecosystems. The agency can identify where gaps exist in valuation and where models and methodologies for valuation and quantification should be identified, tested, modified, and made accessible to maximize the agency's ability to describe ecosystem services benefits, such as the frequency and success of their application, and guidelines for integrating modeling results into current operations, decisionmaking, and adaptive management.

Equally important is the need to conduct national assessments to link USFS activities to the conditions and health of natural resources as well as to the conditions and welfare of communities and people. Because ecosystem services are strongly dependent on geographic relationships between resource conditions, flows, and beneficiaries, a spatial product would be very useful. Mapping trends in quantified ecosystem services values across ownership categories on a national scale, while scaling to local and regional subassessments, will provide a communication tool to the public and a decisionmaking tool for the USFS. The agency has already begun internal and collaborative processes of data inventorying and monitoring regional trends and vulnerabilities as they relate to ecosystem service flows over time. For example, the agency is a member organization in the Appalachian Landscape Conservation Cooperative, which is directing a project mapping ecosystem threats and stressors across the landscape as they affect service flows, as well as collating the data sources and models needed to further their studies. Projects like this have added value in linking stakeholders and external partners to identify shared commonalities and leverage existing technical capacity and datasets.

Meeting needs in quantification, valuation, and mapping will entail:

- Assessing the ability of current agency tools and resources to address ecosystem services objectives.
- Identifying models and methodologies that have potential for USFS use in a variety of settings (e.g., quantitative, qualitative, project scale, landscape scale, rapid assessment, and indepth).
- Analyzing the strengths and weaknesses of the various tools.
- Deciding which tools to apply in which circumstances, or whether to design new applications and, if so, how to integrate them.
- Conducting national-scale assessments of the condition of various ecosystem services.
- Linking quantified ecosystem services changes to USFS management and community values and needs.
- Conducting mapping exercises of these values to support site-specific understanding of benefits and where USFS management affects their delivery.

Develop an ecosystem services research strategy to fill information gaps—

To support all the opportunities identified in this report and others yet to be articulated, USFS programs, units, and resource areas can collaborate with the R&D deputy area to design a shared vision for ecosystem services and tackle information gaps to implement that vision. Research and Development can address a variety of needs including the development of ecosystem services metrics, protocols, and tools for tradeoff analysis; incorporation of ecosystem services into state action plans; understanding of the science of environmental market credit stacking; and additionality in carbon pilots. This research can be coordinated on NFS units through forest management, or in urban areas and diverse ownerships through S&PF. Most critical is the need to better articulate and document the complex causal relationships between changes in ecological structure or function in providing ecosystem services on private and public lands, and the role the agency plays in impacting changes through management, partnerships, and financial assistance. To fully realize and develop a comprehensive strategy, researchers are collaborating with external partners and academic institutions through regional conservation cooperatives and watershed councils to address data needs, consolidate information on projects to leverage expertise, elevate human dimension components, and avoid duplication of efforts. As the USFS inventory, monitoring and assessment is evaluated through an ecosystem services lens, it can also help shape a national research agenda based on information gaps between how data are collected and reported.

Communication—

The ecosystem services concept has tremendous potential to help the USFS communicate the importance of forests and grasslands to staff, Congress, the public, and stakeholders. Highlighting relationships between ecological conditions, management, conservation of public lands, and social benefits can help the agency illustrate the rationale for planning goals and project implementation. Communication about ecosystem services objectives involves an iterative exchange of information across USFS programs, and between the agency and the public. This exchange can help USFS staff understand interdisciplinary drivers for management and how best to address public values and priorities. It is also imperative that the agency clearly articulate the added value of an ecosystem services approach from the perspective of agency effectiveness and efficient management of public resources.

Expand collaborative outreach and partnerships—Partnerships with nongovernmental organizations; federal, state, and local agencies; universities; and other private entities can help the USFS accomplish shared goals for ecosystem services delivery. These partnerships are particularly critical given constrained time and

The ecosystem services concept has tremendous potential to help the USFS communicate the importance of forests and grasslands to staff, Congress, the public, and stakeholders.

resources. To enhance the agency's ability to partner with for-profit entities and exchange financial resources to support the delivery of benefits, the USFS can consider the following options for future action:

- Review learning and share experiences with other federal agencies about the potential impact and regulatory nuance of private partnerships.
- Articulate a shared vision of collaboration between forests and their local partners. This includes increasing an understanding of what ecosystem services are, what their value is to local communities, and what public-private partnerships can do to support the continued delivery of benefits.
- Develop guidance documents to help regional offices design and replicate ecosystem services projects. Lessons learned from existing initiatives have yet to be compiled. Maintaining partnerships can be time and capital intensive, especially for lightly staffed local USFS offices. Publishing step-by-step or how-to guidelines to leverage existing know-how could reduce up-front costs.
- Support expanded national ecosystem services collaborations with mapping and data analysis. Mapping public ecosystem services values and USFS management impacts will help highlight opportunities for collaboration. The USFS is currently working with Forest Trends, the USDA, EPA (USEPA 2008), and U.S. Geological Survey to create an extension on Enviro-Atlas to illustrate the prevalence of environmental markets with geospatially linked qualitative and quantitative data. This map could be a great first step toward exploring opportunities for USFS to facilitate and enable ecosystem services markets.
- Analyze the extent to which forest restoration can help avoid unnaturally high-severity wildfires or reduce the cost of mitigating the impacts of climate change to help the USFS articulate the business case for investments in forest-related ecosystem services. For instance, the USFS collaborated with The Nature Conservancy and the Sierra Nevada Conservancy to research and model the potential effects of fuel treatments in the upper Mokelumne River watershed on the probability, extent, and intensity of wildfire. The partners also evaluated the costs and benefits of fuel reduction treatments on future fire suppression costs. The study found that the "total quantified benefits of fuel treatment would very likely exceed the costs of treatment" (Buckley et al. 2014).

