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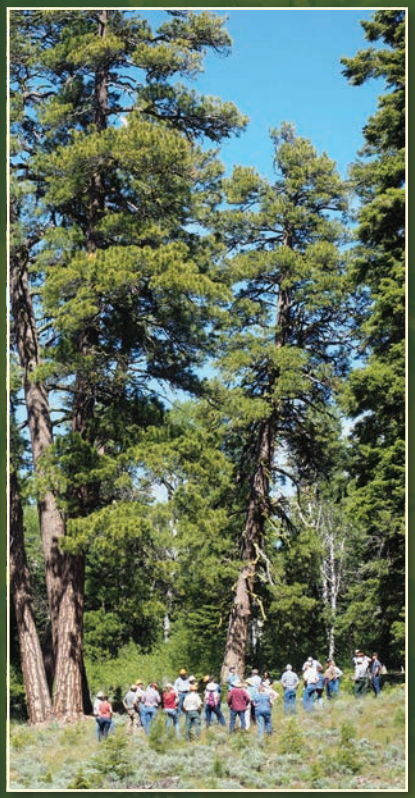
Synthesis of Science to Inform Land Management Within the Northwest Forest Plan Area

Volume 3









Forest Service

Pacific Northwest Research Station

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Cover photos: Left: Inner City Youth Institute, High School Natural Resources Camp, Multnomah Falls, Oregon; photo by USDA Forest Service. Upper middle: roasting salmon over an open fire; photo by Jon Ivy, Coquille Indian Tribe. Lower middle: backcountry skiing on the Willamette National Forest; photo by Emily Jane Davis. Right: a field tour with the Lakeview Forest Landscape Collaborative in the Fremont-Winema National Forest; photo by Tom Spies, USDA Forest Service.

Synthesis of Science to Inform Land Management Within the Northwest Forest Plan Area

Volume 3

Thomas A. Spies, Peter A. Stine, Rebecca Gravenmier,
Jonathan W. Long, and Matthew J. Reilly, Technical Coordinators

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Abstract

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The 1994 Northwest Forest Plan (NWFP) was developed to resolve debates over old-growth forests, endangered species, and timber production on federal forests in the range of the northern spotted owl. This three-volume science synthesis, which consists of 12 chapters that address various ecological and social concerns, is intended to inform forest plan revision and forest management within the NWFP area. Land managers with the U.S. Forest Service provided questions that helped guide preparation of the synthesis, which builds on the 10-, 15-, and 20-year NWFP monitoring reports and synthesizes the vast body of relevant scientific literature that has accumulated in the 24 years since the NWFP was initiated. It identifies scientific findings, lessons learned, and uncertainties and also evaluates competing science and provides considerations for management.

This synthesis finds that the NWFP has protected dense old-growth forests and maintained habitat for northern spotted owls, marbled murrelets, aquatic organisms, and other species despite losses from wildfire and low levels of timber harvest on federal lands. Even with reductions in the loss of older forests, northern spotted owl populations continue to decline. Moreover, a number of other goals have not been met, including producing a sustainable supply of timber, decommissioning roads, biodiversity monitoring, significant levels of restoration of riparian and dry forests, and adaptation and learning through adaptive management.

New conservation concerns have arisen, including a major threat to spotted owl populations from expanding populations of the nonnative barred owl, effects of fire suppression on forest succession, fire behavior in dry forests, and lack of development of diverse early-seral vegetation as a result of fire suppression in drier parts of moist forests. Climate change and invasive species have emerged as threats to native biodiversity, and expansion of the wildland-urban interface has limited the ability of managers to restore fire to fire-dependent ecosystems.

The policy, social, and ecological contexts for the NWFP have changed since it was implemented. The contribution of federal lands continues to be essential to the conservation and recovery of fish listed under the Endangered Species Act and northern spotted owl and marbled murrelet populations. Conservation on federal lands alone, however, is likely insufficient to reach the goals of the NWFP or the newer goals of the 2012 planning rule, which emphasizes managing for ecosystem goals (e.g. ecological resilience) and a few species of concern, rather than the population viability of hundreds of individual species.

The social and economic basis of many traditionally forest-dependent communities have changed in 24 years, and many are now focused on amenity values. The capacities of human communities and federal agencies, collaboration among stakeholders, the interdependence of restoration and the timber economy, and the role of amenity- or recreation-based communities and ecosystem services are important considerations in managing for ecological resilience, biodiversity conservation, and social and economic sustainability.

A growing body of scientific evidence supports the importance of active management or restoration inside and outside reserves to promote biodiversity and ecological resilience. Active management to promote heterogeneity of vegetation conditions is important to sustaining tribal ecocultural resources. Declines in agency capacity, lack of markets for small-diameter wood, lack of wood processing infrastructure in some areas, and lack of social agreement have limited the amount of active management for restoration on federal lands. All management choices involve social and ecological tradeoffs related to the goals of the NWFP. Collaboration, risk management, adaptive management, and monitoring are considered the best ways to deal with complex social and ecological systems with futures that are difficult to predict and affect through policy and land management actions.

Keywords: Northwest Forest Plan, science, management, restoration, northern spotted owl, marbled murrelet, climate change, socioeconomic, environmental justice.

Preface

In 2015, regional foresters in the Pacific Northwest and Pacific Southwest Regions of the USDA Forest Service requested that the Pacific Northwest and Pacific Southwest Research Stations prepare a science synthesis to inform revision of existing forest plans under the 2012 planning rule in the area of the Northwest Forest Plan (NWFP, or Plan). Managers provided an initial list of hundreds of questions to the science team, which reduced to them to 73 questions deemed most feasible for addressing through a study of current scientific literature. The stations assembled a team of 50 scientists with expertise in biological, ecological, and socioeconomic disciplines. At the suggestion of stakeholders, a literature reference database was placed online so the public could submit additional scientific literature for consideration. By spring 2016, writing was underway on 12 chapters that covered ecological and social sciences.

The draft synthesis, which was ready for peer and public review by fall 2016, went through a special review process because it was classified as "highly influential science" in accordance with the Office of Management and Budget's 2004 "Final Information Quality Bulletin for Peer Review." The synthesis was classified as such because it fit the category of a scientific assessment that is novel, controversial, or precedent-setting, or has significant interagency interest. Per the bulletin, the two research stations commissioned an independent entity, the Ecological Society of America (ESA), to manage the peer-review process, including the selection of peer reviewers.

The bulletin also stipulates that such an assessment be made available to the public through a public meeting to enable the public to bring scientific issues to the attention of peer reviewers. Accordingly, a public forum was held in Portland, Oregon, in December 2016. For those who could not travel to Portland, the forum was accessible via live Web stream, and multiple national forests within the NWFP area hosted remote viewing. Written comments on the draft synthesis were collected for 2 months. This generated 130 public comments, totaling 890 pages, which were given to the peer reviewers for consideration in their review, as they deemed appropriate. The OMB guidelines further direct that the peer-review process be transparent by making available to the public the ESA's written guidance to the reviewers, the peer reviewer's names, the peer review reports, and the responses of the authors to the peer reviewer comments—all of which are available at https://www.fs.fed.us/pnw/research/science-synthesis/index.shtml.

The peer reviewer comments, which were received in spring 2017 and informed by public input, resulted in substantive revisions to chapters of the synthesis. The result is this three-volume general technical report (an executive summary of the synthesis is available as a separate report). This document is intended to support upcoming management planning on all public lands in the Plan area, but is expected to serve primarily lands managed by the U.S. Forest Service. We hope it will be a valuable reference for managers and others who seek to understand the scientific basis and possible tradeoffs associated with forest plan revision and management decisions. The synthesis also provides an extensive list of published sources where readers can find further information.

We understand that the term "synthesis" can have many different meanings. For our purposes, it represents a compilation and interpretation of relevant scientific findings that pertain to key issues related to the NWFP that were identified by managers and by the authors of the document. Such a compilation not only summarizes science by topic areas but also interprets that science in light of management goals, characterizes competing science, and makes connections across scientific areas, addressing multilayered and interacting ecological and socioeconomic issues. In a few cases, simple analyses of existing data were conducted and methods were provided to reviewers.

The synthesis builds upon the 10-, 15-, and 20-year NWFP monitoring reports, and authors considered well over 4,000 peer-reviewed publications based on their knowledge as well as publications submitted by the public and others suggested by peer reviewers. For some of the questions posed by land managers, there was ample scientific research from the Plan area. For many of the questions, however, little research existed that was specific to the area. In such cases, studies from other regions or current scientific theory were used to address the questions to the extent possible. In many cases, major scientific uncertainties were found; these are highlighted by the authors.

The synthesis chapters characterize the state of the science but they do not develop management alternatives, analyze management tradeoffs, or offer recommendations as to what managers should do. The synthesis does identify ideas, facts, and relationships that managers may want to consider as they develop plans and make management decisions about particular issues. The final chapter attempts to integrate significant cross-cutting issues, e.g., ecological and socioeconomic interdependencies, compatibility of different management goals, and tradeoffs associated with different restoration actions. All the chapters identify where more research is needed to fill critical information gaps.

We would like to acknowledge the peer reviewers who considered hundreds of public comments as part of the process of reviewing our lengthy draft manuscripts. We also thank the many contributors to the development of the synthesis in draft and final form, including those who provided editing, layout, database, and other support services.

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Log deck resulting from a mechanical forest thinning operation in a Washington Douglas-fir forest. Photo by Robert Keefe.

Chapter 8: Socioeconomic Well-Being and Forest Management in Northwest Forest Plan-Area Communities

Susan Charnley, Jeffrey D. Kline, Eric M. White, Jesse Abrams, Rebecca J. McLain, Cassandra Moseley, and Heidi Huber-Stearns[1]

Introduction

Given the need to conserve forest biodiversity and produce forest products, President Clinton's vision for the Northwest Forest Plan (NWFP, or Plan) was that it would provide "a balanced and comprehensive strategy for the conservation and management of forest ecosystems, while maximizing economic and social benefits from forests" (USDA and USDI 1994: E-1). The Plan was expected to support the production of a predictable, sustainable level of timber and nontimber resources from federal forests to contribute to the stability of local and regional economies over the long term (Charnley et al. 2006a). The Plan also aimed to help rural communities affected by cutbacks in federal timber production by providing economic assistance programs to promote long-term economic development and diversification and minimize the adverse effects of job loss from reductions in timber harvesting (Dillingham 2006).

To monitor effectiveness in achieving these goals, the NWFP record of decision contained two socioeconomic monitoring questions: (1) Are predictable levels of timber and nontimber resources available and being produced? (2) Are local communities and economies experiencing positive or negative changes that may be associated with federal forest management? (USDA and USDI 1994: E-9). After the first 10 years of socioeconomic monitoring, the Regional Interagency Executive Committee identified a new monitoring question: what is the status and trend of social and economic well-being in the Northwest Forest Plan area (at the county level) (Grinspoon et al. 2016)? Socioeconomic well-being in relation to federal forest management continues to be an important concern among agency managers.

Thus, the goal of this chapter is to synthesize findings from NWFP monitoring and scientific research on the relationship between federal forest management and socioeconomic well-being in forest communities in the NWFP area (which includes 72 counties in western Washington, western Oregon, and northwestern California), recognizing that there is a reciprocal relationship between them. We build on Breslow et al. (2016) and define socioeconomic well-being as a state of being with others and the environment that arises when human needs are met, when people can act meaningfully to pursue their individual and collective goals, and when people and communities enjoy a satisfactory quality of life.

"Community" has been defined in many ways in the literature, making it difficult to adopt one general definition here. However, our main focus is on communities of place having social and economic ties to nearby forests, which are typically located in rural areas, where the effects of the NWFP were greatest. Communities are not homogenous; they contain residents with diverse socioeconomic circumstances, values, interests, and relations to federal forests, and federal forest management affects different community residents differently. Although our focus is on the community as a unit of analysis, where possible we draw attention to the diversity that exists among subpopulations in the Plan area. Chapter 10 complements this chapter with a focus on low-income and minority populations and their relations to federal forests in the Plan area.

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Guiding Questions

This chapter focuses on six key questions pertaining to socioeconomic well-being in NWFP-area communities and federal forest management:

1. What is the statutory and policy foundation for considering socioeconomic well-being in federal forest management, and how does it reflect changing understandings of the relation between community well-being and federal forest management over time?
2. What has been the impact of the NWFP on rural communities in the Plan area?
3. How have social and economic conditions in rural communities in the Plan area changed over the past two decades?
4. How do goods, services, and opportunities from federal forests contribute to socioeconomic well-being in rural communities?
5. How do rural communities contribute to federal forest management?
6. What implications do changes in land use and land ownership over the past two decades have for federal forest management?

We summarize key findings pertaining to these questions at the beginning of the sections, below, which address each one in depth.

Summary—
Laws that direct the U.S. Forest Service and Bureau of Land Management (BLM) to create social and economic benefits for communities and the public date back to the inception of the agencies. Legislation in the first half of the 20th century emphasized provision of a continuous flow of timber from federal forests to promote economic stability in the forestry industry and forest communities. Legislation passed in the second half of the 20th century strengthened environmental goals and planning requirements associated with federal forest management, but also reaffirmed the economic goals of the Forest Service, and added or expanded social goals. Law and policy have also often given special consideration to people living near national forests and BLM-managed Oregon and California (O&C) Railroad Revested Lands in the form of payments to counties, for example.

With adoption of the NWFP, the goal of providing social and economic benefits to communities continued alongside an increased focus on environmental protection and restoration. At the same time, community benefit began to be conceptualized as coming from activities beyond traditional timber harvest and milling activities, such as ecosystem management, forest and watershed restoration, outdoor recreation, and the harvest of nontimber forest products. This shift reflected a change in thinking about well-being in forest communities from being a product of nondeclining, even flows of timber, to being influenced by a host of commodity and noncommodity benefits from federal forest lands.

Subsequent to the adoption of the NWFP and the occurrence of several large, high-visibility wildfires, wildfire became the central focus of national forest management-related law and policy. In parallel to the adoption of the NWFP, wildfire policy has shifted from a 20th-century focus on using fire suppression to protect natural resources (i.e., timber), to a focus on protecting firefighters and communities—especially

Key Findings

Statutory and Policy Foundation and Evolving Understandings of Socioeconomic Well-Being and Federal Forest Management

The relationship between federal forest management and community well-being has been understood from different perspectives over time, with both the Forest Service and Bureau of Land Management (BLM) being concerned with community well-being historically. The National Forest System was inspired in part by concerns about the predominant timber harvesting practices of the late 19th century, in which mobile logging camps exploited forests and then moved on without considering reforestation needs. Not only was this pattern of timber exploitation detrimental to U.S. forest stocks, it also raised concerns about the unstable

homes and other structures, community preparedness and forest restoration to create wildfire-resilient landscapes. In turn, the concept of community resilience has emerged, which focuses on the ability of a community to successfully cope with and adapt to natural disturbances and change. Wildfire is now a critical issue to address in the context of federal forest management and community socioeconomic well-being.

livelihoods and lifestyles of forest workers, and communities experiencing boom and bust economic cycles associated with unsustainable logging practices (Hibbard 1999, Quirke et al. 2017). Given many rural communities' high degree of economic dependency on lands that were designated as national forests, there has been a longstanding public policy concern with the effects of national forest management on community "stability" (Dana 1918, Kaufman and Kaufman 1946). Although the BLM came to manage forest lands within the NWFP area under a different set of historical circumstances, the policy framework for managing these Oregon and California (O&C) Railroad Revested Lands has likewise shown a long-standing concern with providing local community benefits (Richardson 1980). Thus, the NWFP focus on the impacts of reduced federal timber harvesting on rural community well-being has continuity with broader policy goals reflected throughout the histories of these agencies.

Conceptually, the social and economic dimensions of laws and policies associated with the Forest Service and BLM can be broken into two categories: (1) those that require or authorize the agencies to create social and economic benefits for the nation or particular populations, and (2) those that authorize or require the agencies to provide opportunities for input into the planning and management process by the public as a whole, or particular subpopulations. The former is the focus of this section.

Social and economic goals in federal forest management law and policy—
Laws that direct the Forest Service and BLM to create social and economic benefits for communities and the public date back to their inception. In the Forest Service's Organic Act of 1897, for example, forest reserves (later national forests) were to provide for water flow and a continuous supply of timber (Wilkinson and Anderson 1987). Under the Organic Act, a central goal of creating forest reserves was to ensure that western timber did not end up in the hands of private industry monopolies and was continually accessible for the "greatest good." Throughout the second half of the 20th century, the focus on timber as the primary public benefit of national forest and BLM O&C land management increasingly came into conflict with other uses and benefits of federal forest lands. Although the National Forest Management Act (NFMA), the BLM's Federal Land Policy and Management Act, the Wilderness Act, and other laws passed in the 1960s and 1970s strengthened environmental goals and planning requirements, Congress also reaffirmed the economic goals of the Forest Service, and added or expanded social goals in these same laws. For example, NFMA expanded the authority of the agencies to harvest timber by legalizing clearcutting, and the Wilderness Act was as much about protecting special places for recreation and scenic beauty as it was about environmental protection in its own right.

In parallel to the "greatest good" concept embedded in much of federal land management legislation, law and policy have also often given special consideration to people living near national forests and BLM O&C lands. The most well known of these laws is the 1908 Twenty-Five Percent Fund Act (Public Law 60-136), which requires the Forest Service to pay 25 percent of its revenue generated from timber sales and other goods and services from national forests to counties to help fund roads and schools. On the BLM side, although the revesting of O&C lands in western Oregon to BLM management was an effort to get timberlands out of the hands of a corrupt railroad company, decisions about what to do with those lands revolved around the likely local economic impacts on communities, specifically the local timber industry and local taxation (Richardson 1980). Ultimately, sustained-yield timber production, and paying counties a portion of agency timber revenues, also became an obligation of O&C forest management (Richardson 1980). Fifty percent of timber revenues from BLM O&C and Coos Bay Wagon Road lands were returned to counties to use for any general county purpose (Phillips 2006b).

The Sustained-Yield Forest Management Act of 1944 (16 U.S.C. Section 583), which authorized the secretaries of the Department of Agriculture and Interior to create sustained-yield units (or "cutting circles") on federal, or combined federal and private lands, is another example of local community consideration in forest policy. The act provided local lumber mills with exclusive access to federal timber and encouraged a continuous supply of timber that would stabilize forest industries, employment, and communities near federal forests. As reflected in the act, from the 1940s through the 1980s, national forest management was thought to be important in contributing to "community stability," defined in terms of stable timber industry employment and income in forest communities (Le Master and Beuter 1989). Contributing to community stability through a policy of sustained-yield timber harvesting to provide a nondeclining, even flow of forest products and associated jobs and income was a central goal of national forest management between the 1940s and 1980s (Le Master and Beuter 1989, chapters in Lee et al. 1990) (fig. 8-1).

The belief that national forest management can ensure community stability was questioned in the 1980s as it was recognized that many variables influence social and economic well-being in rural communities (Charnley et al. 2008b, Cook 1995, Force et al. 1993, Nadeau et al. 2003, Power 2006, Sturtevant and Donoghue 2008). Federal forest managers cannot ensure community economic stability through their management actions alone, particularly if such stability is assumed to arise from a consistent flow of timber. However, management of federal forests and investments in federal forest management (including the presence of a federal workforce) can contribute to community stability and business vitality. The positive economic and social outcomes in the Blue Mountains of Oregon from the Pacific Northwest Region's "eastside strategy" and the state of Oregon's Federal Forest Restoration Program (previously the Federal Forest Health Program) illustrate how investment in federal forest management can promote community well-being (Bennett et al. 2015, White et al. 2015).

Under the NWFP, the goal of providing social and economic benefits to communities continued even as an increased focus on environmental protection and restoration challenged the provisioning of traditional timber-based benefits from federal forest lands. At the same time, community benefit began to be conceptualized as resulting from activities beyond traditional timber harvesting and milling, such as ecosystem management, forest and watershed restoration, outdoor recreation, and the harvest of nontimber forest products (Hibbard and Lurie 2013, Kruger et al. 2008). As the Forest Service adopted

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Figure 8-1—Coos Bay, Oregon, historically supported a diversity of logging and milling operations.

ecosystem management as its new management paradigm (Thomas 1996), it actively invested in job training and management projects with the goal of creating a new class of quality jobs in ecosystem management and restoration for displaced timber workers and communities affected by this transition in forest management (Spencer 1999). One effort to do so was the Jobs in the Woods Program, which began as part of the NWFP and included waivers of federal procurement law that allowed the Forest Service and BLM to set aside service contracts for ecosystem management to benefit contractors located in counties affected by the plan (Moseley 2005). Although this program was too small to offset the number of jobs lost in the timber industry, it did provide short-term employment for some displaced timber workers (Dillingham 2006). Moreover, its intent—to create jobs in local communities associated with restoration and ecosystem management—carried forward into subsequent agency programs (e.g., Secure Rural Schools Act projects, stewardship contracting, and community-focused National Fire Plan projects, described below).

Along with this shift toward ecosystem management, the 1990s gave rise to new understandings of community-forest relations that acknowledged the diverse contributions federal forests make to "community well-being." Studies recognized that well-being in forest communities included quality of life attributes beyond jobs and income, such as health, safety, educational attainment, political participation, social equity, empowerment, community cohesiveness, and access to social services (Beckley 1998, Doak and Kusel 1996, Harris et al. 2000). Studies also recognized that federal forests can contribute to community well-being in multiple ways, including both commodity (e.g., timber, grazing, minerals, nontimber forest products) and amenity (e.g., outdoor recreation, scenic beauty, clean air and water, open space, landscape) values they provide (Beckley 1998, Kusel 2001, Nadeau et al. 2003, Sturtevant and Donoghue 2008). Community capacity—defined as the ability of community residents to respond to internal and external stresses, create and take advantage of opportunities, and meet the needs of residents (Kusel 2001)—was found to be critical to well-being in forest communities.

In the past two decades, little congressional lawmaking has related to federal forest management. That which has occurred has tended to include some attention to local community social and economic needs. Laws that were designed to shore up payments to counties as timber harvest declined, first in the Plan area and then nationwide, are good examples. Timber-sale receipts comprised the vast majority of payments to county governments and dropped dramatically with the spotted-owl-related injunctions on timber harvesting in the early 1990s and subsequent implementation of the NWFP. Consequently, Congress passed a series of measures starting in 1991 to mitigate the lost revenues to counties using new formulas to calculate payments, the most recent of which was the Secure Rural Schools and Community Self-Determination Act of 2000 (Phillips 2006b). Although the Secure Rural Schools Act was initially set to expire in 2006, it has been reauthorized and extended several times, most recently on April 16, 2015, for 2 more years.[2] The Act was allowed to expire in 2017, prompting agencies to revert to making payments to counties from revenues generated by timber sales (25 percent for the Forest Service, 50 percent for the BLM) under the 1908 Payments to States Act. Congress continues to debate reauthorization; this is a subject of ongoing political debate and economic uncertainty in NWFP-area counties that relied heavily on these payments (Hoover 2015). In addition to payments to counties to backstop declining timber revenues, the Secure Rural Schools Act created local resource advisory committees to advise the Forest Service on priority ecosystem management and restoration projects that could be funded through Title II of the act. In addition, stewardship contracting, permanently authorized through legislation in 2014, has meeting local community needs as one of its central goals (P.L. 106-393; P.L. 106-291, Sec 323) (Kitzhaber 1998; Moseley and Charnley 2014). Similarly, for much of the 2000s, Congress provided appropriations language authorizing the Forest Service and BLM to consider local economic benefit when awarding restoration-related service contracts (e.g., PL 108-7, Sec 333). Although the exact language varies from

[2] http://www.fs.usda.gov/pts/.

law to law, typical beneficiaries include workers and businesses in forest communities, local communities, or isolated communities.