Broaden communication to decisionmakers and citizens—In addition to collaborative outreach, the USFS needs a more formal communication strategy at all levels of the agency to support an ecosystem services approach. Communication strategies can be linked from NFS units to regional offices, across research teams, and across national programs, resources, and deputy areas. Communicating the value of USFS activities in delivering public benefits will require the agency to identify and engage key stakeholders, and to craft tailored messages based on input from those stakeholders to illustrate how the agency achieves diverse objectives and serves varied constituencies. These messages need to be consistent but communicated using multiple avenues and mediums. Strengthening public participation in decisionmaking at various scales and points in the planning process can build mutual understanding and trust in USFS activities and underscore the relevance of the USFS mission. Overall, increased communication from USFS supports a better understanding of society's dependence on forest and grassland ecosystems and the role the agency plays in sustaining those benefits.

Policy—

Support leadership agreement on a national strategy and authority for the agency—Support for a governance framework that catalyzes an ecosystem services approach throughout the agency must begin with agreement and coordination from leadership. Presently, program directors, regional directors, forest supervisors, and associate deputy chiefs may have divergent views regarding the potential for using ecosystem services to plan, monitor, and communicate USFS activities. It is important to establish a space for coordinated leadership to promote understanding of the issues and foster open dialogue to reflect upon the tradeoffs among policy options. Deliberate and coordinated leadership can help align program objectives with the agency mission. Leadership can engage with internal and external experts around rapidly evolving ecosystem services science to build on the ideas and suggestions in this report and develop a national strategy for integrating an ecosystem services approach into USFS policy and operations.

Defining policies will result in an energized, synchronized, and transparent agency that is capable of building highly successful partnerships and achieving demonstrable positive outcomes for citizens. To create this framework, the USFS must address policy and governance needs. The agency's policy needs fall into three categories: (1) strengthening existing policy, (2) clarifying existing policy, and (3) addressing absence of policy.

Strengthen ecosystem services concepts within existing policy—

Agency NEPA language: National forests developing land management plans under the 2012 NFS land management planning rule must address ecosystem services in their management vision. Projects that tier to these plans will reflect this vision and can therefore include ecosystem services objectives. The NEPA requires federal agencies to assess project-level management options through a public participation process that considers the social, economic, and environmental impacts of multiple alternative actions. While the NEPA does not specifically mention ecosystem services, the regulation underscores linkages among social, economic, and environmental considerations. Applying ecosystem services concepts to the NEPA process can directly serve the intent of the regulation.

Using the NEPA as a tool to consider project-level ecosystem services delivery will require digestible guidance for NFS units, which can be informed by existing pilot projects with input from national and regional program leadership. This guidance should emphasize the value of such an approach—including allowing for more highly integrated and interdisciplinary management recommendations, and more meaningful articulation of management rationale and outcomes—as well as the efficiency gains experienced by case study units. It should also highlight project characteristics that are most conducive to applying ecosystem services concepts, and those for which it might not be appropriate.

State and national assessment language: The 2008 Food, Conservation and Energy Act (U.S. Farm Bill; USDA 2008) requires all states to complete an assessment of forest resources every five years. This assessment is to be accompanied by a strategy or action plan to accomplish three objectives: preserve working forests, protect forests from harm, and enhance public benefits derived from trees and forests. An ecosystem services approach to long-term forest stewardship on public and private lands can directly address this final objective. Stronger language referring to the benefits of applying ecosystem services to forest action plans would facilitate consistent use of methods and data aggregation on a national scale. The USFS can work with states to capitalize on the potential for addressing ecosystem services in forest action plans.

The 1974 Forest and Rangeland Renewable Resources Planning Act requires the USFS to complete national assessments of renewable resources. This act states that managing renewable resources involves consideration of, “tangible and intangible goods and services, along with estimates of investment costs and direct and indirect returns” (16 U.S.C 1600). This language points to consideration of the full suite of benefits from forests and grasslands, without specifically referencing the concept of ecosystem services. Data on ecosystem services

delivery, threats, and trends developed from national assessments could be highly beneficial for all partners involved in forest stewardship nationwide, and especially for the USFS.

Clarify an ecosystem services approach within existing policy—

Partnership language: Multiple authorities provide for the exchange of funds and services between the USFS and private entities. These include participating agreements, challenge-cost share agreements, collection agreements, and interagency agreements. While the agency has these legal tools at its disposal, it does not have the benefit of clear policy language establishing authority to create investment partnerships with nontraditional partners, such as utility companies and private sector actors. However, there is no policy language that expressly prohibits these actions either. In the absence of clear authorizing language, the USFS established an informal 2011 public-private partnership strategy. This is indicative of agency leadership's dedication to promoting shared investment in the benefits from healthy forests and grasslands. Still, more often than not the USFS chooses to work through nonprofit third party partners to avoid endorsement concerns and other conflicts, rather than working directly with a private entity when attempting to connect providers and beneficiaries of ecosystem services. Clarifying policy can help the agency leverage the impacts and benefits of its interventions. Policy clarification will eliminate misinformation regarding USFS authority to work with private partners and reduce the tentativeness of NFS units, research stations, regional offices, and national programs to pursue innovative investment partnerships.