An area of significant rulemaking in the decades following NWFP adoption were efforts to revise the Forest Service planning rule, which elaborates how national forests should create long-term plans as required under the NFMA.[3] The planning rule had last been modified in 1982 under the Reagan Administration. Several subsequent revisions were attempted but never completed, so forest planning (either full plan revisions or plan amendments) continued to follow the 1982 planning rule (Schultz et al. 2013). From the beginning, the Obama Administration placed a strong emphasis on creating a new planning rule that could become successfully institutionalized, including provisions for significant public involvement and collaboration. The planning rule, as finalized in 2012,[4] requires assessment of numerous social values including social, cultural, and economic conditions and benefits that people obtain from forest plan areas and of recreation opportunities (FR 88 no 68. Sec. 219.6 (6)-Sec 291.6(13)); it directs plans to provide for social and economic sustainability (Sec. 219.8(b)). The planning rule also calls for multiple uses of national forests, including not only timber harvest but also aesthetic values; access to fishing, hunting, and gathering; and access to recreation and water supplies. Among many shifts in the planning rule from prior versions is the introduction of the concept of "ecosystem services," which is framed as the range of social, economic, and ecological benefits from national forests to be provided presently and into the future (Subpart A. Sec. 219.1).

Wildfire policy—

During the early years of the NWFP, the focus of forest management was centered around reconciling competing demands for timber production and threatened and endangered species conservation. However, subsequent to the adoption of the NWFP and the occurrence of several large, high-visibility wildfires in the region (Reilly et al. 2017), wildfire became the central focus of national forest management, eventually consuming over half of the agency budget by the mid-2010s (see chapter 3 for discussion of the wildfire issue). Wildfire policy and practice have also undergone dramatic transformation, although with only relatively little congressional involvement. With wildfire costs increasing from 16 percent of the Forest Service budget in the 1980s to more than 50 percent in 2015,[5] wildfire management now affects every corner of the agency by dramatically reducing funds available for other management activities.

Prior to the NWFP era, wildfire was rarely mentioned in law and policy (Nelson 1979), perhaps because wildfire occurrence nationwide was relatively low from the 1940s through the 1980s (Agee 1993). Nevertheless, wildfire management has deep roots in the founding and early management of the Forest Service (Pyne 1981), and there were decades of wildfire suppression capacity-building prior to the NWFP (Davis 2001). As noted above, the focus of wildfire policy has largely shifted from fire suppression to protect timber, to ensuring firefighter safety and protecting homes and other structures. Restoration for ecological objectives, including increasing the resilience of forests to fire and drought, has also become a forest management goal (chapter 3). The 2001 National Fire Plan increased the focus on community preparedness for wildfire, hazardous fuels reduction, ecosystem restoration, reintroduction of prescribed fire, and other management changes (Steelman and Burke 2007) (fig. 8-2). The Healthy Forest Restoration Act of 2003, among other things, created a community wildfire protection planning process that allowed national forests that had participated in community planning to use expedited planning processes for hazardous fuels reduction projects in the Community Wildfire Protection Plan (CWPP)-designated wildland-urban interface (WUI) (Vaughn and Cortner 2005). Increasingly, there are calls for managing wildfire more to meet the goals of reducing forest fuels and wildfire risk to communities and ecosystems (e.g., North et al. 2015), though it has been difficult to manage wildfire for resource benefits in practice in many landscapes (Calkin et al. 2015).

[3] http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5362536.pdf.

[4] http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5362538.pdf.

[5] http://www.fs.fed.us/sites/default/files/2015-Fire-Budget-Report.pdf.



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Figure 8-2—In the 2000s, wildfire policy has shifted to focus on community wildfire protection and preparedness.

The Federal Land Assistance, Management, and Enhancement Act of 2009 (FLAME Act) sought to reduce the growing impacts of wildfire expenditures on the rest of the Forest Service budget. It also required the creation of the National Cohesive Wildland Fire Management Strategy, which increases the focus on creating resilient landscapes, fire-adapted communities, and safe and effective wildland fire response. From the National Fire Plan of 2001 to the Cohesive Strategy adopted a decade later, there have been significant policy efforts to change wildfire management, many of which have increased focus on community preparedness and protection in wildfire. Both the use of fire (prescribed or naturally ignited) and the use of silvicultural treatments to alter fuels conditions are complicated by ecological, economic, and social challenges that reflect decades of past land use patterns and policies (Carroll et al. 2007). Although much change has occurred, there has been a significant pattern of stasis as well, making clear that wildfire management is an increasingly complex social-ecological problem with few easy solutions (Carroll et al. 2007, Fischer et al. 2016). Nevertheless, it is a critical issue to address in the context of federal forest management and community socioeconomic well-being.

As wildfire law and policy have shifted to emphasize community preparedness, hazardous fuels reduction, and reintroduction of prescribed fire to create wildfire-resilient landscapes, a parallel paradigm shift has occurred in thinking about community-forest relations. Much of this thinking now revolves around the concept of "community resilience" (e.g., Daniel et al. 2007, Lynn et al. 2011, McGee 2011, Paveglio et al. 2009), which focuses on a community's ability to cope with and adapt to natural disturbances and change. Building on Folke (2006), Magis (2010), and Walker and Salt (2006), community resilience is defined here as the

ability of a community to successfully cope with, adapt to, and shape change, while still retaining its basic function and structure. Federal land management policies that help promote community capacity to adapt to change may contribute to socioeconomic well-being (Anderson and Kerkvliet 2011).

The Impact of the Northwest Forest Plan on Rural Communities

From a social standpoint, the primary concern relating to socioeconomic well-being and federal forest management in Plan-area communities historically has been the impacts of reduced timber harvesting from federal lands on forest products workers, businesses, and timber-dependent communities in particular. In the Plan area, a steep harvest decline followed the 1990 listing of the northern spotted owl (*Strix occidentalis caurina*) as threatened under the Endangered Species Act (Charnley et al. 2008b) (fig. 8-3). In the 1980s, timber sales from Forest Service and BLM lands in the Plan area averaged 5.5 billion board feet annually (Charnley et al. 2008b). Intensive timber management on federal lands ended in the early 1990s owing to a series of lawsuits over the protection of the owl and associated species under the Endangered Species and National Forest Management Acts (Thomas et al. 2006), and related injunctions on federal timber sales within the range of the owl (Charnley 2006b). The social controversy engendered by the "owl wars," in which the interests of environmentalists concerned with the impacts of timber harvesting on old-growth forests and associated species were pitted against the interests of forest products workers and forest communities, is well documented (e.g., Carroll 1995, FEMAT 1993, Satterfield 2007). The NWFP was an attempt to balance these interests, and offer a solution that would provide "a sustainable level of human use of the forest resource while still meeting the need to maintain and restore the late-successional and old-growth forest ecosystem" (USDA and USDI 1994: 26–27).

Over the past two decades, a body of literature has emerged that assesses the impacts of the owl listing and NWFP on communities. This literature is composed of the results of NWFP socioeconomic monitoring (Charnley 2006a, Charnley et al. 2008a, 2008b; Grinspoon and Phillips 2011, Grinspoon et al. 2016) and a number of additional studies by economists and other social scientists. It is important to note that changes in the forest products industry in Plan-area communities and economies were not solely a result of declines in timber harvesting on federal forest lands. The most significant factors influencing the

Summary—
Numerous factors have influenced socioeconomic well-being in rural communities in the NWFP area; here we focus on the impacts of the NWFP. We begin by describing regional and national trends in the wood products industry to provide context for understanding Plan impacts. Regarding wood products production, market conditions facing the forest products industry are driven by overall consumer demand for wood products (e.g., lumber, paper, and engineered wood products), global competition, and technological change. Construction and remodeling account for the greatest demand for lumber and engineered wood products; therefore, changes in the housing market over the past 20 years have affected the forest products industry in the Plan area. Over and above changes in demand, industry restructuring and technological improvements have generally led to contractions in wood products manufacturing and a reduction in the number of workers required in the milling process. Nevertheless, demand fluctuations do influence employment levels in wood products manufacturing over short time periods, such as the increase in employment in wood products manufacturing that occurred when the overall economy improved post-2010, as the economic recession that began in December 2007 subsided.

Private forests currently contribute the vast majority of logs processed by mills in the Plan area. Greater timber harvest on federal forests would increase the number of logs available to mills and create additional work opportunities for logging contractors in the short term. If long-term mill output within the Plan area increased as

a result of higher federal harvest levels, these short-term changes in timber supply and harvesting contracts could extend for longer periods and could include additional work in processing facilities. However, log supply is not the sole determinant of the level of output from mills. Rather, demand for wood products in the United States and globally, mill production technology, currency exchange rates, and competition from other domestic and international wood product producers combine with other factors to influence levels of wood products production. As elsewhere in the West (and Nation as a whole), the wood products manufacturing sector in the Plan area has experienced mill closures and employee reductions. However, mills remaining in operation and those coming into production have greater production capacity and lower labor demands than those that closed. This trend results in the seemingly contradictory pattern of falling mill numbers and reductions in mill workers, but smaller declines (or even increases) in aggregate milling capacity, and increasing average mill capacity. Further, within the Plan area, mills are using more of that available capacity relative to mills elsewhere in the West, generally a sign of mill strength and demand for workers.

Within the Plan area, and especially in Oregon, much of the federal timber log supply comes from thinning harvests in plantations that are less than 80 years of age. Recent discussions about future federal forest management within the Plan area have proposed variable-retention harvests and ecological forestry within matrix lands to create more early seral vegetation through regeneration harvests, conserve older forests, and provide a more reliable flow of ecosystem services, including timber.

NWFP-related impacts on communities are associated primarily with cutbacks in federal timber harvesting, loss of federal agency jobs, reductions in federal contract spending, and the setting aside of reserve lands that exclude intensive timber production. Research examining the nature and extent of these impacts on communities has produced different findings. These differences may be attributed to the unit of analysis used to assess impacts (i.e., region, county, community); the period considered (first vs. second decade of the Plan); and the different datasets and indicators used to assess impacts. Most studies evaluate NWFP socioeconomic impacts using secondary indicator data pertaining to population change and economic variables such as employment, income, poverty levels, and property values, rather than primary data (data gathered at the community scale directly from community residents).

The findings of these studies can be generalized as follows:

1. Impacts attributed to the NWFP include population growth and decline, increases and decreases in socioeconomic well-being, and increases and decreases in economic indicators. Some studies found no NWFP impact on population and economic indicators.
2. NWFP impacts on communities differed at the community and county scales, and depended on local social, cultural, economic, and environmental contexts.
3. Impacts (both positive and negative) were greater during the first decade of the NWFP than they were during the second decade.
4. Impacts (both positive and negative) were greater in communities located close to national forests, or to reserved lands set aside by the NWFP, and in communities that had experienced a mill closure (not necessarily a result of the Plan).
5. Impacts were greater at the community scale than at the county and regional scales, and were greater in nonmetropolitan counties than they were in metropolitan counties.
6. Given the growing incidence of large and severe wildfires in the NWFP area, one important way in which federal forest management will affect rural communities moving forward relates to management for forest restoration and wildfire.

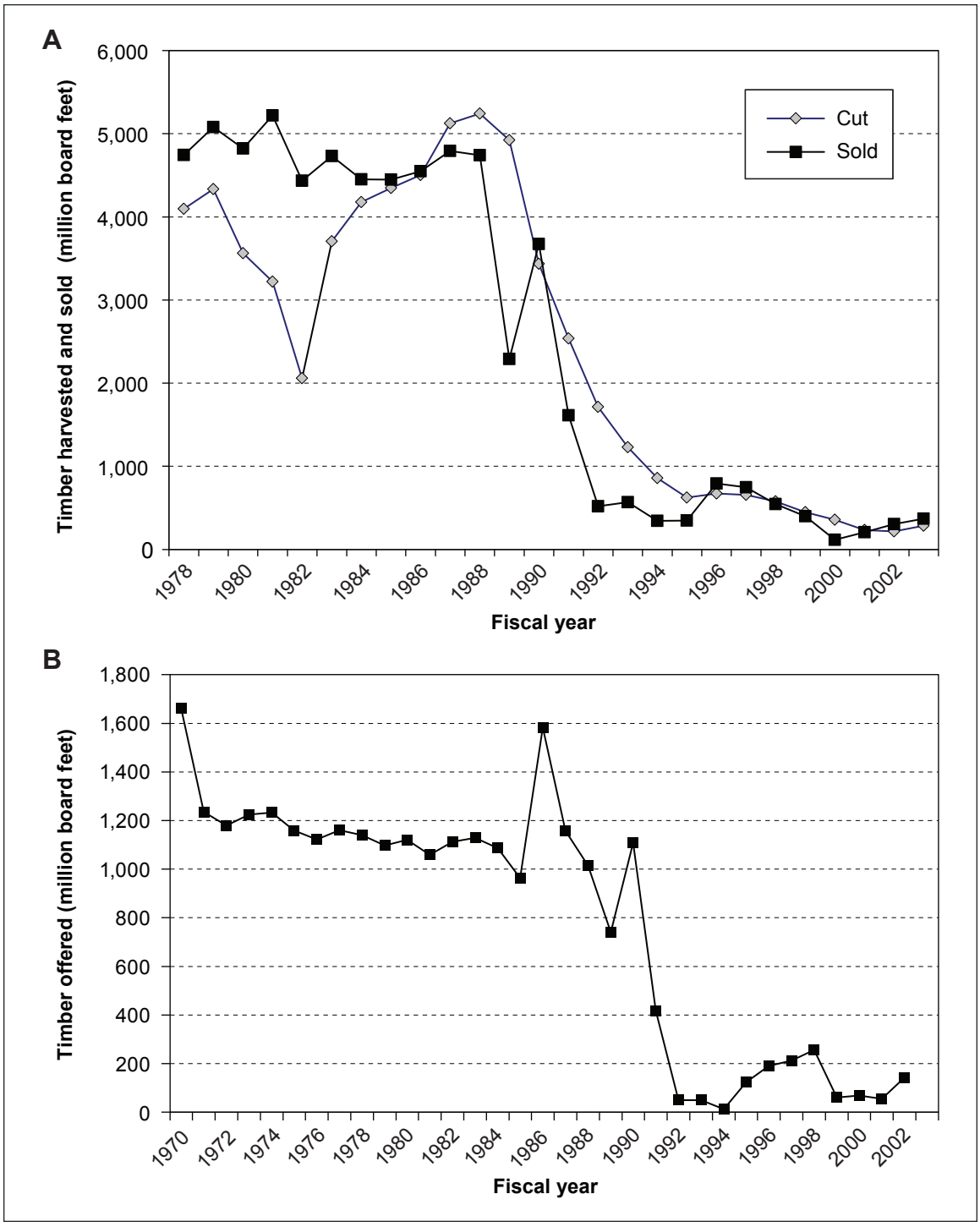


Figure 8-3—Volume of timber offered for sale, sold, or harvested from (A) Forest Service and (B) Bureau of Land Management units in the Northwest Forest Plan area, 1970s–2002. Source: Charnley 2006c.

industry are market conditions (e.g., demands for lumber and paper products), technological advances in wood processing, foreign and domestic competition, the cost of labor and manufacturing equipment, currency exchange rates, and timber availability (Keegan et al. 2006, Ince et al. 2011, Skog et al. 2012). Thus we begin this section by providing a broader picture of changes taking place in the wood products industry in the NWFP area and more broadly during the past three decades. We then focus on the role of federal forest management by discussing the impacts of the owl listing and the NWFP. We also briefly discuss the effects of wildfire management on local communities because wildfire on federal forests has become a salient factor affecting socioeconomic well-being there.

The wood products production market—
The primary wood products manufactured in Oregon, Washington, and northern California are dimensional lumber and plywood used in housing construction and remodeling. For the most part, the wood products produced within the NWFP area are commodity products, meaning they compete, in many cases, with products of the same quality produced from forests in different regions of the United States and around the world (Skog et al. 2012). Consumption of wood and paper products in the United States has risen in recent decades, but that consumption has been increasingly met through imports from other countries with lower costs of production (Skog et al. 2012). Further, wood products produced in the NWFP area must compete with nonwood products, such as concrete, steel, and composites that can be used in the same construction applications. These substitutes have been slowly taking market share from wood products over the past few decades because of consumer preferences, technological advances in materials, and cost (Ince et al. 2007). Although both heavy competition from other countries and substitute materials are anticipated, U.S. lumber production is still projected to increase through 2040, from a low point in 2010, under a variety of alternative future scenarios because of expanding domestic demand for wood products (Ince et al. 2011). The magnitude of the projected increase depends, however, on assumptions about the magnitude of increases in housing starts, gross domestic product (GDP) growth, and global demand for wood to use in energy production (Ince et al. 2011). Smaller increases in housing starts and GDP, and lower demand for wood for energy in foreign markets, yield lower levels of projected future U.S. lumber production.

Lumber production—
In the last decades of the 20th century, the Western United States was the Nation's "wood basket" and supplied the majority of softwood lumber produced nationally. That changed in the first decade of the 2000s, when the South became the predominant lumber-producing region. In 2010, lumber production in the Pacific Northwest states—the largest lumber producers in the Western United States—was at its lowest level since the 1950s (Keegan et al. 2011). The case of Oregon is illustrative. Since the mid-1950s, lumber production in Oregon has gone through cyclical ups and downs, but has generally declined over the long term (fig. 8-4) (Gale et al. 2012). The period since the early 1990s has been especially volatile, with dramatic swings influenced by changing timber availability and surges and collapses in the housing market.

The changing role of the Pacific Northwest in the nation's wood products industry reflects the combined effects of broad-scale changes that affect the industry across the United States and globally (i.e., changing demand for wood products, improved milling technology, foreign competition), and regional steep reductions in federal timber supply within the NWFP area. Despite this downturn, the wood products industry remains an important contributor to the economies of Oregon, Washington, and California, although not to the degree that it was in the past. For example, although wood products manufacturing in Oregon slipped from about 8 percent of the state's gross domestic product in the late 1980s to about 1 percent in 2009 (Lehner 2012), in many rural communities it remains an important source of jobs and income. Overall, the economies of the three states have diversified and expanded into other sectors, but this diversification has not necessarily occurred in some local communities.

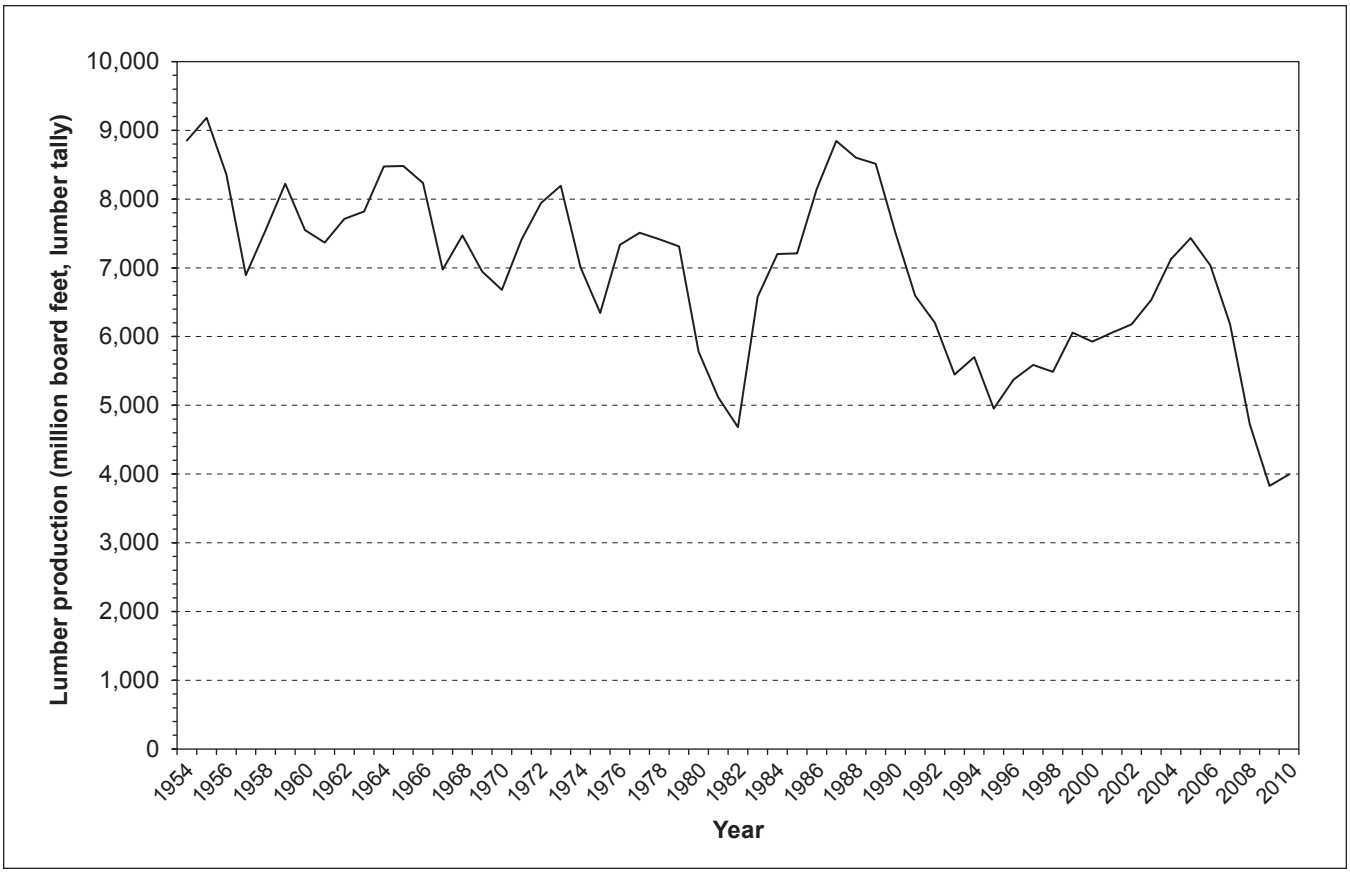


Figure 8-4—Oregon lumber production, 1954 to 2009. Source: Gale et al. 2012.

The role of timber supply—

In California, Oregon, and Washington, since the early 1990s, private (especially private industry lands) and state-owned forests have provided the majority of timber to wood processing facilities (Oswalt et al. 2014). Similarly, in the NWFP area, the majority of timber harvested has come from nonfederal lands (fig. 8-5). Increases in log supply from public or private lands can increase the employment at mills when there is unutilized mill capacity, a healthy market for wood products, and sufficient volume of new logs to warrant adding an additional shift at the mill, or opening another processing line. For example, a sawmill with unutilized capacity in John Day, Oregon, recently increased mill employment over the short term when Forest Service harvest volumes were increased (Bennett et al. 2015). Aside from the amount of federal timber supplied, mill employment remains influenced by market conditions for lumber and other wood products, and changes in milling technology that reduce the amount of necessary labor. Cyclical ups and downs in mill employment (e.g., Lehner 2012) for lumber production follow changing conditions in the economy and markets for housing construction, regardless of federal timber supply conditions (Keegan et al. 2011). Even when timber supply changes are happening, mill employment remains influenced by technological improvements to mill operations. For instance, Helvoigt and Adams (2009) found that 38 percent of the decline in employment at sawmills between 1988 and 1994 (when federal timber harvests declined precipitously) can be attributed to technological change that reduced labor requirements.

Increases in federal timber supply may lead to expansion in lumber production and hiring of mill employees if timber supply is constrained, demand for lumber products is strong, and mill capacity is underutilized. Within the Pacific Northwest, these mill conditions are thought to

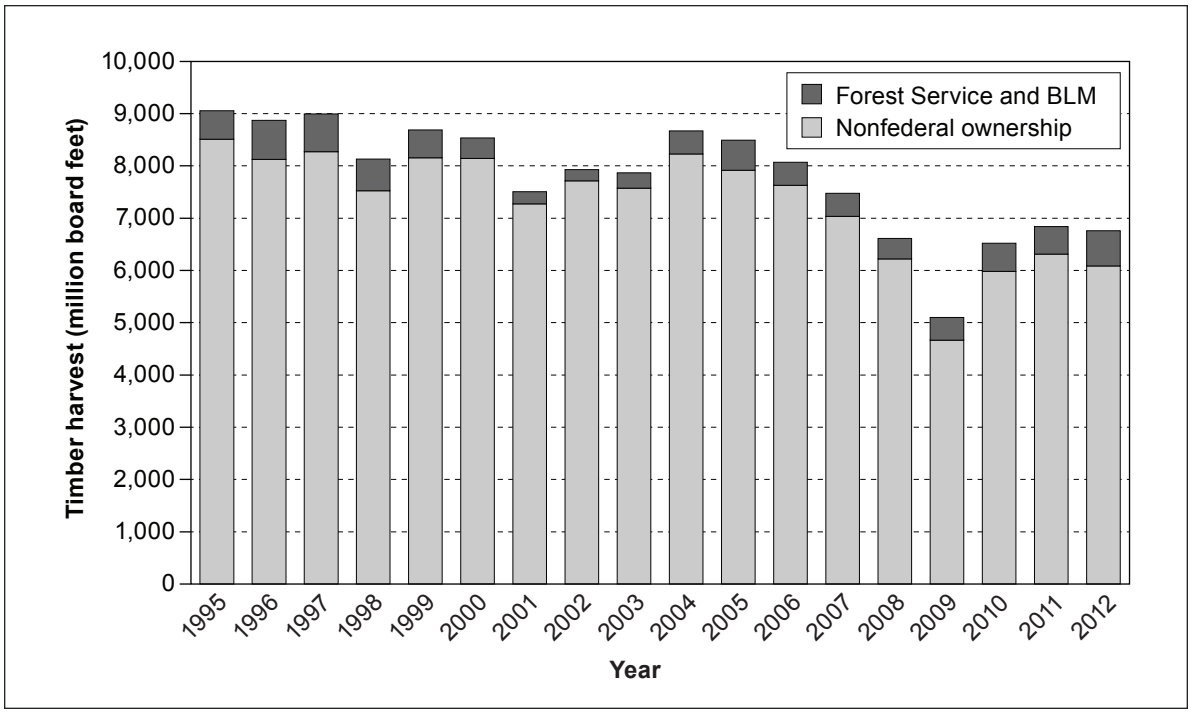


Figure 8-5—Since the 1990s, the majority of timber harvested in the Northwest Forest Plan area has come from nonfederal lands. Source: Grinspoon et al. 2016.

be more commonly found east of the Cascade Range, where productive forests are usually owned by the federal government, and severe losses in milling capacity (Swan 2012) have led to very limited processing infrastructure. In general, economic models have found that significant increases in federal harvest levels benefit wood products manufacturers because more timber is available at lower prices, but pose a disadvantage to private forest owners because the price of stumpage falls, forcing them to sell for less (e.g., Abt and Prestemon 2006, Adams and Latta 2005, Adams et al. 1996, Ince et al. 2011). Stumpage prices may rebound over time if private landowners reduce harvest levels in response to lower stumpage prices. Increased federal timber harvest might improve the well-being of local wood products producers and private forest landowners in situations in which all local milling capacity is in danger of closing, and the addition of federal timber supply helps to keep mills above the tipping point of having to close operations (e.g., Adams and Latta 2005); or where supply increases last for a long time (e.g., Abt and Prestemon. 2006). The potential increased timber supply from "ecological forestry," including variable-retention harvesting[6] (e.g., Franklin and Johnson 2012) in plantations, may well promote improved community well-being if the early seral vegetation created supported long-term timber production, especially in areas with a higher share of dry forest, and in communities that have, or can recreate, a forest products workforce. However, the wood products sector within the NWFP area would remain subject to market conditions and competition from other wood products manufacturers nationally and globally.

Because of the relatively high transport cost, species preference of mills, and supply from private forests, the majority of the wood processed in the NWFP area comes

[6] Franklin and Johnson (2012) identified the key elements of ecological forestry as (1) retaining structural and compositional elements of the preharvest stand during regeneration harvests, (2) using natural stand development principles and processes in manipulating established stands to restore or maintain desired structure and compositions, (3) using return intervals for silvicultural activities consistent with recovery of desired structures and processes, and (4) planning management activities at landscape scales. Variable-retention harvesting is clearcut harvesting that retains a portion (e.g., 10 to 15 percent) of the original forest in undisturbed patches or aggregates distributed across the harvest unit.

from within the region. Historically, there has been relatively little procurement of federal timber from outside the NWFP area by local mills. Under the Forest Resources Conservation and Shortage Relief Act of 1990 (as amended), federal timber in the NWFP area is barred from international export, and, in most cases, purchase by an entity that sells timber into the export market. With that export restriction, federal timber can be a source of wood supply for businesses that have difficulty purchasing logs when there are high prices in the log export market. Additionally, providing a consistent flow of federal timber could offer some certainty to wood processors that some wood volume would be accessible to domestic purchasers in the face of a strong log export market.

Following adoption of the NWFP, the limited social acceptability of harvesting large-diameter and old-growth trees from matrix land allocations on federal lands and of clearcutting (Charnley and Donoghue 2006a), has largely confined harvests west of the Cascades to existing plantations within matrix lands that have younger, smaller trees. Timber harvest prescriptions in these cases often apply commercial variable-density thinning (see chapter 3) to stands younger than 80 years. The focus on harvesting trees under 80 years old in the matrix is counter to the calculation of probable sale quantity (PSQ)[7] in the NWFP (Charnley 2006b), which relied substantially on volume produced from stands over 80 years of age within the timber-suitable base of matrix lands (Johnson 1994, Johnson et al. 1993). One modeling study undertaken in a large landscape in the Coast Range of Oregon estimated that continuing current federal forest management practices that were focused on thinning smaller, young trees in plantations under 80 years of age would ultimately result in a 71-percent decline in federal harvest levels by 2050 (Johnson et al. 2007). The reason for the decline was reduced availability of small- and medium-diameter stands on federal forest lands because thinning did not establish new young stands, and the existing plantations aged beyond 80 years.

[7] Probable sale quantity is an estimate of average annual timber sale levels likely to be achieved over a decade; it is a decadal average. The NWFP identified matrix lands and adaptive management areas as being suitable for producing a predictable and sustainable timber supply, thus only timber produced from these locations counts toward PSQ volume (Charnley 2006c).

Potential future declines in harvest volumes from federal forests would further reduce the contribution of federal timber supply to the traditional forest and wood products sectors of local economies within the NWFP area. As a consequence, the forest and wood products sectors would become more reliant on the supply of timber from private and state-owned forests. Increased use of ecological forestry (Franklin and Johnson 2012) to create early seral vegetation (Swanson et al. 2011) that has been reduced by fire exclusion (chapter 3) and other practices in moist and dry forests could be a way to maintain some level of timber harvest from plantations and other younger forests over the longer run. Challenges to expanded use of ecological forestry and regeneration harvests in the NWFP area include (1) lack of public trust of federal agencies, (2) the scale of restoration needed in dry forests, and (3) the legal and social obstacles to implementing regeneration harvests in moist forests (Franklin and Johnson 2012). In addition, it could be difficult to plan and schedule timber production from early-seral vegetation projects when landscape goals for these conditions can also be met by wildfire, which is unpredictable.

Trends in the number of wood-processing facilities— Reductions in demand for wood products, technology, and reduced log supply from federal forests during the 1980s and 1990s have led to declines in wood-processing infrastructure throughout the United States. Consistent with national trends, over the long term and under varying levels of federal timber supply, the number of operating timber mills and employees in the wood products sector has declined in Oregon, Washington, and California (Gale et al. 2012, Keegan et al. 2011, McIver et al. 2015); the case of Oregon is illustrative (figure 8-6). For example, Oregon had 405 lumber mills in 1980, 282 of which closed over the next three decades for a reduction of two-thirds (Chen and Weber 2012). Similarly, in 1980, 113 rural communities in Oregon had mills (roughly half of them), and by 2007 only 58 communities had mills. Direct job loss per mill closure averaged 100 jobs, a large impact on rural communities whose median population was 2,000 people or fewer (Chen and Weber 2012). It is unknown how many mills in the Pacific Northwest closed specifically because of the NWFP. A variety of factors (e.g., technological change, industry

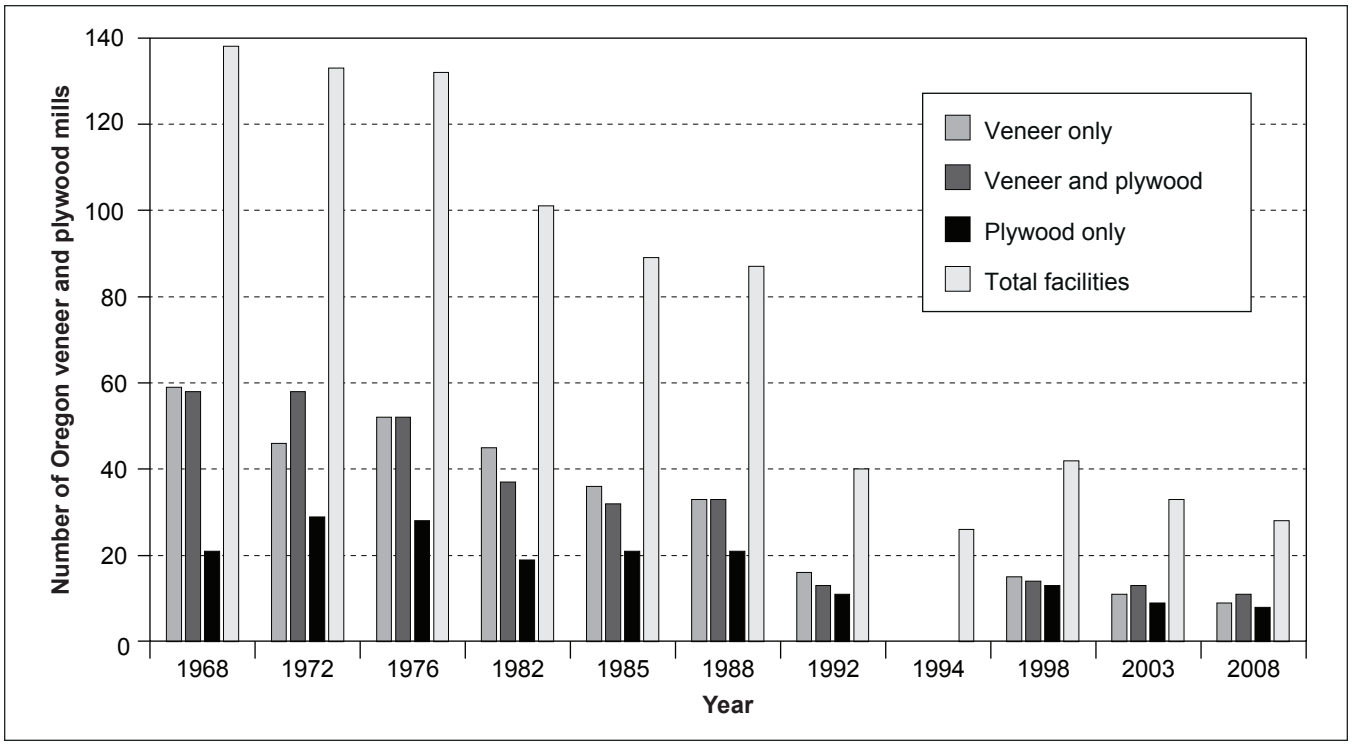


Figure 8-6—Number of veneer and plywood mills in Oregon, 1968–2008. Note that, for 1994, veneer and plywood mills were not counted separately. Adapted from Gale et al. 2012.

restructuring, and competition) have combined to precipitate mill closures in the region. For example, Helvoigt and Adams (2009) found that 38 percent of jobs lost in sawmills in Oregon and Washington between 1988 and 1994 were related to technology improvements in log processing. The remaining jobs losses were due to a variety of factors, including changes in log supply.

More recently, between 2000 and 2003, an estimated 142 wood products plants closed in the United States (Quesada and Gazo 2006). During that time, 20 plants closed in Oregon (the second most in the nation), 13 closed in Washington, and 5 closed in California (Quesada and Gazo 2006). Plant closures (when a cause could be determined) were most commonly attributed to general financial difficulty and reorganization; only 5 of 94 cases cited material shortages as a reason for plant closure (Quesada and Gazo 2006). Between 2005 and 2009, an additional 300 mills temporarily or permanently closed in the Western United States in response to the steep decline in demand for lumber in the housing sector, and competition from other mills (Keegan et al. 2011). The national pattern of mill closures in the 2000s was mirrored in Oregon, Washington, and California (McIver et al. 2015, WDNR 2014).

Mill capacity—

The capacity of operating mills (mill capacity) can be a better indicator of the size of the wood products industry and the potential use of, and demand for, timber harvested from public and private forest lands than the number of mills (Keegan et al. 2011). Because of technological improvements and loss of small mills, the number of mills and mill employees may decline while total aggregate mill capacity across states or regions declines more slowly, remains steady, or even increases. For example, although the number of sawmills in Washington declined from more than 200 in 1968 to 75 in 2002, aggregate mill capacity in the state increased during the period as mills adopted new technology and became larger (Helvoigt and Adams 2009). The average capacity of the mills in operation in 2002 in Washington was three times what it was in 1968 (Helvoigt and Adams 2009).

Historically and currently, the Pacific Coast states (Washington, Oregon, California, and Alaska) have accounted for the majority of the West's milling capacity (Keegan et al. 2006). The change in mill capacity across the West sets the context for considering changes in mill capacity within the NWFP area. Between the late 1980s and 2010, mill capacity in the Western United States declined from about 25 billion board feet to 13 billion board feet—a nearly 50-percent decline (Keegan et al. 2011). Mill capacity losses in the NWFP area during that time reflected, in part, conditions facing the industry elsewhere in the West. Between 1986 and 2003, the Pacific Coast states lost 35 percent of their mill capacity, but this decline was the smallest percentage decline in the West during that period. Post-2005, and influenced in large part by the Great Recession, milling capacity in the Pacific Coast states dropped another 10 percent to a little under 11 billion board feet by 2010. Although that loss was significant, the Pacific Coast region again had smaller percentage declines in mill capacity than elsewhere in the West during that period (Keegan et al. 2011). Within the Pacific Coast states, Oregon and Washington have typically fared better than California and Alaska in rates of change in the industry. For example, in Oregon, mill capacity in 2010 was roughly the same as it was in 1996 (Gale et al. 2012); and in Washington, aggregate milling capacity in 2002 was slightly greater than it was in 1968 (Helvoigt and Adams 2009).

The percentage of mill capacity in use gives an indication of how much additional timber could be processed in the short term with minimal infrastructure investment. Capacity utilization in the Western United States from the 1980s through 2005 (just prior to the Great Recession) remained steady at about 70 to 80 percent (Keegan et al. 2011). In the early 2000s, with high demand for lumber during the housing peak, capacity utilization in the Western United States peaked at a little over 80 percent before subsequently falling to about 56 percent at the height of the recession of the late 2000s (Keegan et al. 2011). After the Great Recession, in 2012, Oregon was utilizing 57 percent of its overall timber processing capacity and 61 percent of its sawmill capacity (Gale et al. 2012); California was using 72 percent of its sawmill capacity (McIver et al. 2015).

Employment in the wood products industry— The U.S. wood products manufacturing sectors have experienced consistent, long-term contraction in employment since the early to mid-1990s (Keegan et al. 2011, Quesada and Gazo 2006, Woodall et al. 2012). Employment in wood products manufacturing in the Pacific Northwest mirrors that pattern. For example, in Oregon, employment in wood products manufacturing has been in a general decline since the late 1970s (Lehner 2012). At various times during that period, contraction in employment has resulted from changes in the demand for lumber and paper products, plant closures, technological advances in manufacturing that led to lower labor requirements, closing of product lines, and consolidation of companies. Demand for softwood lumber closely tracks conditions in the U.S. housing market. Steep declines in demand for new housing and housing remodels in the late 2000s that occurred in association with the Great Recession led to sharp reductions in lumber production, to levels not seen since World War II (Woodall et al. 2012). As result of that decline, the U.S. wood products sector lost nearly 209,000 jobs between 2005 and 2009. This pattern mirrored that seen in other manufacturing sectors, such as the automotive industry, during the same time frame (Woodall et al. 2012).

In the Western United States specifically, employment in the wood products industries dropped by about 50,000, to about 250,000, between 2000 and 2010 (Keegan et al. 2011). Oregon and Washington each experienced wood products manufacturing employment in the 2000s that was below employment levels of the late 1990s (Eastin et al. 2007, Lehner 2012). Subsequent to 2010, there has been a recovery in this sector in Oregon, in line with an overall economic recovery (Rooney 2015). In California, employment remained flat through 2012. Comparable reporting is not available for Washington. Employment in the wood products sector in Oregon is cyclical over the long term, and often tracks in a pattern similar to overall nonfarm employment (although the swings in wood products employment are generally of higher magnitude) (Lehner 2012). Regardless, wood products manufacturing now requires fewer employees than in earlier decades (see Grinspoon et al. 2016), but recovery in recent years has been good relative to employment levels in the 1990s and early 2000s.

It is challenging to predict the complex interactive outcomes of changes in timber production, wood products markets, technologies, and other factors relevant to future timber economies as they interact with global climate trends. However, various climate change scenarios anticipate steady or increasing flows of forest products production worldwide (Alig 2010, Irland et al. 2001, Kirilenko and Sedjo 2007, Latta et al. 2010). Such outcomes could benefit those communities that contain infrastructure for harvesting and processing timber, though effects on wood products prices will influence the distribution of benefits (Alig 2010, Joyce 2007). Within the NWFP area specifically, gains in productivity may be offset by increased incidence of fire, disease, and insect outbreaks, especially in drier forest types within the region (Klopfenstein et al. 2009) and in areas that become more susceptible to other pathogens (Kliejunas et al. 2009).

Effects of the Northwest Forest Plan on timber production and timber industry jobs—
As noted at the start of this section, economic concerns over the impacts of the NWFP on forest communities in the Plan area stemmed mainly from cutbacks in federal timber harvesting. During the 1980s, the allowable sale quantity (ASQ) of timber from federal forests in the Plan area averaged 4.5 billion board feet (BBF) annually (Charnley 2006c). Under the Plan, the PSQ varied during the first decade but averaged 776 million board feet (MMBF) annually between 1995 and 2003. The total volume of timber offered for sale from Forest Service and BLM lands in the Plan area averaged 526 MMBF annually between 1995 and 2003. Of this volume, an estimated 80 percent was from adaptive management areas and matrix lands, and 20 percent from reserve lands. Under the NWFP, only timber offered for sale from adaptive management areas and matrix lands counts toward PSQ, meaning that an annual average of 421 MMBF of PSQ volume was offered for sale between 1995 and 2003 (Charnley 2006c). Reflecting this shift, the total contribution of federal timber to the regional supply dropped from roughly 25 percent in 1990 to under 5 percent in 2000 (Phillips 2006a). By 2003, the expected PSQ volume from federal forests in the Plan area was 805

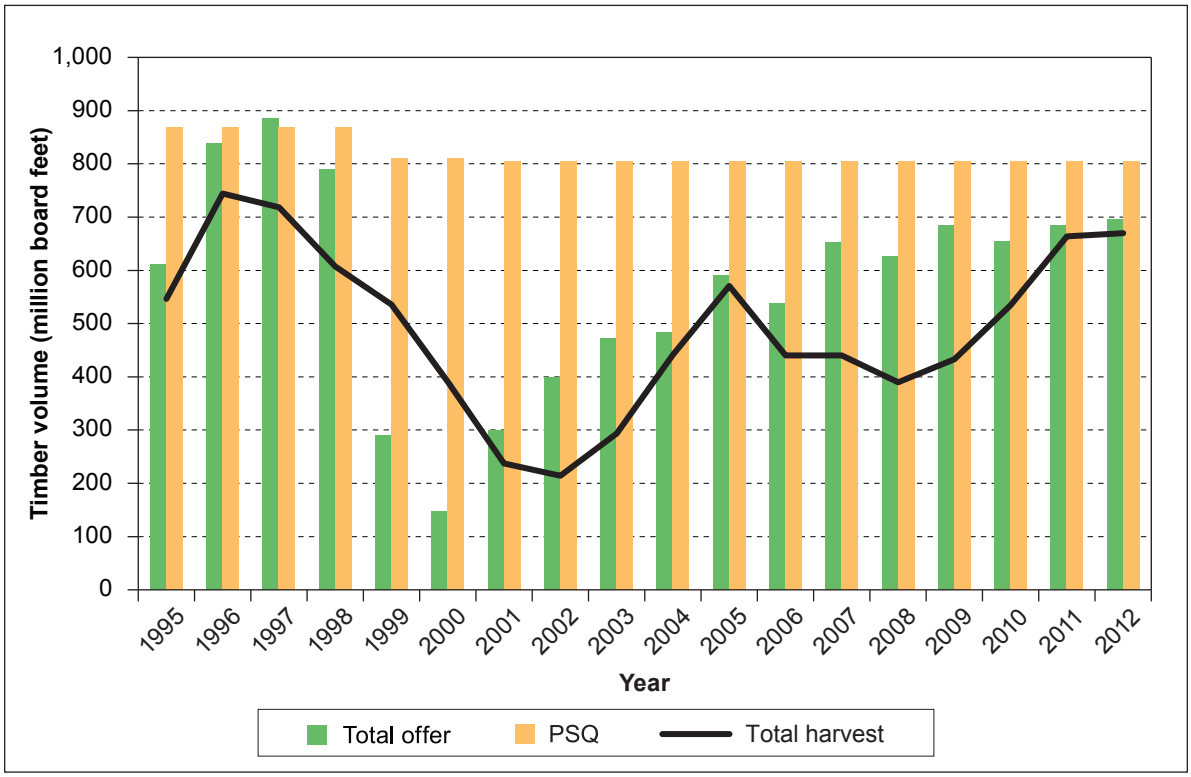


Figure 8-7—Timber offered for sale and harvested from federal forests in the NWFP area, in relation to the probable sale quantity (PSQ), 1995-2012. Source: Grinspoon et al. 2016.