Damage assessments language: Specific authorities allow the USFS to assess damages occurring on or affecting NFS lands, resources, and properties. Calculating damage costs according to impacts on ecosystem service values and ecological function is not expressly authorized or prohibited. The three landmark cases presented earlier, *U.S. vs. Scarry*, the Storrie Fire case, and the PG&E Fire case, validated USFS damage calculations that were based on more than merely timber values, suppression, and restoration costs. In these cases, the final ruling of mitigation costs included both market and nonmarket values. However, most damage assessments do not fully account for the value of the ecosystem services delivered by the impacted resource. This presents a considerable opportunity for USFS. In 2013, the agency closed 350 damage assessment claims for over \$146 million. If all 350 claims accounted for ecosystem services values and reflected the true impact of the damages, this sum would increase significantly. The agency could benefit pursuing clear and decisive policy to mandate, or at least expressly allow, inclusion of ecosystem services and public values in

natural resource damage calculations. These processes should include building an understanding and prioritization of ecosystem service-oriented resiliency goals within the NFS offices of Engineering, Law Enforcement and Investigations, and Budget and Finance Claims, and other relevant resource programs; agreement on a consistent valuation method and ecosystem modeling tools that are cost effective; and exploring avenues for data collection in a systematic fashion to support these techniques.

Address the absence of policy—

Cooperative assistance language: Currently, there is no legislative direction regarding how the USFS should target financial, technical, and cooperative assistance. Similarly, there is also no legislative direction regarding how the USFS should monitor outcomes from this assistance. The USFS can continue to increase the impacts of the financial incentives and technical support it offers by focusing on actions that deliver the most significant ecosystem services benefits.

There is also an absence of policy related to the USFS role in dictating whether private lands enrolled in Forest Legacy Program (FLP), Forest Stewardship Program, or other cooperative forestry assistance programs are able to generate and trade credits in environmental markets. In some instances, private landowners with easements established through the FLP have successfully generated and sold carbon credits in voluntary and regulated markets. In other instances, FLP easements possess language which either intentionally or unintentionally restricts the landowner's ability to participate in carbon markets. Sometimes language in FLP agreements is ambiguous and landowners are unclear about whether participation in environmental markets is permitted. An overarching policy to guide private landowners engaging in cooperative forestry assistance act programs and environmental markets would dramatically decrease this uncertainty.

Environmental markets language: There is currently no national guidance regarding ecosystem services metrics. The USFS is not a regulatory agency, and therefore is not responsible for creating policy clarity for private landowners. However, the agency can collaborate with other governmental agencies to develop scientific analyses and policy recommendations necessary to support credible accounting and verification systems and standardized methods for delivering ecosystem services benefits. The agency can dedicate staff to explore these scientific questions and resources and pilot potential solutions to conceptual challenges in environmental markets such as credit stacking and credit bundling.

The USFS does not have internal policy to indicate whether the agency's lands are eligible to generate saleable credits in environmental markets. The USFS has

engaged in reforestation projects to demonstrate the role of forests in climate mitigation. These projects used market-accepted certification protocols but retired the certified credits, making them ineligible for trading on the open market. The USFS has also developed pilot projects to develop potential metrics for water quality and water quantity trading, but has not enrolled its lands in transactions. These projects have primarily been pursued out of the public eye. The agency has not yet held internal discussions to refine its position on key questions such as: Will credits contribute toward voluntary markets, or offset/mitigate additional impacts? What if the USFS did not retire credits, but instead sold them in an environmental market? What if the USFS did not use third-party nongovernmental organizations partners in accepting money for credits and instead dealt directly with private entities to accept investments for benefits delivered? How should incentives be provided to landowners while not overpaying them for the baseline of services already being delivered (i.e., stacking)? (Marshall and Weinberg 2012). How should the USFS participate in markets to support rather than displace the engagement of private forest landowners? What if NFS units could use ecosystem services markets as a tool within existing federally approved forest management plans? What would the costs and benefits be of certifying public timber through organizations like the Forest Stewardship Council? Before designing policy to provide clarity, the agency can work to understand these implications and formulate answers to these questions. Additionally, it will be necessary for collaboration among land management agencies to create consistency regarding market suitability and interoperability across land ownership types in exchanging and verifying credits.

How to Get Involved

Ecosystem services can serve every level of the USFS organization—from national program leaders across all deputy areas to district resource specialists in every discipline. Examples of ways in which staff with diverse roles and responsibilities can contribute to the integration of ecosystem services in agency programs and operations are provided below.

National program leaders can frame the vision for their program in terms of ecosystem services provided to the public. This can help illustrate how each program serves the agency's mission. Program leaders can establish goals and funding decisions that align with ecosystem service objectives, and articulate accomplishments in terms of ecological, social, and economic outcomes to enhance understanding about the significance of program activities. They can also support the development of consistent national data collection to serve ecosystem services metrics and outcome-based performance indicators.