MMBF. During the second decade of the Plan, the volume of timber offered for sale from Plan-area federal forests increased gradually and became more stable and predictable, but remained below the PSQ (fig. 8-7) (Grinspoon et al. 2016). By 2012, federal timber accounted for about 10 percent of the regional timber supply from all land ownerships (Grinspoon et al. 2016).

Regarding employment, jobs in primary wood products manufacturing declined in the NWFP area by 30,000, or 26 percent, between 1990 and 2000, and stood at roughly 85,000 in 2000 (Phillips 2006a). The bulk of the 30,000 job losses (all but 400 of them) occurred between 1990 and 1994, after injunctions on federal timber harvesting were put into place following the owl listing in 1990. An estimated 39 percent of these jobs were lost as a result of cutbacks in federal timber harvesting; the majority of the job loss (the remaining 61 percent) is attributable to technological changes in the industry (Phillips 2006a). In 2001, there were over 100,000 jobs in the NWFP area in the timber sector/forest products industries (logging, primary and secondary wood processing) associated with production from all forest ownerships; by 2012, there were 65,000, a drop of about 40 percent (Grinspoon et al. 2016). In 2001, 12 percent of the jobs in nonmetropolitan counties in the NWFP area were in the timber sector, and by 2012 only 3 percent were in the timber sector (Grinspoon et al. 2016). During this same period, the volume of federal timber sales within the NWFP area increased from about 150 MMBF in 2000, to about 650 MMBF in 2012, meaning that despite the overall job decline the number of industry jobs associated with timber harvesting from Forest Service and BLM lands increased (Grinspoon et al. 2016). In 2012, timber harvested from federal forests in the Plan area supported an estimated 2,300 direct jobs, and 2,500 indirect and induced jobs in the 72 NWFP-area counties (Grinspoon et al. 2016). Total employment in nonmetropolitan counties of the Plan area increased between 2001 and 2012, more than offsetting job losses in the wood products industries. Nevertheless, if people do not have the skills to take advantage of new job opportunities, they may still suffer unemployment.

Adding to the economic effects of changing timber harvest levels on employment in the private sector, additional economic losses resulted from the contraction of public sector agency jobs: the five BLM units in the NWFP area lost 13 percent of their full-time-equivalent positions between 1993 and 2002 (166 jobs), and 15 of the 17 national forests in the NWFP area (excluding the Lassen and Modoc) together lost 36 percent of their full-time-equivalent positions (3,066 jobs). These trends continued during the second decade of the NWFP, especially on Plan-area national forests in Oregon and Washington, which had about 5,700 full-time-equivalent employees in 1993, and 2,300 in 2012 (Grinspoon et al. 2016). Forest Service job loss during the first decade of the plan was associated with declining budgets. Despite growth in Forest Service and BLM budgets at the national scale during the decade (owing largely to increased appropriations for fire and fuel management), national forest budgets for the Plan area as a whole dropped 35 percent, even with increased allocations for fire and fuel management (Stuart 2006). Budget declines were tied to reduced timber harvest levels (Charnley et al. 2008b). BLM job loss was associated with reduced timber sales, but not with reduced budgets; BLM unit budgets rose overall during the first decade of the NWFP, mainly because of stable O&C funding appropriations and additional budget allocations for NWFP-related programs such as Jobs in the Woods and Survey and Manage (Charnley et al. 2008b, Stuart 2006).

Another way in which federal agencies create local community benefit is through procurement contracting, which can provide jobs for local businesses. Although BLM procurement contract spending remained constant during the first decade following NWFP implementation, Forest Service procurement contract spending declined from $103 million in 1991 to $33 million in 2002, meaning that the agency supported substantially fewer external jobs through contracts for services such as road maintenance, forest management, and professional services (Charnley et al. 2008b). Trends in Plan-area procurement contract spending were not analyzed during the second decade of the Plan.

Mitigation measures designed to offset the negative economic impacts of the NWFP included the Jobs in the Woods Program, the Northwest Economic Adjustment Initiative (NEAI), and changes in federal payments-to-counties formulas so that these payments were not tied to subsequent annual timber revenues from federal forest lands. Community economic assistance provided through

the NEAI was generally viewed as having some successes, but as being "too little, too late" overall (Dillingham 2006). Although changes in legislation related to payments to counties have been successful in mitigating the effects of declining timber receipts (Graham 2008, Phillips 2006b), ongoing uncertainty associated with Secure Rural Schools Act reauthorization makes the future uncertain.

Impacts of job loss on wood products workers— Job loss can have severe impacts on affected workers. Employees who lose their jobs in wood products manufacturing face the challenge of finding work in other sectors of the economy, either where they currently live or elsewhere, including perhaps in other states. Helvoigt et al. (2003) examined Oregon employment records to study employment transitions of those displaced from the wood products market in the early 1990s. In Oregon, about 51 percent of wood products sector employees who lost their jobs during industry downturns in the early 1990s found employment by 1998 in other industries within the state, primarily in the service sector, retail trade, manufacturing, and construction (Helvoigt et al. 2003). The remainder of those who lost their jobs either stayed unemployed, left the state, or became self-employed. Those who were able to find employment in another sector within Oregon had median annual wages that were about 1 percent lower than their former wages. However, that small change in median wage was buoyed by the high incomes of those former wood products manufacturing employees who found new jobs in the technology sectors. Many workers who lost their jobs were working in relatively low-paying service-sector jobs by 1998. Aside from changes in wages, there may have been additional losses in benefits coverage not reported in these figures. In southern and eastern Oregon, about one-third of those who lost their mill jobs moved elsewhere in the state for work (Helvoigt et al. 2003).

The impacts of job loss on wood products workers were not purely economic; they were also social. Existing literature finds that mill workers were concerned about economic stability, and have a strong attachment to their home communities (Lee et al. 1991). This finding implies that moving for a new job elsewhere would have strong social impacts. Loggers' sense of identity was closely tied to their occupation, which fostered independence, pride in their work, and the feeling of having a unique job (Carroll et al. 2005). They were also part of an "occupational community" that included other loggers, social interactions with whom strengthened their sense of identity (Carroll et al. 2005). This attachment to a logging way of life meant that many loggers were willing to move or migrate seasonally in order to pursue it (Carroll et al. 2000b). Thus, not only did job loss represent a loss of jobs and income; it also undermined loggers' sense of identity and personal empowerment, which were tied to working in the woods, making finding a substitute occupation difficult. Moreover, loggers and the timber industry were often vilified during the years of the so-called "owl wars," leading to occupational stigmatization, which had a negative social and psychological impact on loggers and their families (Carroll 1995, Carroll et al. 1999). A study of job loss among company loggers in Idaho (Carroll et al. 2000a) found that many loggers chose to stay in logging if they could, even if it meant lower wages and fewer benefits than they had previously enjoyed. Reasons included the relatively high income from logging, attachment to their local community and region, desire to maintain a rural way of life, and sense of identity tied to logging.

Northwest Forest Plan impacts on communities and counties— The impacts of reduced federal timber harvesting following the spotted owl listing and the NWFP on jobs, wood products workers, and communities in the NWFP area have been debated since the 1990s (e.g., Carroll et al. 1999, Freudenburg et al. 1998). Often, different findings emerge depending on the unit of analysis used to assess impacts (region, county, census tract, definition of community, individual or household), time considered, and datasets and indicators used to assess impacts. Thus, studies on the socioeconomic impacts of the NWFP on communities and counties find mixed results. Most studies evaluate NWFP socioeconomic impacts using secondary indicator data, rather than primary data gathered at the community scale from community residents.

The NWFP caused some 11.5 million ac (4.65 million ha) of federal land to be reallocated from commodity production to ecosystem management and conservation status (Chen et al. 2016, Eichman et al. 2010). A number of studies have looked at the effects of federal lands conservation policies and

protected areas generally on local counties and communities in the Western United States. Some have found these policies to undermine the local economic base associated with natural resource production, causing job loss, lower wages, and outmigration (e.g., Duffy-Deno 1998). Others have found that they can be good for communities because they may increase amenity migration and associated amenity-driven economic development (Holmes and Hecox 2004, Lorah and Southwick 2003, Power 2006, Rasker et al. 2013). And some analyses find no significant impacts on employment or wages from proximity to public lands that are protected from, or experience reduced levels of, resource extraction (Duffy-Deno 1997; Lewis et al. 2002, 2003; Pugliese et al. 2015; Rasker 2006). Eichman et al. (2010) pointed out that because the impacts of conservation policies can be both negative and positive, one must analyze their aggregate effects, including how the positive impacts mitigate the negative ones, to fully understand their effects.

Community-scale research conducted as part of NWFP socioeconomic monitoring during the first decade of the NWFP used a community socioeconomic well-being index derived from six U.S. Census variables[8] to evaluate change in 1,314 nonmetropolitan communities in the Plan area (Donoghue and Sutton 2006). Socioeconomic well-being was evaluated based on index scores that ranged from 0 to 100. The index was used to examine change in well-being for a number of parameters; those reported here are (a) number of communities regionwide whose socioeconomic well-being scores increased, decreased, or remained the same between 1990 and 2000; (b) change in socioeconomic well-being scores between 1990 and 2000 in communities based on their proximity to federal forest lands (<5 miles versus ≥5 miles away); and (c) number of communities having very low (0 to 48.72), low (48.73 to 61.07), medium (61.08 to 73.36), high (73.37 to 85.58), or very high (85.59 to 100) socioeconomic well-being scores in relation to proximity to federal forests. Donoghue and Sutton (2006) also looked at variation in the individual indicators comprising the socioeconomic well-being index between 1990 and 2000, and between communities within and greater than 5 miles of a federal forest, also reported here. The authors compared change in socioeconomic well-being in NWFP-area communities within 5 miles of a federal forest, with those 5 miles or more away, because they inferred that communities near federal forests have distinct connections to those forests that differ from those farther away.

The study found that, regionwide, 27 percent of NWFP-area communities experienced little change in socioeconomic well-being between 1990 and 2000 (scores in 2000 were within +3 to -3 points of the 1990 scores); 37 percent experienced a decrease in well-being (ranging from -51 to < -3 points), and 36 percent experienced an increase in well-being (ranging from >3 to 44 points) (Donoghue and Sutton 2006). When comparing means between 1990 and 2000 for each of the six indicators comprising the socioeconomic well-being index, they found that change in the means of five of these indicators were statistically significant at a regional scale ($p < 0.001$). At a regional scale, the percentage of the population in communities with a bachelor's degree or higher went up, the percentage of the population in poverty went down, employment diversity increased slightly, income inequality increased, and average commute time to work also increased during the decade. Change in unemployment between 1990 and 2000 at the regional scale was not statistically significant (Donoghue and Sutton 2006).

Among communities within 5 miles of a federal forest, 40 percent had socioeconomic well-being scores that decreased during the decade, compared with a 33 percent decrease in scores among communities 5 miles or farther from a federal forest. Moreover, most of the communities with very low or low socioeconomic well-being scores in 2000 (71 percent) were within 5 miles of a federal forest. However, 43 percent of the communities with high or very high socioeconomic well-being scores in 2000 were also within 5 miles. Thus, although some communities close to federal forest lands were doing well in 2000, in general, communities farther away had higher socioeconomic well-being scores. When disaggregating the index indicators and comparing their means for 1990 and 2000,

[8] The variables were diversity of employment by industry, percentage of population 25 years and older having a bachelor's degree or higher, percentage of the population unemployed, percentage of persons living below the poverty level, household income inequality, and average travel time to work.

Donoghue and Sutton (2006) found that, on average, communities farther from federal forests had a greater percentage of the population with a bachelor's degrees or higher, less poverty, less unemployment, and less income inequality during both time periods, and a higher diversity of employment by industry in 1990 (but not 2000). Communities farther away also had higher commute times, but there was a positive correlation between average travel time to work and median household income. There were no statistically significant correlations between community socioeconomic well-being scores and community population size or population change (Donoghue and Sutton 2006).

Another study examined how 2000 poverty and unemployment rates (indicators of community well-being) traced to prior high rates of timber industry employment, the share of minority populations, and other characteristics of communities on the Olympic Peninsula in the context of the establishment of the NWFP (Kirschner 2010). The study used panel regression with U.S. Census data from 1990 and 2000, and the census tract as the unit of analysis (which is larger than a community but smaller than a county). In the study region, the poverty rate in 1990, a high minority population in 2000 (primarily American Indians and Latinos), and the share of the population with college degrees were significant predictors of the poverty rate in 2000. The poverty rate in 1990 was believed to reflect the lingering impacts of timber industry restructuring that occurred in the 1980s. The presence of minorities was the only variable tested that was a statistically significant predictor of the unemployment rate in 2000. These findings likely reflect a history of prejudice and discrimination toward, and disadvantage among, these populations, influencing community socioeconomic well-being (Kirschner 2010). The level of reliance on the timber industry as a local employer (used as a proxy for the potential magnitude of the effect of the NWFP) was not found to be a statistically significant predictor of poverty or unemployment in 2000 on the Olympic Peninsula.

Eichman et al. (2010) studied the effects of the NWFP on employment growth rates and net migration rates during the first decade of the NWFP at the county scale for 73 counties that either contain NWFP reserved land (late-successional reserves, riparian reserves), or are adjacent to such counties. They were interested in how the economic effects of net migration might offset those associated with reduced timber production from the reserved lands. They found that in counties having land reserved by the NWFP, there was a negative effect on annual employment growth rates, reducing them by 0.2 percent for every 1 percent of land in a county that was reserved. Thus the presence of reserved lands (12 percent on average across the 73 counties studied) decreased the average annual employment growth rate from 1.75 to 1.52 percent The percentage of decline in annual employment growth was higher in nonmetropolitan counties than in metropolitan counties. This study also found that the NWFP had a slightly positive effect on net migration to the 73 counties, which the authors attribute to the natural features associated with reserved land that attract amenity migrants (e.g., retirees, telecommuters) or help retain residents. However, the positive economic effects of migration only slightly offset the negative impacts of reduced timber harvesting on employment growth rates (-0.019 [total effect] versus -0.021 [without net migration offset]).

Chen and Weber (2012) examined the impact of the NWFP on 234 rural communities (incorporated cities having less than 50,000 people) in Oregon whose economies were based in the wood products industry before NWFP implementation. The authors found complex relationships between community population change and wealth growth (measured by residential and commercial real estate value), mill closures, and proximity to NWFP-reserved land in the decades around establishment of the NWFP. They found that, during the 1990s, proximity to NWFP reserved land (i.e., within 10 miles of reserved land) had a statistically significant positive effect on community population growth and wealth growth compared to communities located farther away. They attributed this finding to positive amenity-related growth effects of the Plan on communities. This positive effect of proximity to reserved lands on population and wealth disappeared by the early 2000s; it was also not evident in the 1980s. In that decade, mill closures caused by the general downturn in the wood products sector and early reductions in federal timber harvest had a direct negative effect on community population, but no statistically significant effect on wealth change

in communities. In the 1990s, with the NWFP in place, mill closures had a direct negative effect on wealth and an indirect (through wealth loss) negative effect on population. That is, the mill closures did not directly influence population change, but the effect of mill closures reduced community wealth, which in turn led to population loss. Oftentimes these negative effects were not limited to communities close to NWFP reserved land because mills are often located away from the log source. By the early 2000s, the relationship between mill closures and wealth creation disappeared, and there was a direct positive relationship between communities with mill closures and communities with population growth. The authors postulated that relationships between mills closures and population and wealth found for the early 2000s may reflect the arrival of amenity migrants in mill towns (after they had already arrived in communities closest to reserved land), and the corresponding increase in residential housing value that offset (in real estate values community-wide) any continued loss in commercial property values.

Chen et al. (2016) extended this analysis by testing for any effect of proximity to NWFP reserved areas on population, income, and wealth through the late 2000s. The authors found that small communities (100 to 2,500 people) within 5 miles of protected NWFP land experienced positive increases in all three attributes relative to those that were farther away. They attribute the correlation between proximity to protected NWFP lands and income, population, and property value growth to the amenity values associated with conservation lands set aside by the NWFP, where land uses were restricted. Because a share of amenity migrants are often individuals with strong purchasing power who can purchase existing homes or build new ones, amenity migration can lead to increases in property values within a community without an associated increase in income in the community. In this study, the authors did find that property values in NWFP-proximate small communities grew more than median income, resulting in a decrease in real income in those communities. The authors found no effect of NWFP proximity for medium-size communities (2,500 to 20,000 residents).

It is difficult to generalize about the effects of the NWFP on rural communities and counties, and its role as a driver of change there, from quantitative studies based on secondary data because the body of research encompasses different periods, different geographic scales and locations, and different indicators. Moreover, although several studies find correlations between different social and economic indicators and lands protected by the NWFP, these correlations do not necessarily imply causation. For example, some studies attribute their findings to the NWFP when they may be the result of proximity to federal lands generally, instead of a specific forest management policy such as the NWFP (Charnley et al. 2008c). Nevertheless, to summarize the results of these studies: impacts attributed to the NWFP include population growth and population decline, both increases and decreases in socioeconomic well-being, and both increases and decreases in economic indicators. Some studies found no NWFP impact on population and economic indicators. Studies also found that NWFP impacts on communities differed at the community and county scales, and depended on local social, cultural, economic, and environmental contexts. In general, impacts (both positive and negative) were greater during the first decade of the NWFP than they were during the second decade. Impacts (both positive and negative) were also greater in communities located closer to national forests, or to reserved lands set aside by the NWFP; and in communities that had experienced a mill closure (not necessarily as a result of the Plan). Finally, impacts were greater at the community scale than at the county and regional scales; and were greater in nonmetropolitan counties than in metropolitan counties.

Qualitative accounts providing insight into causal relationships between the NWFP and socioeconomic conditions in rural communities are less common. Seventeen community case studies that included primary qualitative data collection were undertaken in communities surrounding federal forests in the NWFP area to evaluate its impacts on community well-being during the first decade (Buttolph et al. 2006, Charnley et al. 2008a, Dillingham et al. 2008, Kay et al. 2007, McLain et al. 2006). Charnley et al. (2008c) and Charnley and Donoghue (2006b) summarize the findings of these case studies.

They found that not all communities were affected in the same way, or to the same extent. The NWFP's impacts depended on the relative strength of the wood products industry as an economic sector around 1990; the extent to

which federal timber supported that sector; and the degree to which local residents depended on federal jobs (as agency employees or contractors). Communities that participated heavily in the wood products industry in the late 1980s and early 1990s, where loggers worked mainly on federal forest lands and local mills obtained most of their wood from federal forests, were heavily affected. Communities having a large number of Forest Service or BLM employees were also heavily affected. In communities where tribal or private forest lands were the main source of supply for the industry, the NWFP had a minor impact. Although timber workers and agency employees experienced impacts, at the community level, the effects of the NWFP also depended on economic activity in other sectors. In places where other industries were also in decline (e.g., the fishing industry in coastal communities), the NWFP added to these impacts. In places with more diversified local economies, its impacts were somewhat mitigated, although jobs in other sectors did not necessarily provide opportunities for those who experienced NWFP-related job loss. In communities where the timber industry had declined prior to the late 1980s, or was never prominent—as in some agriculturally oriented communities—the NWFP had little impact.

Effects of wildfire management on communities— Several of the studies reviewed here suggest that rural communities near federal forests are more affected by federal forest management policy than communities located farther away. Communities near federal forests—no matter what their economic orientation—are also likely to face greater risks from the heightened incidence of wildfires that occur there, and that are predicted to increase under a warming climate (see chapter 2). These risks will likely be greatest in areas of WUI expansion (Wimberly and Liu 2014) (fig. 8-8). Socially vulnerable WUI populations may be at



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Figure 8-8—Home expansion into the wildland-urban interface increases the risk of losses from high-severity wildfire on federal forest lands.

even greater risk (Ojerio et al. 2011). Beyond the strictly economic impacts of wildfire, there are multiple social and health concerns associated with wildfires generally, and large wildfires specifically (Finlay et al. 2012). Recent large wildfires have resulted in injuries, property loss, and death among WUI residents. Wildfire smoke has been associated with increased risk of respiratory disease, and may also be associated with increased cardiovascular disease and mortality (Kochi et al. 2010, Liu et al. 2015, Moeltner et al. 2013, Mott et al. 2002).

Displacement of residents, stress, psychological trauma, and conflict have also been documented in communities affected by wildfires (Carroll et al. 2006, Finlay et al. 2012). The activities of federal fire managers during fires that threaten or damage the built environment can influence trust and relationships between community members and agency managers in the future (Carroll et al. 2006, 2011; Paveglio et al. 2015a). Management activities intended to alter fire behavior, restore forest conditions so they are more resilient to wildfire, or protect human values from fire are often warranted in various forest types throughout the NWFP area (see chapter 3 of this volume). Thus, eliminating fire from these systems is not possible, nor is it possible to eliminate smoke impacts, especially where prescribed fire is a needed forest restoration tool to increase forest resilience to wildfire.

Social and Economic Change in Rural Communities in the Northwest Forest Plan Area

Social science research from the Plan area that examines how communities have changed in the two decades since the NWFP was implemented forms part of a broader literature on rural restructuring in the American West that followed the decline in natural resource extraction as a prominent economic activity in rural communities. Following a brief overview of demographic change in the region, we discuss key findings of this body of research.