Ecosystem services can serve every level of the USFS organization—from national program leaders across all deputy areas to district resource specialists in every discipline.

Forest supervisors can use ecosystem services to tell the story of why their forest matters to local communities and the Nation as a whole. Related dialogues can strengthen connections with collaborators and inspire staff engagement with the public. Forest supervisors can work with staff and partners to identify land management challenges that an ecosystem services approach can help address.

District rangers can identify projects that are suitable for application of ecosystem services to on-the-ground planning efforts and inspire collaborative, cross-jurisdictional restoration efforts. Along with forest supervisors, district rangers can help structure their organizations and staff time to support ecosystem services approaches to management and establish a vision for new ways of doing business.

Resource specialists can articulate connections between ecological conditions and a landscape's capacity to provide ecosystem services. They can work across disciplines to establish landscapewide context for planning efforts and to clarify the rationale for management actions.

Partnership coordinators can support the involvement of stakeholders and partner organizations in characterizing ecosystem services provided by forests. They can also identify beneficiaries of public and private forest stewardship and apply ecosystem services concepts to initiative engagement and investment in forest management.

Research scientists can help develop agency capacity and understanding of the ecosystem services that landscapes provide, and describe relationships between management activities, ecological condition, ecosystem services provision, and monetary and nonmonetary value of those services. They can help design production functions and valuation methodologies that articulate these relationships and assist resource specialists with assessments of the connections between ecological conditions and service provisions. Protocols, metrics, and tools can also support the development of ecosystem services markets in the private sector.

State and Private Forestry program leaders can apply ecosystem services approaches to articulate the benefits provided by grant programs that are directed to private landowners but intended to serve the public good. They can support the development of ecosystem services markets and payment programs and engage private landowners in these opportunities. State and Private Forestry also plays a critical role in working with states to address ecosystem services with state forest action plans.

Acknowledgments

This general technical report was greatly improved by the detailed comments from numerous USFS reviewers from the National Forest System, Research and Development, and State and Private Forestry. In particular, we want to thank Carita Chan, Tracy Hancock, Chris Miller, Jeff Kline, Timory Peel, Michelle Aldridge, Nat Gillespie, Karen Dante, Sam Gaugush, Joe Carbon, Kristin Meroney, Paul Arndt, Robert Haight, Jim Beck and Nick Goldstein.” Special thanks to William Connelly, planning specialist, USFS Ecosystem Management Coordination, for his advice and review of content related to land management planning.

References

- Bear, D. 2014.** Integration of ecosystem services valuation analysis into National Environmental Policy Act compliance: legal and policy perspectives. In: Federal Resource Management and Ecosystem Services Guidebook. Durham, NC: National Ecosystem Services Partnership, Duke University. <http://www.nespguidebook.com>. (14 July 2016).
- Bedell-Loucks, A. 2014.** Personal communication. Assistant director, Cooperative Forestry, USDA Forest Service, State and Private Forestry, 201 14th St. SW, Washington, DC 20250.
- Boyd, J.; Banzhaf, S. 2007.** What are ecosystem services? The need for standardized environmental accounting units. *Ecological Economics*. 63(2–3): 616–626.
- Brown, H. 2010.** Climate change and the Forest Service. Unpublished report. On file with: USDA Forest Service, Washington office, Policy Analysis Staff, 201 14th St., SW, Washington, DC 20024.
- Brown, T.C.; Bergstrom, J.C.; Loomis, J.B. 2007.** Defining, valuing, and providing ecosystem goods and services. *Natural Resources Journal*. 47: 329–376.
- Buckley, M.; Beck, N.; Bowden, P.; Miller, M.E.; Hill, B.; Luce, C.; Elliot, W.J.; Enstice, N.; Podolak, K.; Winford, E.; Smith, S.L.; Bokach, M.; Reichert, M.; Edelson, D.; Gaither, J. 2014.** Mokelumne watershed avoided cost analysis: why Sierra fuel treatments make economic sense. Auburn, CA: Sierra Nevada Conservancy. 294 p.
- Carpenter, S.R.; Bennett, E.M.; Peterson, G.D. 2006.** Scenarios for ecosystem services: an overview. *Ecology and Society*. 11(1): 29.

- Carson, R.T.; Mitchell, R.C.; Hanemann, M.; Kopp, R.J.; Presser, S.; Ruud, P.A. 2003.** Contingent valuation and lost passive use: damages from the Exxon Valdez oil spill. *Environmental and Resource Economics*. 25(3): 257–286.
- Casey, F.; Vickerman, S.; Hummon, C.; Taylor, B. 2006.** Incentives for biodiversity conservation: an ecological and economic assessment. Washington, DC: Defenders of Wildlife. 92 p.
- Cerretani, K.; Jones, W.D. 2011.** Planning for the future of southern forests summary document: 2010 statewide forest resource assessments and strategies. R8-PR 61. Atlanta, GA: U.S. Department of Agriculture, Forest Service, Southern Region. 32 p.
- Collins, S.; Larry, E. 2007.** Caring for our natural assets: an ecosystem services perspective. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 11 p.
- Costanza, R.; d’Arge, R.; de Groot, R.; Farber, S.; Grasso, M.; Hannon, B.; Limburg, K.; Naeem, S.; O’Neill, R.V.; Paruelo, J.; Raskin, R.G.; Sutton, P.; van den Belt, M. 1998.** The value of the world’s ecosystem services and natural capital. *Ecological Economics*. 25(1): 3–15.
- Daily, G.C.; Alexander, S.; Ehrlich, P.R.; Goulder, L.; Lubchenco, J.; Matson, P.A.; Mooney, H.A.; Postel, S.; Schneider, S.H.; Tilman, D.; Woodwell, G.M. 1997.** Ecosystem services: benefits supplied to human societies by natural ecosystems. *Issues in Ecology* No. 2. Washington, DC: Ecological Society of America. (<http://www.esa.org/esa/science/issues/>). (16 June 2016).
- Deal, R.; Weidner, E.; Smith, N. 2014.** Integrating ecosystem services into Forest Service programs and operations. In: *Federal Resource Management and Ecosystem Services Guidebook*. Durham, NC: National Ecosystem Services Partnership, Duke University.<http://www.nespguidebook.com>. (14 July 2016).
- Duraiappah, A.K. 2006.** Markets for ecosystem services: a potential tool for multilateral environmental agreements. Winnipeg, Manitoba, Canada: International Institute for Sustainable Development. 25 p.
- Ecosystem Marketplace. 2013.** Innovative markets and market-like instruments for ecosystem services: the matrix 2013. *Forest Trends*. http://www.ecosystemmarketplace.com/wp-content/uploads/2015/09/the_matrix.pdf. (18 June 2016).
- Ehrlich, P.R.; Ehrlich, A.H. 1981.** Extinction: the causes and consequences of the disappearance of species. New York: Random House. 305 p.

- Farley, J.; Costanza, R. 2010.** Payments for ecosystem services: from local to global. *Ecological Economics*. 69(11): 2060–2068.
- Fisher, B.; Turner, R.K. 2008.** Ecosystem services: classification for valuation. *Biological Conservation*. 141(5): 1167–1169.
- Foley, T.; Bowles, J.; Smith, N. Caligiuri., P. 2014.** An ecosystem services approach to management of a complex landscape: the Marsh Project. In: *Federal Resource Management and Ecosystem Services Guidebook*. Durham, NC: National Ecosystem Services Partnership, Duke University. <http://www.nespguidebook.com>. (14 July 2016).
- Forest Trends; The Katoomba Group; United Nations Environment Programme. 2008.** Payments for ecosystem services: getting started: a primer. Washington, DC. 74 p.
- Gledhill, R.; Grant, J.; Low, L.P. 2008.** Review of carbon markets. United Kingdom: Pricewaterhouse Coopers and The Climate Group. 23 p.
- Government Performance and Results Act [GPRA] Modernization Act of 2010. 2011.** 5 U.S.C. 306 Chapter 3; 31 U.S.C. 1105, 1115, 1116, 1120, 1122 and 901 Chapter 11.
- de Groot, R.S.; Wilson, M.A.; Boumans, R.M.J. 2002.** A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological Economics*. 41(3): 393–408.
- Haines-Young, R.; Potschin, M. 2010.** Ecosystem ecology: the links between biodiversity, ecosystem services and human well-being. In: *Rafaelli, D.G.; Frid, C.L.J., eds. Ecosystem ecology: a new synthesis*. Cambridge, United Kingdom: Cambridge University Press: 110–139. Chapter 6.
- Hill, B.T. 2000.** Forest Service-status of efforts to improve accountability [Testimony before the Subcommittee on Interior and related agencies, Committee on Appropriations, U.S. House of Representatives]. Washington, DC: U.S. General Accounting Office.
- Jones, M. 2003.** Guidance for the establishment, use, and operation of conservation banks [Memorandum]. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service.
- Kline, J.D. 2006.** Defining an economics research program to describe and evaluate ecosystem services. Gen. Tech. Rep. PNW-GTR-700. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 46 p.

- Kline, J.D.; Mazzotta, M.J.; Spies, T.A.; Harmon, M.E. 2013.** Applying the ecosystem services concept to public land management. *Agricultural and Resource Economics Review*. 42(1): 139–158.
- Kretchun, A.; Gravenmier, B.; Smith, N. [In press].** Guide for applying ecosystem services in plan revisions under the 2012 Planning Rule. Gen. Tech. Rep. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.
- Kroeger, T.; Casey, F. 2007.** An assessment of market-based approaches to providing ecosystem services on agricultural lands. *Ecological Economics*. 64(2): 321–332.
- LaRocco, G.L.; Deal, R.L. 2011.** Giving credit where credit is due: increasing landowner compensation for ecosystem services. Gen. Tech. Rep. PNW-GTR-842. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 32 p.
- Lucero, C. 2014.** Developing markets for ecosystem services [Presentation]. Washington, DC: U.S. Department of Agriculture, Office of Environmental Markets. Presentation. On file with: USDA Forest Service, Washington office, Cooperative Forestry Staff, 201 14th St., SW, Washington, DC 20024.
- Lynn, K.; MacKendrick, K.; Donoghue, E.M. 2011.** Social vulnerability and climate change: synthesis of literature. Gen. Tech. Rep. PNW-GTR-838. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 70 p.
- Marshall, E.; Weinberg, M. 2012.** Baselines in environmental markets: tradeoffs between cost and additionality. Economic Brief No. 18. Washington, DC: U.S. Department of Agriculture, Economic Research Service. 8 p.
- Millennium Ecosystem Assessment. 2005.** Ecosystems and human well-being: synthesis. Washington, DC: Island Press. 137 p.
- Miller, C.; Ng, K.; Smith, N. 2014.** Ecosystem services and land management plan revision: preliminary observations of three ecosystem services evaluation framework group members. In: *Federal Resource Management and Ecosystem Services Guidebook*. Durham, NC: National Ecosystem Services Partnership, Duke University. <http://www.nespguidebook.com>. (14 July 2016).
- Muradian, R.; Corbera, E.; Pascual, U.; Kosoy, N.; May, P.H. 2010.** Reconciling theory and practice: an alternative conceptual framework for understanding payments for environmental services. *Ecological Economics*. 69(6): 1202–1208.