Demographic change—
Published accounts of demographic change in the 72 counties of the NWFP area as a whole since the Plan was implemented come from the Plan's socioeconomic monitoring reports. These are inconsistent in their data sources and

Summary—
The population of the NWFP area has been increasing at a faster rate than for the United States as a whole, with the majority of population growth occurring in metropolitan areas. Population trends in nonmetropolitan communities have been variable. Over the past two to three decades, many rural communities in the Plan area have undergone changes in demographic and economic conditions following declines in commodity production. One general trajectory is the "amenity" trajectory, in which communities that are relatively accessible and situated near natural amenities such as mountains and water bodies experience population growth owing to in-migration by people who are seeking an improved quality of life or are fleeing cities, telecommuting, becoming creative entrepreneurs, and living off of retirement or investment incomes. Amenity migration may drive local community development. A second trajectory is for communities to continue with traditional modes of production, albeit at lower levels, or to attract new forms of commodity production or service-oriented economic activity to bolster the local economy. These new businesses may be less desirable but provide jobs, at least in the short term; illegal (e.g., marijuana production on federal lands); or may seek to use natural resources in new and diverse ways through investments in sustainable agriculture and natural resource management. Many communities pursue a range of strategies, with diverse development pathways increasing their resilience. A third trajectory, however, is one in which communities find it difficult to recover from declines in commodity production, and therefore experience population and employment declines. Nevertheless, these communities have latent potential for development associated with the availability of labor, land, natural resources, or infrastructure that may become valuable in the future.

scale of analysis, making simple reporting of trends difficult. Socioeconomic monitoring of the NWFP area during the first decade (1994 to 2003) occurred at the community scale and used decennial U.S. Census data from 1990 and 2000 (Donoghue and Sutton 2006). Socioeconomic monitoring during the second decade (2004 to 2013) occurred at the county scale and used annual mid-year population estimates from the U.S. Census Bureau (reported by the Bureau of Labor Statistics and Bureau of Economic Analysis) for the years 1999 through 2012 (Grinspoon and Phillips 2011, Grinspoon et al. 2016). All of these reports distinguish between trends in metropolitan and nonmetropolitan areas. A metropolitan area is a core urban area with a population of 50,000 or more people, and can be composed of several counties.[9] The 10-year socioeconomic monitoring report identifies 10 metropolitan areas and 1,314 nonmetropolitan communities in the NWFP area (Donoghue and Sutton 2006), and identifies trends for these communities. The 15- and 20-year monitoring reports distinguish 32 metropolitan counties and 40 nonmetropolitan counties (Grinspoon and Phillips 2011, Grinspoon et al. 2016), and show population trends for these two groups of counties. General findings from the two reports are as follows:

1. Between 1990 and 2000, the total population of the NWFP area went from 8.57 million in 1990 to 10.26 million in 2000, a population increase of 19.8 percent (Donoghue and Sutton 2006). The population of the United States as a whole grew by 13.2 percent during this decade.[10] Population in the 1,314 nonmetropolitan communities went from 4.13 million in 1990 to 4.98 million in 2000, increasing by 20.6 percent. However, 21 percent of communities lost population during this period; these tended to be small (under 2,000 people). About 40 percent of communities grew at a slower rate than for the region as a whole, and about 40 percent grew more quickly. The fast-growing communities were typically bigger than the slow-growing communities (Donoghue and Sutton 2006).
2. Between 2000 and 2012, the total population of the NWFP area grew to 11.87 million, an increase of 15 percent since 2000 (Grinspoon et al. 2016). In comparison, the U.S. population grew by 11.6 percent during this period (based on 2012 population projections from the 2010 Census).[11]
3. The population of NWFP-area counties grew by 10 percent in California, 16 percent in Oregon, and 19 percent in Washington between 1999 and 2012. Population growth between 1999 and 2012 in metropolitan counties overall was twice what it was in nonmetropolitan counties, and accounted for nearly all of the population growth in the Plan area during this period. And, NWFP-area counties (both metropolitan and nonmetropolitan) grew faster than non-NWFP-area counties in the three states (Grinspoon et al. 2016), perhaps because they contain the largest metropolitan areas. These trends obscure changes occurring in individual counties and at the community scale.
4. Overall, people residing in nonmetropolitan communities and counties in the NWFP area are aging.

Changing socioeconomic conditions—

Over the past two to three decades, many rural communities in the NWFP area and elsewhere in the Western United States have undergone "rural restructuring"—changes in their demographic and economic conditions (Nelson 1997)—owing to declines in natural resource production and agriculture, which previously were the economic mainstays of these communities. Researchers investigating this phenomenon in rural forest communities in the United States and in the West have identified general trajectories of change in response, leading to different community/county types that have emerged today. This does not mean that communities were static prior to the 1980s, nor that they can be neatly categorized into one ideal type today. Nevertheless, researchers have distinguished several rural community development pathways, typically integrating

[9] http://www.census.gov/population/metro/.
[10] https://www.census.gov/prod/2001pubs/c2kbr01-2.pdf.
[11] http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmkPl.

considerations of economic activities, "connectedness" to urban areas, population, and stocks of financial, social, or other forms of capital in doing so. These different development pathways can be used to characterize change in the NWFP area as well.

The degree of community economic dependence upon "traditional" resource use (e.g., logging, ranching, and mining) is one common variable used to differentiate rural Western communities. For example, so-called "old West" economic activities are typically contrasted with "new West" economic activities associated with the service industries, particularly tourism and real estate (Winkler et al. 2007). We apply three general trajectories of socioeconomic change documented in rural forest communities in the United States (based on Morzillo et al. 2015) to the Plan area because they are consistent with the literature from the region: (1) amenity-driven development, (2) development driven by new production strategies, and (3) economic decline. These are archetypes; communities following different trajectories can occur in the same county, and individual communities may pursue a combination of development strategies (fig. 8-9).

Gaps in the published literature prevent us from quantifying the number of communities in the NWFP area that have followed these different trajectories, and from identifying their geographic distribution. However, other researchers have developed typologies that classify counties according to variables that help to characterize socioeconomic conditions there. For example, the U.S. Department of Agriculture's Economic Research Service (ERS) developed nine different rural-to-urban continuum codes, which classify metropolitan counties based on the size of the population in their metropolitan area (three categories), and nonmetropolitan counties based on their

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Figure 8-9—Weaverville in Trinity County, California, retains a sawmill and has also experienced amenity-driven development.

degree of urbanization and adjacency to a metropolitan area (six categories).[12] Rasker et al. (2009) developed a similar typology of urban connectivity for counties in the U.S. West that further differentiate nonmetropolitan counties. In that typology, counties are classified as metropolitan, connected, and isolated based on location within a metropolitan area or location within one hour of an airport with daily commercial passenger service. About 50 percent of the counties in the U.S. West were classified as "isolated;" 18 counties within the NWFP area (25 percent) were classified as "isolated."

The ERS has also typed counties based on several social and economic characteristics (not necessarily mutually exclusive).[13] Examples include economic dependence on recreation (fig. 8-10); economic dependence on manufacturing (fig. 8-11); retirement-destination counties (fig. 8-12); and low-employment counties (fig. 8-13). In the NWFP area, the majority of recreation-dependent counties are located along the Pacific Coast or on the east side of the Cascade Range, in areas commonly perceived as being rich in natural amenities. Manufacturing-dependent counties are rare, and are all metropolitan. Two of the manufacturing-dependent counties are focused on advanced manufacturing: Snohomish County, Washington, is a key manufacturing center for the aerospace industry, and Washington County, Oregon, is home to semiconductor and bioscience manufacturers. Retirement counties are sprinkled throughout the Plan area and are in a mix of metropolitan and nonmetropolitan locations. In general, the retirement counties tend to be associated with areas that are rich in natural amenities (e.g., Deschutes County, Oregon; Skagit County, Washington; and Shasta County, California) or that have a relatively low cost of land and housing (e.g., Douglas County, Oregon, and Lewis County, Washington). Low-employment counties are predominantly nonmetropolitan, and within the NWFP area are concentrated in northern California, southern Oregon, and the Olympic Peninsula of Washington. It is important to bear in mind that county-scale typologies do not necessarily reflect conditions at the community scale.

Amenity communities—

The most studied form of rural restructuring in forest communities nationwide, and in the Western United States, is the one that follows the commodity production → decline → amenity trajectory (Morzillo et al. 2015), in which rural communities or counties become places that attract people who wish to enjoy the natural amenities they offer, rather than because they are pursuing employment in natural resource production (Lawson et al. 2010, Morzillo et al. 2015). Natural amenities include water bodies, mountains, and public lands, and communities following this trajectory of change are typically located in or near places that offer nearby natural amenities and are relatively accessible from urban areas (McGranahan 1999, Rasker et al. 2009). Amenity communities are characterized by high population growth rates owing to in-migration by amenity migrants—people who seek an improved quality of life outside of cities, telecommute, are entrepreneurs, or who live on retirement or investment income (McGranahan and Wojan 2007, Winkler et al. 2007). For overviews of the phenomenon of amenity migration see Gosnell and Abrams (2011) and Waltert and Schläpfer (2010).

High-amenity communities and counties draw people and businesses, which in turn can drive economic development (Rasker et al. 2013). Waltert and Schläpfer (2010) identified five ways that natural amenities have been found to affect rural development: (1) new residents with flexible income sources move to the area to be closer to natural amenities; (2) new residents accept lower pay or higher costs of living in rural areas to be close to natural amenities; (3) entrepreneurs willing to accept lower profits move to rural areas to be closer to natural amenities; (4) natural amenities provide a basis for tourism, recreation and outdoor industries; and (5) amenities provide benefits from nature that improve the well-being of individual people or make businesses more profitable. In some cases, population change that provides a potential labor force with desirable skills may attract new businesses looking for workers (Waltert and Schläpfer 2010).

Research on amenity migration and amenity communities in the Northwest is relatively sparse compared to research on this topic from other parts of the American West. In the Northwest, amenity counties have been found

[12] http://www.ers.usda.gov/data-products/rural-urban-continuum-codes/.aspx.
[13] http://www.ers.usda.gov/data-products/county-typology-codes.aspx.

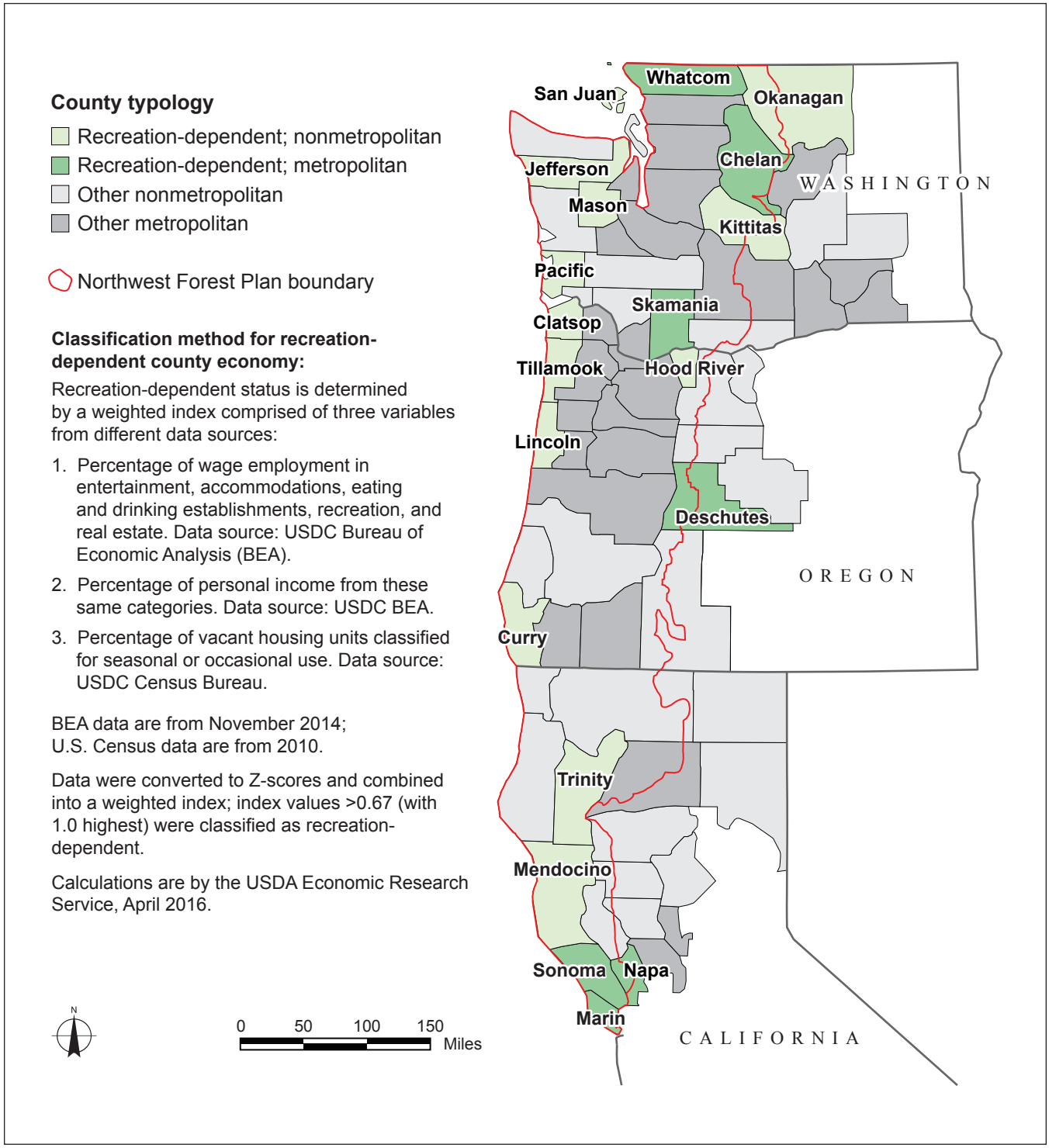


Figure 8-10—Recreation-dependent counties in the Northwest Forest Plan area. Source: U.S. Department of Agriculture, Economic Research Service.

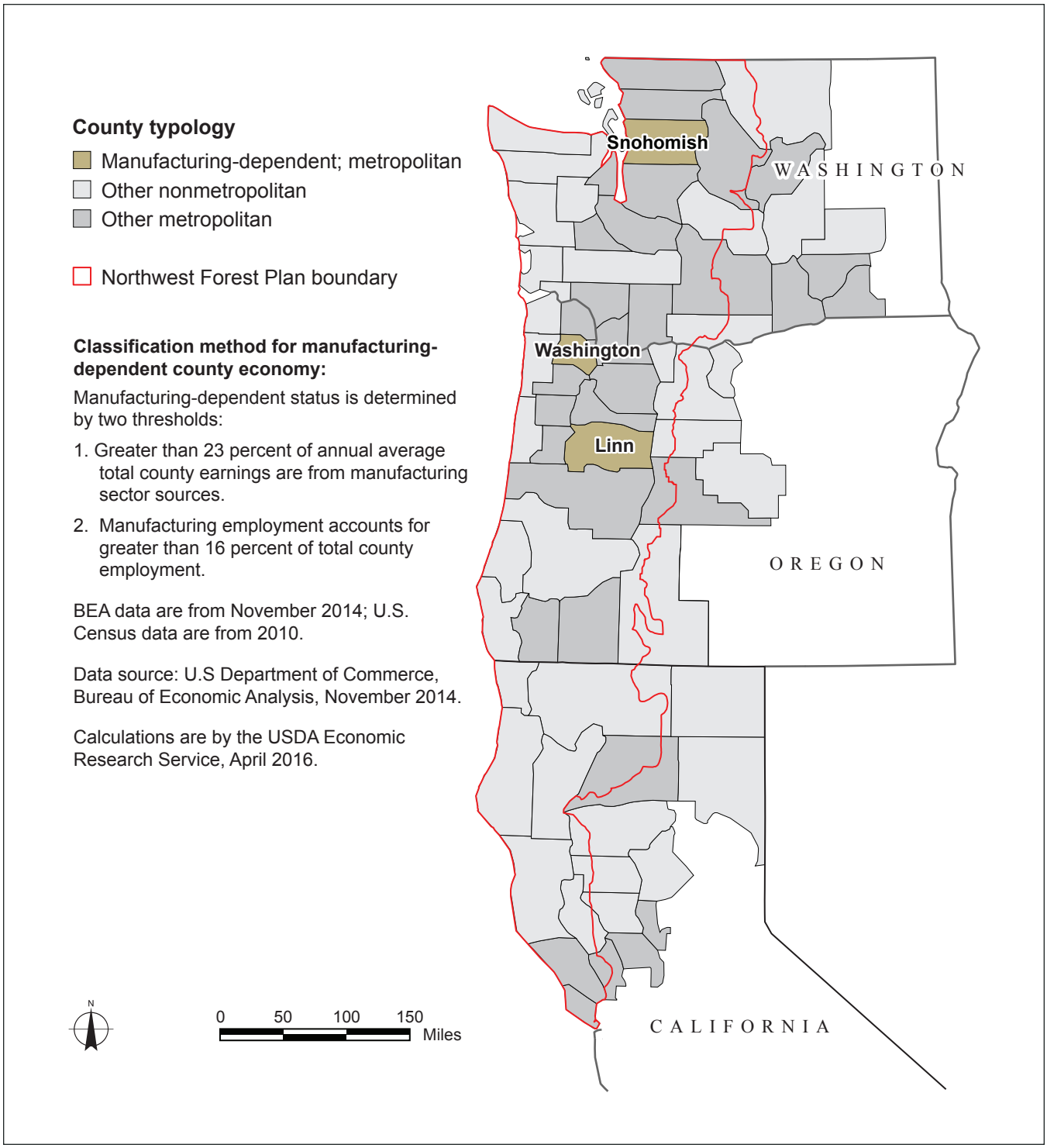


Figure 8-11—Manufacturing-dependent counties in the Northwest Forest Plan area. Source: U.S. Department of Agriculture, Economic Research Service.

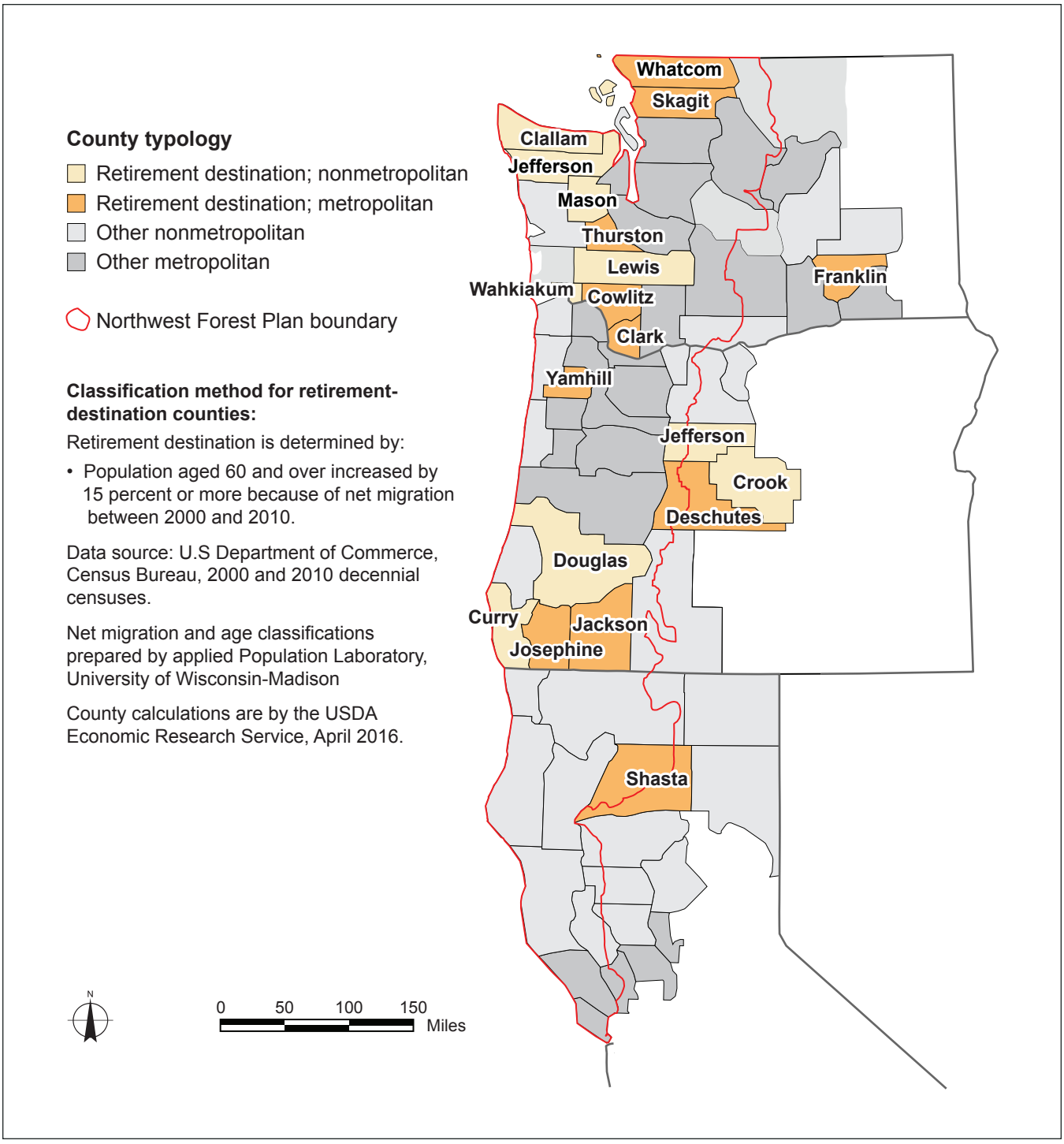


Figure 8-12—Retirement-destination counties in the Northwest Forest Plan area. Source: U.S. Department of Agriculture, Economic Research Service.