National Association of State and Private Foresters [NASF]. 2014. State & Private Forestry. <http://stateforesters.org/about-action-plans/state-private-forestry>. (16 June 2016.)

National Ecosystem Services Strategy Team [NESST]. 2013. National Ecosystem Services Strategy Team Charter. Washington, DC: U.S. Department of Agriculture, Forest Service.

National Ecosystem Services Partnership [NESP]. 2014. Federal Resource Management and Ecosystem Services Guidebook. Durham, NC: U.S. Department of Agriculture, Forest Service. <https://nespguidebook.com>. (14 July 2016).

Office of Management and Budget [OMB]. 2003. Regulatory analysis. Circular A-4. (September 17, 2003). Washington, DC. 48 p.

Patil, P.G. 2012. Moving beyond GDP: how to factor natural capital into economic decision making. Working paper 69612. Washington, DC: The World Bank, Wealth Accounting and the Valuation of Ecosystem Services. 23 p.

President's Council of Advisors on Science and Technology [PCAST]. 2011. Report to the President sustaining environmental capital: protecting society and the economy. Executive Report. Washington, DC: White House Office of Science and Technology Policy. 145 p.

Ribaudo, M.; Hansen, L.; Hellerstein, D.; Greene, C. 2008. The use of markets to increase private investment in environmental stewardship. Economic Research Report 64. Washington, DC: U.S. Department of Agriculture, Economic Research Service. 77 p.

Roessing, M.; Innes, J.; Dougherty, T.; Raaf, T. 2014. Stewardship contracting: overview, update and examples [Presentation]. Washington, DC: U.S. Department of Agriculture, Forest Service, Forest Management.

Ryan, M.G.; Harmon, M.E.; Birdsey, R.A.; Giardina, C.P.; Heath, L.S.; Houghton, R.A.; Jackson, R.B.; McKinley, D.C.; Morrison, J.F.; Murray, B.C.; Pataki, D.E.; Skog, K.E. 2010. A synthesis of the science on forests and carbon for U.S. forests. Issues in Ecology No. 13. Washington, DC: Ecological Society of America. 16 p.

Scarlett, L.; Boyd, J. 2011. Ecosystem services: quantification, policy applications, and current federal capabilities. Discussion paper (11-13). Washington, DC: Resources for the Future. 75 p. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1794242. (5 January 2016).

- Simpson, H.; Taylor, E.; Li, Y.; Barber, B. 2013.** Texas statewide assessment of forest service ecosystem services. College Station, TX: Texas A&M Forest Service. 92 p.
- Smith, N.; Deal, R.; Kline, J.; Blahna, D.; Patterson, T.; Spies, T.A.; Bennett, K. 2011.** Ecosystem services as a framework for forest stewardship: Deschutes National Forest overview. Gen. Tech. Rep. PNW-GTR-852. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 46 p.
- TCW Economics. 2010.** Economic contributions and impacts of salmonid resources in southeast Alaska. Final report. Prepared for: Trout Unlimited Alaska Program, 419 Sixth Street, Suite 200, Juneau, AK 99801.
- The National Forest Foundation; U.S. Department of Agriculture, Forest Service. 2005.** Partnership guide: The power of people working together. [Location of publisher unknown]. <http://www.partnershipresourcecenter.org/resources/partnership-guide/>.
- Thorsen, K.A. 2011.** Office of Wildland Fire Policy Memorandum 2011-1. Department of the Interior Hazardous Fuels Prioritization and Allocation System [Memorandum]. Washington, DC: U.S. Department of the Interior, Office of the Secretary.
- Urban, D.; Olander, L. 2014.** Framework overview. In: Federal Resource Management and Ecosystem Service Guidebook. Durham, NC: National Ecosystem Services Partnership, Duke University. <https://nespguidebook.com>. (14 July 2016).
- U.S. Army Corps of Engineers; U.S. Environmental Protection Agency. 2008.** Compensatory mitigation for losses of aquatic resources; Final Rule. 33 CFR Parts 325 and 332; 40 CFR Part 230. Washington, DC.
- U.S. Department of Agriculture, Forest Service [USDA FS]. 2007.** The Forest Service Manual. Amend. 1400. Washington, DC.
- U.S. Department of Agriculture, Forest Service [USDA FS]. 2008a.** S&PF national priorities and objectives. Washington, DC.
- U.S. Department of Agriculture, Forest Service [USDA FS]. 2008b.** Who owns America's forests? Forest ownership patterns and family forest highlights from the National Woodland Owner Survey. Rep. NRS-INF-06-08. Newtown Square, PA: Northern Research Station. 7 p.