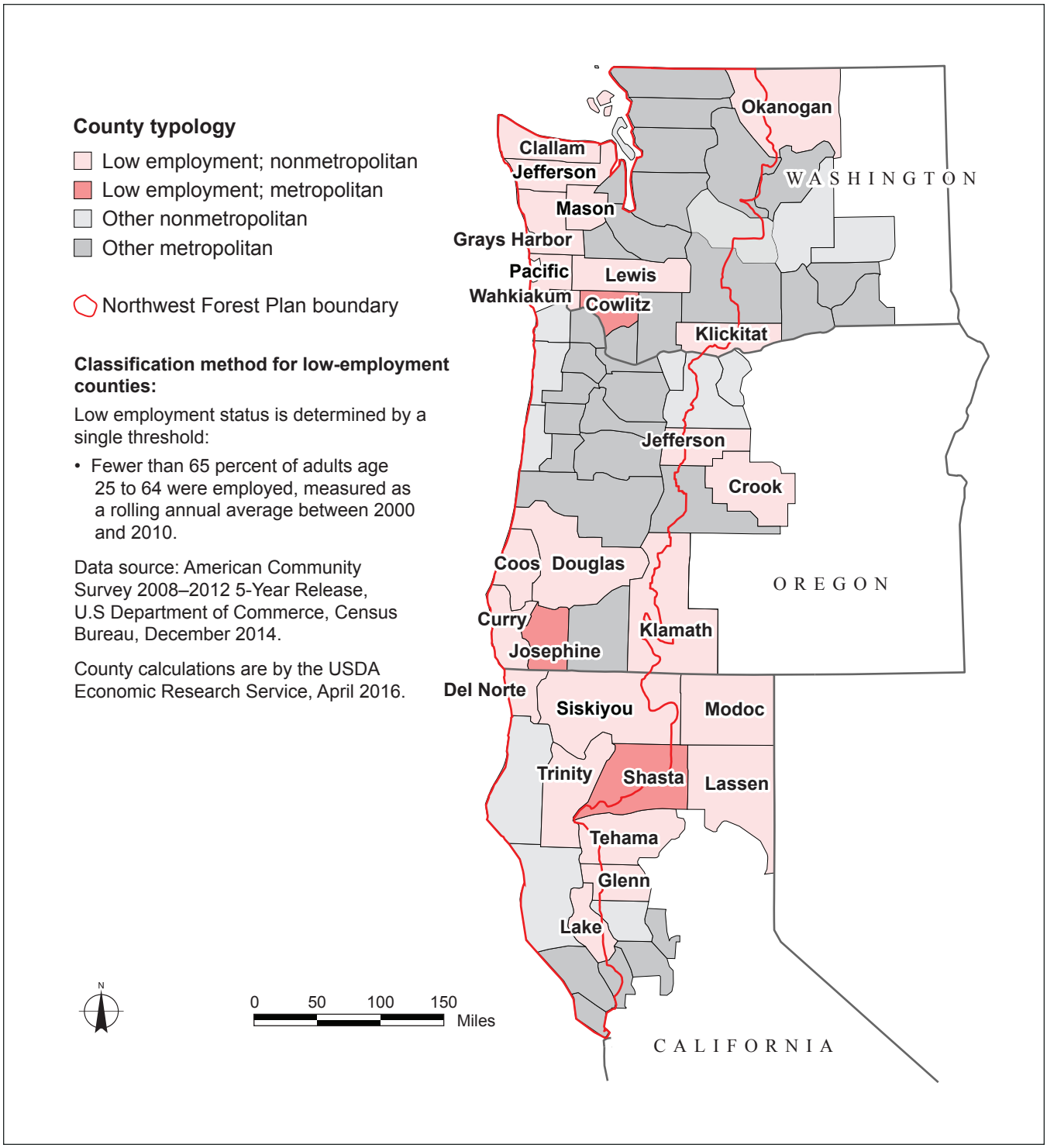


Figure 8-13—Low-employment counties in the Northwest Forest Plan area. Source: U.S. Department of Agriculture, Economic Research Service.

to attract investments in recreation and tourism, to draw middle- and high-income residents, and to be economically diversified relative to other rural counties (Lawson et al. 2010). Amenity counties also often have a high proportion of second homes; nonmetropolitan Washington counties had an average of 17 percent of their housing stock in second homes in 2010, with the number increasing rapidly (Kondo et al. 2012). Employment in the retail and services sectors in these areas is typically more important economically than employment in agriculture or natural resource extraction (Lawson et al. 2010) (fig. 8-14). Although poverty has been found to be relatively low in high-amenity counties in the Northwest compared to other nonmetropolitan counties (Lawson et al. 2010), these places are often characterized by high social and economic inequality, and by sociocultural divisions between long-time residents and newcomers (Kondo et al. 2012, Morzillo et al. 2015, Nelson 1997, Ohman 1999). In Oregon and Washington, high-amenity rural counties are concentrated along the Pacific Coast and the Cascade Range (Lawson et al. 2010). One example is Hood River County, Oregon (Pierce 2007).

The presence of public lands can be an important driver in attracting amenity migration; new arrivers often wish to live near public land boundaries. A study of housing growth within 50 km of designated wilderness areas, national parks, and national forests in the coterminous United States between 1940 and 2000 found that national forests experienced the highest absolute growth in number of housing units in their vicinity (from 484,000 to 1.8 million within 1 km of a national forest; and from 9.0 to

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Figure 8-14—Services and retail are important economic sectors in amenity-based communities.

34.8 million within 50 km) (Radeloff et al. 2010). Population growth and associated housing and road development can lead to habitat fragmentation and threats to water quality and biodiversity on federal lands (Radeloff et al. 2010), and other patterns of ecological degradation (Abrams et al. 2012). For example, Radeloff et al. (2010) found that, between 1940 and 2000, 940,000 housing units were built on private inholdings within national forests nationwide. Housing growth and associated road development near these protected areas can make them ecologically isolated by causing habitat fragmentation around their boundaries, disrupting habitat corridors between them, increasing the spread of invasive species, and increasing predation by pets (Radeloff et al. 2010). The study does not provide comparable statistics for the Pacific Northwest.

The expansion of the WUI also poses challenges for fire managers (Hammer et al. 2007). During the 1990s, 61 percent of the new housing units built in Oregon, Washington, and California (combined) were built in the WUI, causing 18 percent growth in the number of WUI housing units in these states during the decade (Hammer et al. 2007). Most of this growth occurred in the intermix, where homes and forests intermingle, making fire management especially difficult. In 2000, about two-thirds of the WUI in these states occurred in places with a 35 to 100+-year fire-return interval, the vast majority of which had departed from its historical range of variability (Hammer et al. 2007). These past patterns may portend future trends in WUI development in the NWFP area.

Communities pursuing new production strategies— A second trajectory of change in rural forest communities in the United States has been characterized as commodity production → decline → (new) production (Morzillo et al. 2015). Places that follow this trajectory find ways to continue traditional forms of commodity production, albeit often reduced or altered, or they find new forms of commodity production or service-oriented economic activity to bolster the local economy (Morzillo et al. 2015). Research indicates that change along this trajectory has various outcomes.

On the one hand, it can lead to industrial recruitment (Lawson et al. 2010). Research from the Northwest characterizes such communities as being as remote or less attractive then amenity communities, and as having weak farming and natural resource production sectors. Thus, community leaders try to lure in new businesses such as hog farms, food processing plants, corporate dairies, or prisons in the hope that they will lead to job creation. To be competitive, they may loosen environmental, labor, and zoning standards, and provide economic incentives and cheap land. Although such industries may be deemed undesirable—providing low-wage jobs, paying low property taxes, having undesirable environmental consequences, or departing after a few years—they are pursued as a means to create large numbers of jobs in the short term to keep the local economy afloat (Crowe 2006, Lawson et al. 2010). In Washington state, local control over land and resources, physical space for expansion, and accessibility to markets were found to be important community characteristics associated with industrial recruitment. Well-developed social infrastructure (e.g., schools, health care services, active community organizations, and links to agencies or organizations in nearby communities or at the state or national levels) also positively influenced industrial recruitment (Crowe 2006).

An alternative to industrial recruitment is the emergence of new but illegal production economies, exemplified by the marijuana economy that has developed in the California portion of the NWFP area since the 1980s (Polson 2013). An estimated 60 to 70 percent of the marijuana consumed in the United States is produced in California (Carah et al. 2015). The collapse of the mining and timber industries in northern California, economic stagnation, and the rise of service-oriented industries—in which many jobs are low paying, temporary or seasonal, and lack benefits—created conditions of economic vulnerability (Keene 2015). This lack of economic opportunity led many people to experiment with marijuana production. Initially illegal, marijuana production increased substantially in the 1990s and 2000s as a result of local economic restructuring and legislative changes in California legalizing the use, cultivation, and possession of marijuana for medicinal purposes (although some illegal modes of production continued, e.g., growing on federal lands). Marijuana production now plays a significant role in sustaining rural

livelihoods in the region and in shaping land values there (Keene 2015, Polson 2013). This role may increase because California legalized marijuana for recreational use by adults in 2016. Large-scale production (hundreds to thousands of plants) on private lands funded by nonlocal residents for investment purposes can create conflict by driving up land prices, taking land out of food production, affecting water use, and failing to consider or contribute to local community interests (fig. 8-15). Washington and Oregon have also legalized marijuana for medicinal and recreational use, but we are not aware of any published literature on marijuana production in Oregon and Washington and its effects on local communities, economies, and the environment.

The environmental impacts of commercial-scale, outdoor marijuana cultivation in northern California's forested landscapes are beginning to be documented (Bauer et al. 2015, Carah et al. 2015, Gabriel et al. 2012). They include forest clearing, land terracing, and road construction; and diversion of large quantities of surface water for irrigation during summer when water flows are low, posing a threat to fish, amphibians, and other wildlife in watersheds important for their aquatic biodiversity. These impacts can occur on both public and private lands. Chemical pollution from heavy use of pesticides, herbicides, and fertilizers is another threat that has been documented on public lands, with these pollutants contaminating watersheds and

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Figure 8-15—Large-scale marijuana production funded by nonlocal community members and its impacts on Karuk and Yurok ancestral lands in northern California is controversial.

entering local food chains, poisoning wildlife, including fishers (*Pekania pennanti*), recently considered for listing under the Endangered Species Act (Bauer et al. 2015, Carah et al. 2015, Gabriel et al. 2012). Whether these kinds of environmental impacts will decrease in response to recent legislation legalizing marijuana cultivation remains to be seen.

Another distinct development pathway for communities pursuing new production strategies is what Hibbard and Lurie (2013) refer to as the "new natural resources economy." This strategy entails using natural resources in new and diverse ways to help drive local economic development through investments in sustainable agriculture and natural resource management (fig. 8-16), including restoration. Such activities draw on the natural resource base of rural communities in ways that both diversify the local economy and promote socioeconomic well-being by producing new goods and services for export, generating new jobs and income-earning opportunities, and producing goods and services for local use rather than importing them, thereby increasing self-sufficiency. Examples of such activities in Oregon communities include (1) sustainable farming/ranching, forest products production, and alternative energy production (production related); (2) ecotourism and agritourism (consumption related); and (3) watershed restoration, wildlife habitat protection and restoration, forest restoration, and environmental education (protection related) (Hibbard and Lurie 2013).



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Figure 8-16—Mount Adams Resource Stewards' small business incubator and log yard in Glenwood, Washington.

Examples of NWFP-area communities that are developing new natural resource economies are Hayfork, California, (Abrams et al. 2015) and Vernonia, Oregon (Hibbard and Lurie 2013). In Hayfork, a local community-based organization—the Watershed Research and Training Center—helped the community transition by developing workforce training and job opportunities associated with ecosystem management work and hazardous fuels reduction on national forests. It also invested in a small-log processing facility and a business incubator to encourage development and marketing of value-added forest products (Abrams et al. 2015). In Vernonia, some family forest owners engage in commercial nontimber forest products production from their lands, and there is a tourism economy developing in association with a recent rails-to-trails project. In addition, the community is reinventing itself as a "green" community, with rural development projects revolving around rebuilding schools according to Leadership in Energy and Environmental Design-certified standards and heat from locally produced biomass energy, and a new rural sustainability center promoting forest sustainability and clean energy (Hibbard and Lurie 2013). Hibbard and Lurie (2013) discussed barriers to the development of new natural resource economies, and suggested policies and programs that might help; none pertain directly to federal forest management.

Communities in decline—
A third general trajectory of change identified for rural forest communities in the United States experiencing dwindling commodity production is decline (Morzillo et al. 2015). Such communities are unable to recover from significant job losses associated with traditional modes of production, and therefore experience population and employment declines. They are often remote, may have undesirable environmental legacies from former extractive industries such as forestry or mining, and often have high and growing poverty rates (Lawson et al. 2010, Morzillo et al. 2015). These communities have not attracted investors or wealthy, educated immigrants; have limited development options; and are economically and politically marginalized. Not only have they failed to attract new investments; the viability of traditional economic activities such as forestry, ranching, farming, and mining continues to dwindle (Lawson et al. 2010, Nelson 1997). An example is Happy Camp, California, which was heavily affected by cutbacks in timber harvesting associated with the NWFP (Charnley et al. 2008a). Nevertheless, these communities have latent potential for development associated with the availability of labor, land, natural resources, or infrastructure that may become valuable in the future (Morzillo et al. 2015).

Adaptation to change—
A common theme that crosscuts the discussion above is community adaptation to change. Community capacity and community resilience are important to well-being in forest communities, making them more resilient to change and disturbances (such as wildfire, climate variability, and declines in the wood products industry) (Berkes and Ross 2013, Folke et al. 2010). The elements, mechanisms, and determinants of community resilience are not necessarily the same across community contexts, implying a need to consider the various development pathways of rural communities over time and their particular relationships with nearby public forest lands (Donoghue and Sturtevant 2008).

As noted, our discussion of rural community development pathways above identifies archetypes. Rural communities that have strongly "multifunctional" characteristics are more likely to be resilient to social, economic, and ecological changes associated with federal forest management, and to mitigate their negative impacts, making them more resilient (Wilson 2010). Multifunctional rural landscapes are those that have a mix of uses, including commodity production (e.g., forest products, agriculture); amenity-driven development (e.g., recreation, tourism, services); and natural resource protection (e.g., forest restoration, jobs with land management agencies). Multifunctionality helps communities diversify their rural economies and contributes to both environmental and economic health (Hibbard and Lurie 2013). Not all communities are able to develop multifunctional characteristics, and doing so depends on their natural and social assets.

Research on NWFP impacts conducted in 17 communities around federal forests in the NWFP area following the first decade of the Plan's implementation (Charnley et al. 2006b, 2008b) found that different communities experienced the different trajectories of change described above in pursuing (or not pursuing) new opportunities. Owing to

their proximity to natural amenities, several communities experienced an influx of retirees, commuters, mobile or self-employed workers, or second-home owners, and benefitted from being popular recreation or tourism destinations, although not all community residents viewed this as a positive change (Charnley et al. 2008c). Other communities reoriented around new forms of production such as agriculture; new industries or service sectors associated with proximity to a major transportation corridor in or near a regional center; or the growth of tribal businesses, administration, and services. And some were in decline—especially those that were remote, surrounded by federal lands, and previously highly dependent on the wood products industry. Regardless, all communities were making efforts to develop and diversify, which was easier for some than others, depending on community characteristics.

One study (Harrison et al. 2016) examined the role of social capital (defined as behavioral norms and social networks that facilitate collective action) in influencing the capacity of three Pacific Northwest communities affected by the decline of the wood products industry to adapt to change and take advantage of new opportunities. The study found that a community's ability to develop along new trajectories aligned with local goals was influenced by interactions between different forms of social capital (bonding, linking, bridging).[14] In particular, a combination of strong bridging and linking social capital was found to facilitate desirable community outcomes. This finding builds on earlier work from the 1990s that found social cohesion to be an important characteristic influencing rural community well-being (Beckley 1998, Doak and Kusel 1996, Harris et al. 2000). Local cultural context also plays an important role in influencing how communities respond and adapt to changes like mill closures (Lyon and Parkins 2013).

These observations suggest that there is no one pathway, or set of variables, that will make communities resilient in the face of change, ensure successful adaptation, or promote socioeconomic well-being. Individual communities draw on the assets and opportunities available to them, which differ depending on social, cultural, economic, and environmental conditions. Moreover, community well-being is based on a host of quality-of-life attributes, including health, safety, political participation, social equity, and access to social services as well as jobs and income. Federal forest management can contribute to socioeconomic well-being in multiple ways (Kusel 2001, Nadeau et al. 2003, Sturtevant and Donoghue 2008), but it is only one of many factors influencing community well-being.

How Goods, Services, and Opportunities from Federal Forests Contribute to Community Socioeconomic Well-Being

Federal forest management contributes to socioeconomic well-being in rural communities by providing timber and nontimber forest products, recreation opportunities, jobs, other ecosystem services, and backdrops for where people want to live and work. Charnley (2006c) and Grinspoon et al. (2016) detailed and quantified many of these contributions for NWFP-area national forests and BLM districts over the first 20 years of the Plan. Here we focus on jobs in forest restoration and firefighting, nontimber forest products (NTFPs), the economic effects of recreation on federal forests, and ecosystem services from federal forests. NTFPs are also addressed in chapters 10 and 11, and recreation is also addressed in chapter 9.

Summary—
Federal forest management contributes to socioeconomic well-being in rural communities in ways that go beyond providing timber and associated jobs in the wood products industries. This section discusses jobs in forest restoration and firefighting, biomass use, nontimber forest products (NTFP) gathering, the economic effects of recreation on federal forests, and other ecosystem services from federal forests.

Restoration of federal forest lands may benefit forest communities through associated economic

[14] Bonding social capital refers to relations between individuals within a community who have similar social and economic backgrounds. Bridging social capital refers to relations between individuals having different backgrounds. Linking social capital refers to relations between community members and people outside the community who have the ability to affect community outcomes (Harrison et al. 2016).

activities (e.g., in-woods work and processing of restoration byproducts) as well as by providing the ecosystem services associated with restored ecosystems. In the Pacific Northwest, the ability of local communities to compete for and obtain contracts for work on nearby federal forests, and to retain local dollars, is an important factor in the adaptive capacity of communities. The Pacific Northwest has a high concentration of both hand crew and equipment-based fire suppression contracting, many of which also engage in forest restoration contracting. In some regions of the Pacific Northwest, the restoration contracting industry has transitioned to lower skill jobs, and Forest Service contracting practices for such activities tend to favor mobile businesses that employ a high proportion of temporary and migrant laborers. Although in some places the type of forest-related contracting has changed, many nongovernmental organizations and private businesses still depend on these forest-based activities for economic and social benefits, and continue to build their business around meeting federal agency needs for forest activities. Biomass energy production presents one possible pathway for adding value to restoration byproducts; examples from across the West demonstrate its potential economic benefits and suggest its role in reconciling diverse interests in forest management.

Federal forests in the NWFP region are important sources of a wide variety of commercial and noncommercial nontimber forest products, such as moss, mushrooms, cones, grasses, and firewood. These products provide important safety net, buffering, and provisioning functions for rural and urban households, and activities surrounding their harvest, processing, and use often help build social capital and cultural identities, as well as strengthening human-nature connections. The retail value of NTFPs in the United States is estimated to be at least $1.4 billion, with much of that coming from the NWFP region. Studies that have measured NTFP employment in the Pacific Northwest have estimated that roughly 10,000 individuals work as harvesters, buyers, or processors in the floral greens/bough sector, and an equal number of people who earn income in the wild mushroom sector. State recreation surveys for Oregon and Washington suggest that the rate of participation in NTFP gathering and collecting activities (excluding hunting and fishing) exceeds that of many other outdoor activities. The 10- and 20-year socioeconomic assessments for the NWFP indicate that the Plan likely reduced physical access to NTFPs through road closures and restricted legal access to NTFPs owing to harvesting prohibitions in some late-successional and riparian reserves, and restrictions on the harvest of special-status plants. However, the most important impact of the NWFP on NTFP resources is likely to be the landscape-level changes in forest structure and composition brought about by the Plan's management provisions. Likely, these changes will bode well for NTFPs such as matsutake mushrooms and moss that do well in late-successional forests, but will lead to reduced supplies of NTFPs found in early-seral-stage forests, such as salal and boughs.

Recreation on federal forests supports economic activity in local forest communities as visitors spend money while on recreation trips, and federal agencies spend money maintaining recreation resources. In this synthesis we focus on the former. Recreation visitors to NWFP-area national forests spend about $612.6 million in the communities around those forests each year. That spending supports employees and proprietors of businesses that sell goods and services to recreationists, and generates additional economic activity through the multiplier effect. In general, the economic activity generated around federal forests from recreation visitor spending depends on (1) the amount of recreation use, (2) the types of trips (i.e., day or overnight, local or nonlocal) taken by recreationists, and (3) the size of the local economy. The activity of recreationists can influence some patterns in spending, but is less important than trip type. All else being equal, those visitors on overnight trips spend 5 to 8 times more in local federal forest communities than those on day trips.

In addition to providing the socioeconomic benefits identified above, federal forests also provide important ecosystem services both to local communities and more distant urban populations. These include fresh water, food and fiber, wildlife habitat, and outdoor recreation opportunities, among others. Federal agencies are beginning to develop methods and protocols for evaluating ecosystem services and how they are influenced by various federal actions. Within the NWFP area, efforts largely have focused on identifying and quantifying key ecosystem services produced on the region's national forests. Although these efforts have made significant progress in raising awareness and concern for these important forest benefits, formal methods for routinely including ecosystem services values into national forest management largely are still in development by the Forest Service.

Forest restoration and wildfire-suppression contracting— Despite the overall reduction in traditional timber management activity on national forest lands, in both the Forest Service and many rural communities there has been interest in and support for restoration and stewardship activities that generate both direct employment and byproducts of potential economic value (Nechodom et al. 2008). This opens the possibility for development of a "restoration economy" (Nielsen-Pincus and Moseley 2013) based on various activities, including "ecological forestry" (Franklin and Johnson 2012), associated with the restoration of structure or function to forest ecosystems. Such activities include stream rehabilitation, fish passage improvement, road decommissioning, riparian planting, forest fuel reduction treatments (designed to decrease fuel loads, break up fuel continuity, and reduce the risk of crown fire), and thinning projects designed to introduce structural heterogeneity to second-growth stands (fig. 8-16). All these activities entail employment in planning, implementation, oversight, monitoring, or other duties, and some of them produce byproducts that can be used for bioenergy, with associated economic benefits. Nielsen-Pincus and Moseley (2013) found that an average of 16.3 jobs, $589,000 in total wages, and $2.3 million in overall economic activity were associated with every $1 million of restoration grant spending in Oregon; and economic impacts were greater in rural counties than in metropolitan counties. Baker and Quinn-Davidson (2011) calculated that the restoration sector brought nearly $135 million into Humboldt County, California, between 1995 and 2007. Thus, restoration contracting now represents a potentially significant source of forest-based jobs in rural communities.

In the Pacific Northwest, restoration contracting includes a variety of forest-related management actions, such as reforestation, thinning, mastication and chipping, and other practices aimed at improving or restoring the health of the forest (see chapter 3). Forestry support work involves seasonal and labor-intensive activities including planting and maintaining tree seedlings, piling and burning brush, thinning trees, harvesting cones, and applying herbicides (Moseley 2006b) (fig. 8-17). These activities contribute to a variety of forest management goals, from forest and watershed restoration to timber management and wildfire mitigation (Moseley et al. 2014). Related wildland fire suppression work can include heavy-equipment operation and more manual tasks such as digging fire lines.

Relatively little scholarly research has focused on the forest management-related service-contracting sector. Past research suggests that these contractors operate in regional markets that involve working close to home as well as traveling relatively long distances, sometimes across state lines, to perform forest management services on federal lands (Nielsen-Pincus and Moseley 2013). Contractors are more likely to travel long distances if the work is manual and labor intensive, such as tree planting and hand thinning. Contractors that work on equipment-intensive activities such as stream restoration, road construction, and mechanical thinning tend to work closer to home (Moseley and Reyes 2008, Moseley and Shankle 2001, Moseley and Toth 2004).

Understanding where contractors are located has been an important component of the research on restoration contracting because it sheds light on where and how contracting

Susan Charmley



Figure 8-17—Thinning to restore forest resilience to wildland fire can be equipment-intensive.

businesses create local community benefit. An intended outcome of the NWFP was for the Forest Service and BLM to offset job loss in the timber production, harvesting, and processing markets through public land restoration, including the use of contracting (Moseley 2006b). Both the Forest Service and BLM have transitioned away from intensive forest management for timber (e.g., replanting clearcuts) to more restoration-focused work (Moseley 2006b). Moseley (2006b) found that significant declines in Forest Service contract spending subsequently decreased the amount of contracting money flowing to rural communities. These trends have continued, as an increasing amount of the Forest Service budget is allocated to wildfire suppression (Calkin et al. 2011, Gebert and Black 2012, North et al. 2015).

In some regions of the Pacific Northwest, the restoration contracting industry has transitioned to lower skill jobs. Changes in federal policy and practice, and a refocus on reducing wildfire risk in drier, fire-prone forests in the early 2000s, led to a need for low-skill, labor-intensive fuels reduction work in federal forests (e.g., thinning trees and clearing brush). Forest Service contracting practices for these kinds of activities tend to favor mobile businesses that employ a high proportion of temporary and migrant laborers (Moseley et al. 2014; Sarathy 2008, 2012). The implications of these transitions and of contracting for lowest bid Forest Service work are further detailed in chapter 10. In northern California, for example, the availability and structuring of restoration contracts have put many smaller businesses based in rural communities at a disadvantage relative to larger, more mobile urban-based contractors (Baker and Quinn-Davidson 2011), which led a local, community-based nonprofit organization to begin

training and hiring local residents to be able to contract with the Forest Service to perform this fuels-reduction work (Abrams et al. 2015). This example illustrates a shift by community organizations from other work into contracting, which is part of a growing trend in which organizations (nongovernmental and private businesses alike) are changing and adapting their roles to fit new or amplified needs emanating from changes in Forest Service forest restoration and fire-suppression contracting.

In the Pacific Northwest, the ability of local communities to compete for and obtain work contracts on federal forests, and retain local dollars, is an important factor in the adaptive capacity of communities. State or federal contracts for restoration or wildfire suppression services that are captured by local businesses can benefit local economies. In contrast, hiring contractors from outside local communities can reduce the amount of forest restoration dollars that circulate in the local economy.

Contracting for fire suppression purposes began in the 1970s, when loggers and other forest workers would fight fires as needed to protect their livelihoods—which were based on work in the forest. Fire suppression was conducted in the shoulder seasons for other forest work, or when forests were closed to forestry work in the hottest fire-prone months of the summer. Recent research exploring connections between restoration contracting capacity and fire suppression capacity found that the amount of money captured during a fire by community businesses located near the fire increases with the number of vendors involved in forest and watershed restoration prior to a fire, suggesting that local business restoration capacity might influence local fire suppression response (Moseley et al., n.d.). Similar to evidence about wildfire hazard mitigation (Moseley and Toth 2004), findings by Moseley et al. (n.d.) also suggest that counties containing more diversified urban economic centers may be more likely and prepared to capture wildfire suppression contracting work than smaller, less diversified, and moderately isolated counties.

Research on the effects of large wildfires in the Western United States by Nielsen-Pincus et al. (2013) found that wildfires generally improved county-level employment and wage growth while suppression efforts were active. However, following a wildfire, counties experienced increased economic volatility, though these effects differed by the type of county in which the wildfire occurred. Employment growth associated with fire-suppression spending suggests that developing community capacity could change how local economies experience wildfire, potentially facilitating more local community capacity to participate directly (fire crews or equipment), or indirectly (e.g., support services) in fire suppression, keeping wildfire suppression funds in the community longer (Nielsen-Pincus et al. 2013). Although these studies provide evidence of links between a community being engaged in forest management and restoration and local participation in fire suppression efforts, the lack of historical analysis of restoration and fire suppression contracting markets means that little is known about how these relationships have changed over time. However, recent related research on the location and diversity of fire suppression contractors and their equipment suggests that the two markets have become more complex as private wildfire contracting has become more nationalized and mobile (Huber-Stearns et al., n.d).

Changes in federal wildfire contracting policy, such as creating more nationalized dispatch systems, or the contracting award system, may unintentionally limit local contractors' ability to participate in local fire suppression efforts (Davis et al. 2014). In a time of increased focus on collaborative fire management and local workforce capacity development (e.g., the National Cohesive Wildland Fire Management Strategy), the finding that participation in federal contracting prior to a fire shapes suppression capacity can help focus policy and practice on these linkages.

The Pacific Northwest still has one of the highest concentrations in the United States of both hand crew and equipment-based fire suppression contracting (Huber-Stearns et al., n.d). In the past decade, fire-suppression contracting in the region has been experiencing a transition, as contracting processes have become more standardized, and more businesses have joined the industry. All the 48 regional and national hand crew businesses, and more than 600 of the 2,016 total equipment contractors active in

2015, were located in Oregon, Washington, and northern California (Moseley et al., n.d.).

Although many restoration businesses are still engaged in fire suppression contracting, there has been a shift in the past decade toward contracting companies entering the market primarily for fire contracting purposes (e.g., businesses purchasing equipment specialized for fire suppression, and hiring crews for fire suppression). This shift is in contrast to 20 years ago, when restoration contractors took on fire suppression work as needed and with the forestry equipment they had on hand (Moseley et al., n.d.). Recent research has also found that in several cases, these contracting companies come from other sectors, such as construction, heavy equipment, and services (e.g., portable showers, food, and housing units), and have now expanded their work into fire contracting. In many instances, restoration contracting is not the primary source of income for these businesses. Rather, it is fire suppression work, or the other sectors in which they operate during the rest of the year (e.g., construction) (Moseley et al., n.d.). As fire suppression needs differ year to year, some of the businesses that hire fire hand crews have faced critical challenges with employee retention, and looked to find other sources of income to extend the employment period for their seasonal hand crew employees. One option has been to enter the forest restoration contracting realm, using their fire suppression equipment and resources to conduct forest restoration work outside of fire season (Huber-Stearns et al., n.d).

As both Forest Service and BLM budgets and workforces decline, and are constricted further by a larger proportion of the budget going to wildfire suppression, agencies are contracting out an increasing amount of their land management work, which includes forest restoration and wildfire suppression (Moseley 2005). This suggests a continued (yet unpredictable) demand for forest-based restoration and fire contracting activities across the NWFP area. Although in some places the type of forest-related contracting has changed, many nongovernmental organizations and private businesses still depend on these forest-based activities for economic and social benefits, and continue to build their business around meeting federal agency needs for forest management and restoration work.

Biomass use—

In addition to the "in-woods" work associated with removing trees and other forest fuels, fuel reduction and thinning projects result in the production of restoration byproducts with potential economic benefit to forest communities. These include biomass materials such as tops, branches, and small-diameter trees as well as larger materials suitable for traditional commercial processing. The development of biomass-use infrastructure capable of adding value to otherwise unmarketable byproducts has been specifically supported through grant programs, targeted policies, and research efforts (Becker et al. 2009, 2011b). In particular, biomass energy production has been identified as a potential means of integrating forest restoration and rural community development while producing energy from renewable sources (Becker and Viers 2007, Hjerpe et al. 2009) (fig. 8-18).

It is extremely difficult for forest biomass energy production to be profitable as a stand-alone activity, owing to issues such as the dispersed nature of the raw material, long haul distances, the low energy density of wood, and low prices of other energy sources (Aguilar and Garrett 2009, Sundstrom et al. 2012). Development of forest biomass energy in areas with a large federal forest presence has been challenged by additional factors such as a lack of predictability in access to raw materials (Becker et al. 2011a, Stidham and Simon-Brown 2011). The cost of forest biomass harvesting is often greater than the value of resources removed (Evans and Finkral 2009); biomass treatments therefore tend to rely upon supportive public policies (e.g., direct subsidies, renewable energy mandates) to remain feasible. Biomass energy installations themselves can generate controversy regarding issues such as the possible effects of raw material demand on nearby forests (Stidham and Simon-Brown 2011). However, given appropriate public consultation and collaboration, the use of biomass can also represent an approach to reconciling diverse social, economic, and environmental restoration interests (Hjerpe et al. 2009).

The collection, transportation, and processing of biomass materials represents a potential economic opportunity



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Figure 8-18—Forest restoration byproducts provide fuel for biomass energy production.

for forest communities. An analysis of 43 timber-producing counties in east Texas suggests that residue procurement and biomass energy production could collectively generate direct, indirect, and induced jobs equal to nearly one-third of current logging sector employment (Gan and Smith 2007). Using fiscal year 2005 data from five national forests in the Southwest, Hjerpe and Kim (2008) determined that fuel reduction expenditures (including prescribed fire) resulted in 337 direct full-time equivalent jobs and 151 indirect and induced jobs. Communities with installed biomass-use capacity may also benefit forests, as the presence of small-diameter processing facilities results in a greater ability to perform treatments on nearby forest land (Nielsen-Pincus et al. 2013). There is some evidence that development of local processing infrastructure can lower the per-acre cost of forest restoration activities, therefore allowing more area to be treated with a given level of funding (Becker et al. 2011a). Stakeholders in a number of communities have collaborated with one another and with Forest Service managers to design long-term, large-scale restoration projects capable of catalyzing this beneficial relationship between biomass-use capacity, forest restoration treatments, and associated economic benefits (Abrams 2011, Schultz et al. 2012). A key challenge in this context is aligning biomass-use infrastructure, state or federal policies regarding biomass utilization, and contracting mechanisms to stimulate investments that simultaneously support community economic development and forest restoration activities. An additional challenge is providing a long-term, reliable supply of biomass material from federal lands to incentivize infrastructure investments. Stewardship contracting is one mechanism the Forest Service and BLM can use to address this barrier (Nielsen-Pincus et al. 2013).

Nontimber forest products—

Nontimber forest products, or special forest products as they are known by the Forest Service and the BLM, include "bark, berries, boughs, bryophytes, bulbs, burls, Christmas trees, cones, epiphytes, fence material, ferns, firewood, forbs, fungi (including mushrooms), grasses, mine props,[15] mosses, nuts, pine straw, posts and poles, roots, sedge, seeds, shingles and shake bolts,[16] transplants, tree sap, rails, and wildflowers" (USDA FS 2001). These NTFPs are often grouped into broad functional categories, with common categories consisting of edibles, medicinals, arts and crafts, ornamental and decorative materials, fuel, transplants and other landscaping products, and construction materials (Alexander et al. 2011b). NTFP management and research are complicated by the extremely large number of species from which this broad array of products is derived. Vance et al.'s (2001) guide to commercial NTFPs in the Pacific Northwest describes products from 59 native species in detail, lists 60 additional native species that are commercially harvested, and emphasizes that many other species are bought and sold in markets. NTFP species harvested in the Pacific Northwest likely number in the hundreds (Jones and Lynch 2007). Table 8-1 lists some of the most common commercial NTFPs harvested in the Plan area. This chapter provides a broad overview of NTFP harvesting in the Plan area, whereas chapter 10 describes commercial NTFP harvesting by low-income and minority populations; and chapter 11 addresses the importance of specific NTFPs to American Indians.

It is difficult to characterize the contribution that NTFPs from federal forest lands in the Plan area make to community socioeconomic well-being because of the large number of products, variety of organism parts, and diversity of species that make up this category of forest products. No studies have systematically evaluated the relative importance of federal lands as a source of supply for NTFPs in the Plan area. Charnley (2006c) and Grinspoon et al. (2016) documented the quantities of special forest products sold from Plan-area Forest Service and BLM lands during the first two decades of the NWFP based on permits and contracts the agencies issue to members of the public. However, systems for tracking the quantities of NTFPs harvested on national forests and BLM lands are not structured in ways that would allow one to determine whether permittees have harvested more or less than the quantities indicated on their permits (Alexander et al. 2011b). And, no studies document the extent to which unauthorized NTFP harvesting takes place on federal lands in the NWFP region, although it is probable that a significant portion of NTFPs are harvested without authorization (Dobkins et al. 2016, McLain and Lynch 2010, Muir et al. 2006, NFWC 2015). Nevertheless, research suggests that federal forests are important sources of supply for a number of products, including wild mushrooms (McLain 2008, Pilz et al. 2007, Richards and Creasy 1996); beargrass (Charnley and Hummel 2011, Hummel et al. 2012); huckleberries (Kerns et al. 2004); firewood, Christmas trees, floral greens, limbs and boughs, moss, cones, and posts and poles (Charnley 2006c, Grinspoon et al. 2016) (fig. 8-19).

Table 8-1—Commonly harvested commercial nontimber forest product species in the Northwest Forest Plan area

Species	Scientific name
Floral greens:	
Salal	*Gaultheria shallon*
Evergreen huckleberry	*Vaccinium ovatum*
Beargrass	*Xerophyllum tenax*
Tall Oregon grape	*Berberis aquifolium*
Western redcedar	*Thuja plicata*
Noble fir boughs	*Abies procera*
Deer fern	*Blechnum spicant*
Western swordfern	*Polystichum munitum*
Mushrooms:	
Morel	*Morchella* spp.
Chanterelle	*Cantharellus cibarius*
Matsutake	*Tricholoma magnivelare*
Bolete	*Boletus* spp.

Sources: Blatner and Alexander 1998, Lynch and McLain 2003, Schlosser and Blatner 1995, Weigand 2002.

[15] Mine props are lengths of wood used to hold up a mine roof.
[16] Shake bolts are blocks of wood used for making shingles.



Rebecca McLain

Figure 8-19—Mushroom picking is an important commercial and recreational gathering activity on federal forest lands.

***Market context*—**Market demand for many NTFPs has increased over the past 20 years in response to growing consumer interest in wild-harvested and organically produced foods and medicines (Pilz et al. 2007, Smith et al. 2010) as well as shortages in supply in other parts of the world for products such as wild mushrooms that are traded primarily in international markets (McLain et al. 1998, Pilz et al. 2007). No reliable data exist for the amounts and values of NTFPs harvested in the United States or from the NWFP area. However, extrapolating from Forest Service and BLM permit and contract data, Alexander et al. (2011b) estimated that the retail value for NTFPs harvested from BLM and Forest Service lands in the United States in 2007 was at least $1.4 billion, with the majority attributable to NTFPs harvested in the Pacific Coast region. A similar analysis covering the years 2004 to 2013 found that the estimated retail value of NTFPs trended upward and was roughly $1.9 billion in 2013 (Chamberlain 2015). Nationwide, firewood, crafts and floral products, and Christmas trees—in that order—consistently had the highest total retail values (Alexander et al. 2011b, Chamberlain 2015). In both studies, the Pacific Coast region dominated in permitted harvest quantities (and therefore retail value) for arts, crafts, and floral products; edibles; grasses; nursery and landscape products; and regeneration and silviculture products. The region was second after the Rocky Mountain region in permitted harvest quantities of fuelwood and posts and poles. However, Alexander et al. (2011b) cautioned that it is unclear whether regional differences in permitted harvest quantities reflect differences in actual quantities harvested, or cross-regional differences

in agency permitting and enforcement capacity. A 2014 survey of Forest Service employees in the agency's Pacific Northwest Region (Oregon and Washington) found that respondents most commonly labeled the following products as being among the "five most important" products gathered on the national forest where they worked: firewood (53 percent of respondents); boughs (14 percent); mushrooms (10 percent); beargrass (10 percent); Christmas trees (10 percent); and floral greens (5 percent) (Crandall 2016).

The only NTFP industries in the Pacific Northwest for which annual wholesale values have been calculated are floral greens and wild mushrooms. Schlosser et al. (1991) estimated the wholesale value of floral greens and boughs harvested in western Washington, western Oregon, and southwestern British Columbia during 1989 at $128.5 million. The wholesale value of wild edible mushrooms harvested in Oregon, Washington, and Idaho during 1992 was estimated at $41.1 million. Unfortunately, more recent valuations of NTFP industries in the Pacific Northwest (or elsewhere in the United States) do not exist. Many NTFPs harvested in the Pacific Northwest are sold in global markets (Alexander et al. 2002, 2011b), making them susceptible to demand and price fluctuations linked to economic and environmental conditions elsewhere. Although floral greens (including holiday greens for wreaths and swags), wild mushrooms, and huckleberries are commonly identified as the most economically important NTFPs in the Plan area (Schlosser and Blatner 1997), the values extrapolated from NTFP permit and contract data suggest that firewood and posts and poles are equally important economically, if not more so. No studies of the socioeconomic dimensions of either firewood or post and poles harvesting for the region exist.

The number of persons who currently earn a full or partial livelihood from NTFPs is unknown. However, Schlosser et al. (1991) estimated that, in 1989, processors in western Washington, western Oregon, and southwestern British Columbia bought floral greens and boughs from roughly 10,000 harvesters. In a later study, Schlosser and Blatner (1995) estimated that the wild mushroom industry provided income-earning opportunities for roughly 10,400 harvesters in Oregon, Washington, and Idaho. Whether and how much overlap there is between the two industries is unknown. Most of the processing facilities for NTFPs harvested in the Pacific Northwest were located west of the Cascade Range (Schlosser and Blatner 1997), but the number employed in those facilities is unknown. The NTFP sector offers income-earning opportunities that are easily accessible with little capital investment, but as described in chapter 10, working conditions for harvesters are sometimes poor, and it is likely that the more lucrative opportunities are in processing and marketing (Schlosser and Blatner 1997). As currently structured, the NTFP sector is "one piece of a larger mosaic of rural development options" (Schlosser and Blatner 1997: 2) rather than an economic driver. The NTFP sector contributes to the well-being of individuals, households, and firms located in both rural and urban areas. More than half of the harvesters interviewed during a study of beargrass harvesting on the Gifford Pinchot National Forest lived in the cities of Tacoma and Aberdeen, Washington (NFWC 2015). Many wild mushroom harvesters on the Deschutes National Forest in central Oregon also live in cities located west of the Cascades or in northern California (McLain 2008, Tsing 2015). However, the extent to which urban residents rely on NTFP-related work and the impacts that the NWFP has had on urban residents have not been the subjects of scientific studies.

Nonmarket contributions of NTFPs to socioeconomic well-being—The NTFP sector differs from most other natural resource sectors (i.e., mining, wood products, livestock production), in that much economic activity linked to the harvesting, processing, and exchange of NTFPs remains strongly rooted in the informal sector. Informal economic activity is defined as "economic activity that takes place outside of governmental regulatory and reporting systems" (McLain et al. 2008: 1), and as numerous studies attest (Brown et al. 1998, Carroll et al. 2003, Emery 1998, Hinrichs 1998, Levitan and Feldman 1991, Love et al. 1998, Nelson 1999, Richards and Alexander 2006), such activities are both ubiquitous and important contributors to community and household well-being. Assessments of the contribution of NTFPs to community well-being must therefore account for contributions from activities taking place at the edges and outside of the formal sector, as well as those tracked within the formal sector. Practically, this means that one cannot rely solely on standard economic measures, such as number of jobs created or the value of products sold in formal markets, to assess the contribution that NTFPs make

to community well-being. In part this is because the number of jobs and market values associated with NTFPs are often not well captured in many of the standard economic activity accounting systems, such as the Harmonized Tariff Schedule that the U.S. government uses to track exports and imports (Alexander et al. 2011b), or the U.S. Census Bureau's County Business Patterns database, which tracks the number of businesses operating in each county, as well as how many people each business employs and the size of its payroll (Smith et al. 2010).

Ethnographic studies of NTFP harvesters and buyers indicate that NTFPs perform safety net, buffering, and provisioning functions for both rural and urban households (Emery 1998, Emery and Pierce 2005, Hinrichs 1998, Love et al. 1998, McLain et al. 2014, Poe et al. 2014). NTFP activities taking place outside of formal markets function as a type of "intergenerational and cultural glue," helping community members and families build and strengthen social ties and maintain cultural identities (Brown et al. 1998, Carroll et al. 2003, Love et al. 1998, McLain 2008, Richards and Alexander 2006, Poe et al. 2014). Unlike timber harvesting, which few people would categorize as a leisure activity, some commercial NTFP harvesting falls "somewhere in between" (Carroll et al. 2003, McLain 2008), with participants viewing harvesting as simultaneously work and leisure. A common theme among commercial and noncommercial harvesters alike is that NTFP harvesting is important to them in part because it provides an opportunity to strengthen their connections with the natural world and improve their physical and mental health (Emery and Ginger 2014, Love et al. 1998, McLain 2008, Poe et al. 2014, Tsing 2013).

Recent surveys of outdoor recreationists in Oregon and Washington show that "gathering/collecting things in a nature setting" is an activity practiced by a significant percentage of the population in the NWFP region. We are not aware of any comparable data for California. Washington state's Statewide Comprehensive Outdoor Recreation Plan (SCORP) survey results for 2012 analyzed the participation by residents from across Washington in four types of gathering/collecting activities (Responsive Management 2012). As indicated in table 8-2, slightly more than one-quarter of adult residents had participated in

Table 8-2—Percentage of Washington and Oregon SCORP survey respondents participating in specified outdoor activities during the 12 months preceding the survey

Outdoor activity	Washington respondents	Oregon respondents
	Percent	
Gathering/collecting things in nature setting:	27.2	21.9
Berries or mushrooms	14.9	—
Shells, rocks, vegetation	18.4	—
Firewood	6.7	—
Christmas trees	4.2	—
Selected outdoor activities:		
Bicycle riding (trails)	24.4	12.2
Camping (car/motorcyle with tent)	26.5	34.6[a]
Cross-country skiing	4.5	5
Downhill skiing	10.4	16.3
Hiking	53.9	48
Hunting (big game)	8.4	8.3
Off-roading (four-wheel drive)	9.5	9.8
Snowshoeing	6.7	8.5

SCORP = Statewide Comprehensive Outdoor Recreation Plan; — = No data.
[a] Car camping only.
Source: Responsive Management 2012 and Rosenberger and Lindberg 2012.

gathering or collecting in a nature setting in the previous 12 months, with participation rates in mushroom/berry picking and shell/rock/plant collecting being more than double the participation rates in harvesting firewood or Christmas trees. Table 8-2 shows that participation rates for gathering/collecting were greater than for many other outdoor activities, including downhill and cross-country skiing, hunting, off-road vehicle riding, and bicycling on forest or mountain trails. Residents of rural areas or small towns were somewhat more likely to participate in gathering or collecting than urban or suburban residents (29 percent and 24 percent of respondents, respectively). Table 8-3 shows that respondents gathered on diverse landownership types, with 18 percent gathering on national forests and only 1 percent on BLM lands. This difference is likely because very little BLM-managed land is located in Washington. Overall, the percentage of persons gathering or collecting on national forests or BLM-managed lands in Washington is relatively small compared with those who gather or collect on private or other types of public lands. However, these figures represent recreational gathering only; the bulk of commercial harvest likely takes place on federal and state forests and large private timber holdings.

Table 8-3—Percentage of Washington SCORP survey respondents who gather or collect things in nature settings on specified land ownerships

Land ownership category	Respondents
	Percent
National park or monument	8
State park	18
County/city/municipal park	8
National forest	18
State forest	8
National wildlife refuge	1
Bureau of Land Management land	1
Other public land	19
Own property	14
Someone else's private property	27

SCORP = Statewide Comprehensive Outdoor Recreation Plan.
Source: Responsive Management 2012.

The Oregon SCORP survey, which was also administered to residents statewide, collected data about gathering/collecting participation rates by Oregon residents during 2011, but did not break down the data by type of gathering activity (Rosenberger and Lindberg 2012). The percentage of Oregon residents who participated in gathering/collecting ranged from a low of 16.3 percent in the area around Portland to a high of 47 percent in northeastern Oregon, with an average of 22 percent for the entire state. Unfortunately, the authors lumped rock collecting in with plant, mushroom, and berry collecting, making it difficult to ascertain the percentage associated with NTFP gathering. The Oregon survey did not gather data about landownerships on which collecting took place. Table 8-2 shows how participation rates for gathering/collecting in Oregon compared with a selection of other activities.