- U.S. Department of Agriculture, Forest Service [USDA FS]. 2009.** Stewardship contracting: basic stewardship contracting concepts [Brochure]. FS-893. Washington, DC.
- U.S. Department of Agriculture, Forest Service [USDA FS]. 2012a.** National Forest System Land Management Planning. 36 Federal Register 219. (9 April 2012). Washington, DC.
- U.S. Department of Agriculture, Forest Service [USDA FS]. 2012b.** Partner with us: a look at partnerships within the USDA Forest Service. Washington, DC. 8 p. http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5400216.pdf. (June 19, 2016).
- U.S. Department of Agriculture, Forest Service [USDA FS]. 2013.** Forest Legacy Program. <http://www.fs.fed.us/cooperativeforestry/programs/loa/flp.shtml>. (12 February 2016).
- U.S. Department of Agriculture, Forest Service [USDA FS]. 2014a.** High-Performance Partnership Report Second Quarter FY14 January–March 2014. Washington, DC.
- U.S. Department of Agriculture, Forest Service [USDA FS]. 2014b.** Stewardship end result contracting. http://www.fs.fed.us/restoration/Stewardship_Contracting/. (14 July 2014).
- U.S. Department of Agriculture, Forest Service [USDA FS]. 2015a.** Fiscal year 2016 budget overview. Washington, DC.
- U.S. Department of Agriculture, Forest Service [USDA FS]. 2015b.** Forest Service Handbook. FSH 1909.12 §13.12. Washington, DC.
- U.S. Department of Agriculture, Forest Service [USDA FS]. 2016.** Partnership Resource Center. <http://www.fs.usda.gov/detailfull/prc/home/?cid=stelprd3804156&width=full#Western%20Utilities%20Partnership>. (15 January 2016).
- U.S. Department of Agriculture, Forest Service [USDA FS]. 2015c.** Forest Stewardship Program. <http://www.fs.fed.us/cooperativeforestry/programs/loa/fsp.shtml>. (14 July 2016).
- U.S. Department of Agriculture. 2015a.** The Farm Bill USDA. <http://www.usda.gov/wps/portal/usda/usdahome?navid=farmbill>. (2 March 2016).
- U.S. Department of Agriculture. 2015b.** USDA Office of the Chief Economist: environmental markets: understanding environmental markets. http://www.usda.gov/oce/environmental_markets/understanding.htm. (18 February 2016).

U.S. Department of the Interior, Fish and Wildlife Service [USFWS]. 2012.

Conservation banking: incentives for stewardship. http://www.fws.gov/endangered/esa-library/pdf/conservation_banking.pdf. (24 December 2015).

U.S. Environmental Protection Agency, Office of Water [USEPA]. 2015.

Mitigation banking factsheet. <http://www.epa.gov/cwa-404/mitigation-banking-factsheet>. (2 March 2016).

Waage, S.; Kester, C. 2014.

Global public sector trends in ecosystem services, 2009–2013. Business for Social Responsibility. San Francisco, CA. http://www.bsr.org/reports/BSR_Global_Public_Sector_Trends_Ecosystem_Services_2009_2013.pdf

Western Environment and Ecology, Inc. 2006.

Colorado state-wide forest legacy assessment of need five year review. Presented to: Colorado State Forest Service, Fort Collins, CO 80523-6010.

Wheldon, L.A.C.; Hubbard, J.E. 2013.

Memo to regional foresters, station directors, area director, IITF director, deputy chiefs and WO directors. Geospatial requirements for national record Keeping. On file with: USDA Forest Service, 1400 Independence Avenue SW, Washington, DC 20250.

Willamette Partnership, Pinchot Institute for Conservation, and World

Resources Institute. 2012. In it together: a how-to reference for building point-nonpoint water quality trading programs. Willamette Partnership, 4640 SW Macadam Ave., Portland, OR 97239. http://willamettepartnership.org/wp-content/uploads/2014/09/In-It-Together-Part-3_2012-07-31.pdf. 44 p. (15 July 2016)

Willamette Partnership, World Resources Institute, and the National Network on Water Quality Trading. 2015.

Building a water quality trading program: options and consideration. Willamette Partnership, 4640 SW Macadam Ave., Portland, OR 97239. <http://willamettepartnership.org/wp-content/uploads/2015/06/BuildingaWQTProgram-NNWQT.pdf>. 207 p. (15 July 2016).

World Bank. 2012.

Massive show of support for action on natural capital accounting at Rio summit. <http://www.worldbank.org/en/news/press-release/2012/06/20/massive-show-support-action-natural-capital-accounting-rio-summit>. (12 February 2016).

Appendix 1

Table 5—U.S. Forest Service (USFS) Ecosystem Services Governance Framework

Policy	Description	Ecosystem services relevance for USFS
National Forest Management Act of 1976 (NFMA), (16 U.S.C. §§ 1600–1687)	NFS units must revise land management plans every 15 years. USFS must conduct activities following an analysis of environmental and economic impacts.	The policy calls for transparent analyses of ecological, social, and economic tradeoffs and consideration of natural resource management impacts to public values through intentional planning.
The Multiple Use Sustained Yield Act (MUSYA)	National forests must be managed for multiple uses (recreation, range, timber, watershed, wildlife).	“Multiple use means: The management of all the various renewable surface resources of the NFS.” (16 USC 528) This language is inclusive of multiple resources, including ecosystem services.
The National Forest System (NFS) Land Management Planning Rule of 2012 (36 C.F.R. § 219)	The rule was developed by the Forest Service to implement the 1976 NFMA. Forest plans must include components for integrated resource management to provide ecosystem services.	Guides management of NFS units so, “they have the capacity to provide people and communities with ecosystem services and multiple uses.” The rule uses ecosystem services as a facilitating approach for planning. Note: Forest Service Handbook directives for the 2012 rule are in public comment and are expected to be final in 2014.
The National Environmental Policy Act (NEPA) of 1970	The law requires federal agencies to assess the impacts of project-level management actions on environmental conditions and to balance those impacts against social and economic considerations through public participation.	Federal agencies are directed by Congress to “utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences....in planning and decision-making” (42 U.S.C. 4332(A))
Forest Service Handbook Chapter 1940—Inventory, Monitoring, and Assessment Activities	Inventory, monitoring and assessment (IMA) activities are coordinated through a national integrated program planning process that addresses information needs across the agency.	IMA objectives include: “Support an adaptive land management process that includes social, economic, and ecological evaluations.”

Table 5—U.S. Forest Service (USFS) Ecosystem Services Governance Framework (continued)

Policy	Description	Ecosystem services relevance for USFS
Government Performance and Results (GPRA) Modernization Act of 2010	Agencies must develop 5-year strategic plans which outline a mission statement, goals and performance indicators. Agencies must prepare annual performance reports against performance goals.	This legislation requires that the agency develop performance indicators and performance reports which flow from this mission. Ecosystem services are a link between land and people.
Cooperative Forestry Assistance Act of 1978 (16 USC 2013), Amended through Public Law 110-246 in 2008	USFS is authorized to provide financial, technical, educational, and related assistance to state and private stakeholders for the protection and maintenance of forest land.	Legislation enables USFS to provide assistance to ensure the maintenance of forests and “the multiple values and uses that depend on such lands.”
Food, Conservation, and Energy Act of 2008, H.R. 2419, Section 2709	This act established the Office of Environmental Markets under the USDA Secretary. The mandate for the office is to design science-based methods to measure, report, and maintain ecosystem services from the land management activities of farmers, ranchers and forest landowners.	The act is a guide for the department’s vision of public involvement and support in environmental markets. USFS is an agency of the department, and acts in tandem with the Office of Environmental Markets.
State and Private Forestry Redesign Implementation Council	In 2008, the council approved new national objectives for S&PF.	Objectives include maintain economic benefits and values of trees, connect people to forest stewardship, manage forests to adapt to global climate change.

Appendix 2

Acronyms

BEST	Biodiversity and Ecosystem Services Trends
CCF	Carbon Capital Fund
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFLRP	Collaborative Forest Landscape Restoration Program
CFR	Code of Federal Regulations
EMC	Ecosystem Management Coordination
EPA	U.S. Environmental Protection Agency
ESEF	Ecosystem Services Evaluation Framework
FIA	Forest Inventory and Analysis
FLP	Forest Legacy Program
FSH	Forest Service Handbook
FSM	Forest Service Manual
GARP	Geospatial Accomplishment Reporting Project
HFPAS	Hazardous Fuels Prioritization and Allocation System
IMA	Inventory, Monitoring and Assessment
MEA	Millennium Ecosystem Assessment
MUSYA	Multiple Use Sustained Yield Act
NASF	National Association of State and Private Foresters
NEEF	National Environmental Education Foundation
NEPA	National Environmental Policy Act
NESP	National Ecosystem Services Partnership
NESST	National Ecosystem Services Strategy Team
NFF	National Forest Foundation
NFMA	National Forest Management Act of 1976
NFS	National Forest System
NFWF	National Fish and Wildlife Foundation
NGO	Nongovernmental organization
NMSA	National Marine Sanctuaries Act
NRD	Natural Resource Damage
OMB	Office of Management and Budget
OPA	Oil Pollution Act
PCAST	President’s Council of Advisors on Science and Technology
PES	Payment for ecosystem services
PG&E	Pacific Gas and Electric
PPP	Public-Private Partnerships
R&D	USFS Research and Development
S&PF	USFS State and Private Forestry
USDA	United States Department of Agriculture
USFS	USDA Forest Service
WCF	Watershed Condition Framework
WO	USFS Washington office

Pacific Northwest Research Station

Website	http://www.fs.fed.us/pnw/
Telephone	(503) 808-2592
Publication requests	(503) 808-2138
FAX	(503) 808-2130
E-mail	pnw_pnwpubs@fs.fed.us
Mailing address	Publications Distribution Pacific Northwest Research Station P.O. Box 3890 Portland, OR 97208-3890



Federal Recycling Program
Printed on Recycled Paper

U.S. Department of Agriculture
Pacific Northwest Research Station
1220 SW 3rd Ave., Suite 1400
P.O. Box 3890
Portland, OR 97208-3890

Official Business
Penalty for Private Use, \$300