A study by Starbuck et al. (2004) is the only example of research that has looked at the economic value of recreational NTFP harvesting in the Plan area. By using travel cost methods with 1996 permit data from the Gifford Pinchot National Forest, they estimated that one visitor day of berry and mushroom harvesting was worth $30.02 (in 1996 U.S. dollars). This compared with roughly $87/day for camping and $53/day for picnicking (Alexander et al. 2011a). More studies using the travel cost method or other forms of non-market valuation are needed to understand how much different types of recreational NTFP harvesting contribute to local economies.

***How the NWFP affects NTFP supplies from federal lands*—**Permitted harvest quantities are currently the best data available for analyzing trends in the demand for NTFPs on federal lands. However, two important caveats limit the utility of permit data as an indicator of NTFP demand. Both the Forest Service and BLM lack the capacity to track with any accuracy the quantities of NTFPs actually being harvested, and permit data merely reflect the maximum amount that the permit holder hopes to be able to harvest. Additionally, other factors, such as price shifts, weather conditions, and changes in consumer preferences can and do affect how many permits are issued in any given year (Charnley 2006c). The NWFP 10-year socioeconomic monitoring report described trends in permitted

quantities for BLM districts and national forests for the period 1994–2002 (Charnley 2006c); the NWFP 20-year socioeconomic monitoring report described these trends from 2004 through 2012 (Grinspoon et al. 2016). Table 8-4 shows the permit trends for NTFP products during these two periods. Unfortunately, the NTFP data in the 20-year report are presented in a format that does not permit a determination of the trends for a number of product categories. Nevertheless, the products for which a comparison across land ownerships and time is possible, some patterns do emerge. For both BLM lands and national forests, permitted harvest quantities of firewood initially declined and then increased, whereas greenery and foliage showed an upward trend for the entire period. Permitted harvest quantities for wild mushrooms increased on BLM lands through both periods, but on national forests they declined before trending upward between 2004 and 2012.

Based on interviews with specialists on three national forests and one BLM district, Charnley (2006c) identified several ways in which the Plan affected opportunities for the commercial harvest of NTFPs on national forests and BLM-managed lands between 1994 and 2006. Some provisions, such as road closures linked to the Plan's management guidelines, reduced the ability of harvesters to physically access resources. Other provisions, such as guidelines related to the management of late-successional reserves (LSRs) and riparian reserves, resulted in the closure of some areas to legally sanctioned commercial harvesting. Additionally, provisions prohibiting the harvest of special-status plants affected some commercially harvested species. The extent to which the standards and guidelines for LSRs and riparian reserves affected NTFP harvesting depended on how local Forest Service and BLM units interpreted them, and whether they were strictly applied. For example, some forests prohibited commercial harvesting of wild mushrooms in LSRs, while others did not (McLain 2000). Charnley (2006c) concluded that, during the first 10 years of implementation the Plan had the greatest negative impact on the harvesting of firewood and Christmas trees, both of which were previously closely linked to timber harvesting activities. Comparable interview data were not collected for the 20-year report, and consequently it is unclear what factors might account for the observed increases in permitted harvest quantities for firewood and stabilization in Christmas tree permits. Charnley (2006c) pointed out that, over the long term, the most important impact of the NWFP on NTFP resources is likely to be the landscape-scale

Table 8-4—Trends in permitted harvest quantities of nontimber forest products in the Northwest Forest Plan area (1994–2002 and 2004–2012)

	Bureau of Land Management districts		National forests	
Product	**1994–2002**	**2004–2012**	**1994–2002**	**2004–2012**
Fuelwood	-	+	-	+
Christmas trees	-	No data	-	Stable
Cones	-	No data	+	-
Moss	-	No data	Stable	-
Posts and poles	+	+	-	No data
Greenery and foliage	+	+	+	+
Boughs	+	-	Unclear	-
Mushrooms	+	+	-	+
Transplants	+	No data	-	No data

- = negative; + = positive.
Source: Charnley 2006c and Grinspoon et al. 2016.

changes it causes in forest structure and composition, changes that will affect the types, quantities, and qualities of NTFPs present in an area. Whether those impacts are negative or positive, however, depends on what changes in forest conditions have occurred in NTFP harvesting sites, as well as the types of products that are harvested there (Pilz and Molina 2002). The NWFP provisions and fire suppression are expected to encourage the development of older forest structure and processes, with a concomitant decrease in early-seral vegetation. Such conditions favor NTFPs such as matsutake mushrooms and moss, but will likely lead to reductions in the supply of products found in early-seral-stage forests, such as huckleberries, salal, and boughs (Charnley 2006c).

A promising avenue for enhancing the contribution of the NTFP sector to socioeconomic well-being is a forest management approach known as "compatible management" or "joint production." In this approach, forest stands are managed simultaneously for timber and one or more NTFPs (Alexander et al. 2002, 2011a). For example, in a study comparing three scenarios of timber management, one using a timber management strategy that increased matsutake production, another using a timber management approach with a neutral effect on matsutake productivity, and the third with no timber harvest, Pilz et al. (1999) found that the most lucrative approach was to manage the forest for both timber and matsutake. A joint production approach to federal forest management would have the additional advantage of supporting other goals of the NWFP, including enhancing structural and biological diversity.

Recreation—

The Forest Service and BLM provide opportunities for urban and rural residents to recreate in a wide variety of settings and to participate in a wide variety of recreation activities. Current annual estimates are that 20 million visits take place each year to federal forests in the NWFP area—with 5.3 million to BLM lands and 14.6 (± 5.3 percent) million to Forest Service lands (Grinspoon et al. 2016, USDA FS 2016). Other federal agencies, state and local governments, and private businesses and organizations also provide places to recreate for many of the same individuals. Relative to other providers, the recreation opportunities provided by the Forest Service and BLM are typically farther from population centers and less intensively developed. Chapter 9 includes a detailed description of the amount of recreation use on NWFP-area national forests and common activities of those recreating. This chapter focuses on the economic contributions of recreation activity on federal forests in the NWFP area to local communities.

Recreation on federal forests drives economic activity in local communities, states, and across the NWFP region when recreation visitors spend money on recreation trips, and the agencies and their partners spend money to manage recreation sites. Recreation visitors also support economic activity when they purchase equipment and other durable goods (e.g., boots, binoculars, off-highway vehicles, skis) that they need for particular recreation activities. This spending is not attributable solely to a single recreation opportunity provider (e.g., a single NWFP-area federal forest or all of them combined), and is not discussed here. This section focuses instead on the effects of visitor spending during recreation trips.

The amount of recreation use, the types of trips visitors take, their activities (to a lesser extent), and the size of the local economy all combine to influence how and to what degree recreation visitation leads to private sector employment and business activity (Stynes and White 2006, White and Stynes 2008). The amount of recreation use determines the potential number of visitors who can spend money in an area. All else being equal, a national forest with more recreation use supports more visitor spending in local communities. The type of recreation trip (day trip, overnight trip, near or far from the visitor's residence) is the key factor in determining recreation visitor spending (White and Stynes 2008). On average, spending by national forest recreation visitors nationwide ranges from $36 per party per trip for visitors on local day trips (trips within 50 miles of their residence), to $580 per party per trip for those on nonlocal (more than 50 miles between residence and destination) overnight trips where lodging is off the national forest (table 8-5). Average spending figures represent both those who spend money and those who do not spend money during the recreation trip. About 12 percent of visits to national forests involve no visitor spending; about 30 percent

Table 8-5—National forest visitor spending profiles for the United States by trip-type segment and spending category, dollars per party per trip[a]

Spending categories	Nonlocal			Local			Non primary	All visits[b]
	Day	OVN-NF	OVN	Day	OVN-NF	OVN		
	Dollars							
Motel	0	44.77	203.85	0	6.39	51.62	139.67	53.96
Camping	0	27.79	13.68	0	28.25	23.01	12.23	7.43
Restaurant	14.77	27.47	116.41	5.66	7.65	32.43	93.23	37.63
Groceries	10.67	55.09	72.52	6.62	71.54	59.62	49.85	29.68
Gas and oil	30.20	62.27	82.47	15.43	46.59	58.05	62.71	38.74
Other transportation	0.58	1.34	4.98	0.16	0.04	1.19	3.35	1.45
Entry fees	4.12	7.13	12.85	2.70	4.51	5.12	7.58	5.38
Recreation and entertainment	2.96	7.36	33.31	1.01	2.01	3.61	21.84	9.38
Sporting goods	3.15	10.77	13.75	3.83	11.78	9.48	7.91	6.62
Souvenirs and other expenses	1.93	7.73	25.87	0.60	1.10	11.48	23.74	8.62
Total	68.39	251.74	579.70	36.00	179.86	255.60	422.12	198.87
Sample size (unweighted)	2,112	3,600	2,289	9,225	1,388	295	3,955	22,864
Standard deviation of total	72	399	714	53	199	325	653	n/a

OVN = overnight, NF = national forest, n/a = not applicable.

[a] Outliers are excluded and exposure weights are applied in estimating spending averages. All figures are expressed in 2014 dollars. These averages exclude visitors who reported that their primary activity was downhill skiing/snowboarding. When completing analyses involving skiers/snowboarders, refer to subsequent tables. Local visitors are those who live within 50 miles of their recreation destination. Nonprimary visitors are those who were away from home to visit family, work, or recreate somewhere else. Their visit to the national forest was secondary to that other purpose.

[b] The all-visit averages are computed as a weighted average of the columns using the national trip segment shares for nondownhill skiing/nonsnowboarding as weights. Source: White 2017.

of visits involve spending of $20 or less. Because the spending averages include nonspenders and low spenders, some average values may appear low relative to typical costs.

Recreation activity has a secondary influence on visitor spending once trip type has been accounted for. For example, the spending of visitors who are downhill skiing or snowmobiling is systematically higher than average; and spending by visitors engaged in backcountry or primitive camping is lower than average (White and Stynes 2008). On average, spending by downhill skiers ranges from $60 per party per trip for local day trips (e.g., a couple who live in Bend, Oregon, and visit Mount Bachelor for morning skiing), to nearly $750 per party per trip for nonlocal overnight trips (table 8-6).

Following the processes outlined in White (2017), we calculate that, in total, recreation visitors to all the NWFP-area national forests combined spend roughly $612.6 million each year in the communities within about 50 miles of those national forests. About one quarter of that spending is generated by visitors engaged in downhill skiing and snowboarding ($156.8 million). Visitors who are hunting, fishing, or viewing wildlife on a national forest spend about $82.1 million in local communities; visitors engaged in other activities (excluding downhill skiing and snowboarding) spend about $374.8 million in local communities each year. Employees and proprietors of businesses that provide goods and services to recreationists receive direct benefits, in the form of income, from recreation visitor expenditures. The majority of expenditures by recreation visitors to NWFP-area forests are made for purchases of lodging and camping, food and beverages in grocery stores and restaurants, and fuel. The Mount Hood National Forest ($95 million), the Deschutes National Forest ($84 million), and the Siuslaw National Forest ($58 million) account for the greatest levels of spending at individual national forests. The presence of ski areas on the Mount Hood and

Table 8-6—Spending profiles of downhill skiers and snowboarders recreating on U.S. national forests, dollars per party per trip[a]

	Nonlocal segments		Local segments			
Spending category	Day	Overnight	Day	Overnight[b]	Nonprimary	All visits[c]
			Dollars			
Motel	0	193.53	0	88.83	146.10	95.76
Camping	0	0.43	0	0.20	4.23	0.37
Restaurant	20.53	158.80	9.83	72.89	129.36	85.48
Groceries	4.57	76.78	3.21	35.24	68.60	40.21
Gas and oil	24.43	64.96	13.44	29.82	55.28	40.73
Other transportation	0.28	1.89	0.24	0.87	9.78	1.39
Entry fees	37.68	90.73	17.93	41.65	107.20	58.39
Recreation and entertainment	18.62	107.74	11.13	49.45	52.21	58.79
Sporting goods	5.02	26.08	2.81	11.97	22.14	14.73
Souvenirs and other expenses	2.01	22.88	0.68	10.50	12.84	11.69
Total	113.15	743.81	59.26	341.41	607.74	407.54
Sample size (unweighted)	371	431	784	n/a	71	n/a
Standard deviation of total	96	825	81		772	n/a

n/a = not applicable.

[a] Outliers are excluded and exposure weights are applied in estimating spending averages. All figures are expressed in 2014 dollars. These averages are based on visitors who reported that their primary activity was downhill skiing or snowboarding. Analyses involving nonskier/nonsnowboarder visits should refer to previous tables on national forest visitor average spending. For downhill skiers and snowboarders, we have combined the overnight (OVN) national forest and OVN segments into a single OVN segment. Local visitors are those who live within 50 miles of their recreation destination. Nonprimary visitors were away from home to visit family, work, or recreate somewhere else. Their visit to the national forest was secondary to that other purpose.

[b] The sample size for local overnight visitors sampled at ski areas was insufficient, and here we calculate average spending as 46 percent of the nonlocal overnight average.

[c] The all-visit averages are computed as a weighted average of the columns using the national skier/snowboarder segment shares as weights.

Source: White 2017.

Deschutes National Forests helps explain the high levels of recreation expenditures there.

When a recreation visitor buys a good or service, economic activity that starts with the initial purchase spreads out to the broader economy in what is commonly referred to as the "multiplier effect" (e.g., Hjerpe et al. 2017). The size and diversity of other area businesses influence how that additional economic activity spreads within the local region, or leaves the area. Those areas with larger economies, such as Multnomah County near the Mount Hood National Forest or King County near the Mount Baker–Snoqualmie National Forest, will have greater multiplier effects from purchases by recreationists than places with smaller economies, such as Douglas County near the Umpqua National Forest or Skamania County near the Gifford Pinchot National Forest.

Recreation-related economic activity may be affected by climate change as wildfire and forest insect (e.g., bark beetle) activity are expected to increase with a warming climate, potentially leading to impacts on popular hiking and mountain biking areas (Hesseln et al. 2003, 2004; Loomis et al. 2001). Economic activity associated with forest recreation can be expected to decline when forests are closed because of high fire danger or active fire events (Starbuck et al. 2006), or trails or recreation sites are closed following fire events (Sánchez et al. 2016). Negative impacts on recreational quality can last for many years after a wildfire (Englin et al. 2001). However, research from southern California suggests that there can be positive economic effects when a fire creates opportunities for viewing postfire landscape processes (e.g., viewing flowers or new growth) (Sánchez et al. 2016).

Across mountainous regions of the world, alarm has also been expressed regarding possible climate change impacts on the ski industry and associated economic activity (Scott and McBoyle 2007). Potential concerns include a shortened ski season (Lal et al. 2011) as well as changes to avalanche conditions (Lazar and Williams 2008). Other recreational impacts may stem from heavy rainfall events that wash out access roads or otherwise result in flood-related damage (Sample et al. 2014). Climate change will affect multiple recreation-related variables, creating differential impacts depending on region, elevation, and other factors, with some areas potentially benefiting, for example, from longer snow-free seasons or fewer days of extreme cold (Irland et al. 2001, Richardson and Loomis 2004).

Ecosystem services—

In addition to providing the socioeconomic benefits previously discussed, federal forests also provide important ecosystem services both to local communities and more distant urban populations. These include contributions like fresh water, food and fiber, wildlife habitat, and outdoor recreation opportunities, to name a few (fig. 8-20). Della-Sala et al. (2011), for example, noted substantial economic and ecological benefits associated with clean water that originates from national forests of the Western United States, and in particular from roadless areas, where timber harvest is prohibited. The importance of national forests for supplying surface drinking water in the NWFP area has been mapped,[17] but the economic value of this contribution

[17] https://www.fs.fed.us/ecosystemservices/FS_Efforts/forests-2faucets.shtml.



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Figure 8-20—Federal forests provide many ecosystem services, including clean water and fish and wildlife habitat.

has not been calculated. Brandt et al. (2014) identified several ecosystem services associated with Pacific Northwest forests, including timber harvesting, salmon populations, carbon storage in vegetation, soil organic matter, and landscape aesthetics. Many ecosystem services considered to be amenities (e.g., scenic views, recreation opportunities) contribute to rural residents' quality of life (e.g., Deller et al. 2001, Rudzitis and Johnson 2000), as well as attract inmigration of new residents (e.g., Gosnell and Abrams 2011, McGranahan 1999).

The past decade has seen significant and increasing effort among state and federal agencies, nongovernmental organizations, and others to identify and evaluate ecosystem services associated with various landscapes, including forests (e.g., Kline and Mazzotta 2012, Kline et al. 2013, Smith et al. 2011). There also has been increasing interest in developing and implementing policy instruments that provide monetary compensation to private forest landowners who produce particular ecosystem services, including direct payment programs, tax incentives, and ecosystem services markets, among others (e.g., Kline et al. 2000a, 2000b, 2009).

Within the Forest Service, the 2012 planning rule formally incorporated the concept of ecosystem services into national forest management and requires forest personnel to address ecosystem services as they prepare national forest plan revisions (USDA FS 2012). More recently, the Obama administration directed all federal agencies to consider ecosystem services values in federal planning and decisionmaking (Donovan et al. 2015), inducing agencies to develop methods and protocols for evaluating ecosystem services as outcomes of federal policies, programs, and agency performance. There also have been efforts to examine the potential for developing partnerships with nonfederal entities that may be willing to provide funding to assist in federal land management when it produces mutual benefits, such as restoration on federal lands that improve municipal watersheds (e.g., McCarthy 2014).

Within the NWFP area, federal efforts largely have focused on identifying and quantifying key ecosystem services produced from the region's national forests (e.g., Smith et al. 2011). In addition to characterizing biophysical ecosystem services such as water, habitat, food, and fiber, efforts also have included improving understanding of cultural ecosystem services associated with national forests and their importance to Pacific Northwest residents (e.g., Asah et al. 2012). Landscape modeling efforts have attempted to characterize tradeoffs among ecosystem services associated with alternative forest management regimes. For example, Kline et al. (2016) examined the potential for Pacific Northwest forests to store and sequester additional carbon, harvest timber, and retain/enhance habitat for seven focal wildlife species across an exhaustive array of management regimes for western Cascade Range forest landscapes. Results showed the levels of each ecosystem service produced under each management regime, as well as the tradeoffs among them from choosing one management regime over another. Northern spotted owl habitat was found to be complementary with stored carbon, with both generally increasing in older forests. Northern spotted owl habitat and timber harvest were found to range from largely competitive to neutral depending on the characteristics of the management regime examined. Joint production relationships involving northern spotted owl habitat and other wildlife species ranged from competitive for western bluebird to mostly neutral for Pacific marten, and complementary for the olive-sided flycatcher and red tree vole, depending on the differences or similarities in the forest conditions preferred by individual species (Kline et al. 2016).

Last, within the NWFP area there has been analysis of the willingness of nonindustrial private forest landowners to accept direct payments in return for agreeing to lengthen timber rotations to improve habitat for spotted owls (Kline et al. 2000b) and coho salmon (Kline et al. 2000a). Kline et al. (2000b), for example, suggested that many forest land owners would require little or no payment to forego harvest to improve habitat, while others would require a significant incentive.

Increasing recognition of ecosystem services by federal land management agencies can be viewed as an extension of the multiple-use approach toward more earnest

consideration of the diversity of uses and values derived from national forests, and to a broader coalition of public parties interested in federal land management (Kline et al. 2013). Although efforts to identify and quantify key ecosystem services have made significant progress in raising awareness and concern for these important forest benefits, formal methods for routinely including ecosystem services values into federal forest management are being developed by the Forest Service and BLM. Formally incorporating ecosystem services concepts into federal land management processes generally requires information about: (1) current landscape conditions and how they are changing; (2) how management activities likely will affect ecosystem services; and (3) what people value about the landscape, how much they value those things, and how their values might be changing (Kline and Mazzotta 2012). Meeting these informational requirements depends on addressing various methodological challenges involving the availability of ecological data and analytical models for describing the responses of ecosystem services to management, as well as adequate staffing for conducting such analysis (Kline et al. 2013). Federal directives (e.g., Donovan et al. 2015, USDA FS 2012) suggest that efforts to develop and improve methods for evaluating ecosystem services and including them in federal land management will continue as policymakers and the public increasingly recognize the importance of addressing these benefits in federal decisionmaking.

Summary—
Just as forest management can contribute to socioeconomic well-being in rural communities, so can rural communities contribute to federal forest management. Agency budgets have been reduced substantially since the NWFP was implemented, reducing agency capacity to accomplish forest management goals. In response, community-based groups and partner organizations have raised money and provided labor to help undertake forest work on federal lands. Wood processing infrastructure in communities has also declined throughout the Plan area since the 1980s, making timber sales less economical and creating a financial barrier to restoration. By working together, communities and federal land management agencies in the Plan area can develop strategies to support and maintain the business infrastructure needed for forest restoration while creating more local economic opportunities.

How Rural Communities Contribute to Federal Forest Management

The community forestry literature from the United States emphasizes the reciprocal relationship between healthy forests and healthy communities (Baker and Kusel 2003, Kelly and Bliss 2009, Kusel and Adler 2003). Just as federal forest management can contribute to community well-being, so can communities contribute to federal forest management. For example, many communities and national forest units have begun to plan over large spatial scales and long time frames to create the consistency of work needed to attract investments in processing and contracting capacity (Schultz et al. 2012). Doing so provides both a more predictable employment base in local communities and the business capacity required to accomplish forest restoration.

Agency budgets, and the number of agency employees and field offices, have dropped substantially since the NWFP was implemented, particularly for the Forest Service and especially in its Pacific Northwest Region (Grinspoon et al. 2016, Stuart 2006). These declines have reduced agency capacity to undertake forest restoration and other forest management work. One way in which the Forest Service has dealt with declines in budget and personnel is through outsourcing work to contractors, partners, or volunteers. For example, Seekamp et al. (2011) identified 35 different types of recreation partnerships that the Forest Service engages in to help accomplish recreation-related work on national forests nationwide. Partners range from individual volunteers to service organizations, commercial outfitters, and other government agencies (fig. 8-21). Community-based organizations, local business partners, environmental and recreation organizations, and other groups have helped raise money and provide labor to accomplish forest management goals

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Figure 8-21—A partnership between the Six Rivers National Forest and the California Conservation Corps makes it possible to accomplish trail work on the national forest.

on federal lands in the face of declining agency capacity to do so, filling critical gaps. But communities must have an interest in and capacity to provide support, which is linked to their assets and overall community health and well-being.

There are several such examples from the NWFP area. On the Siuslaw National Forest in Oregon, local partner organizations formed the Siuslaw Stewardship Group in the early 2000s (Sundstrom and Sundstrum 2014). The group has worked with the Forest Service to facilitate forest restoration on private and public lands in the Siuslaw watershed by pooling resources, assisting with monitoring activities, and cooperating in work activities by using stewardship contracts and the Wyden Amendment Authority (which allows federal dollars to pay for work on private lands in shared watersheds to protect and restore resources or reduce natural disaster risk), while contributing to community economic health and avoiding legal conflict over treatments (Sundstrom and Sundstrom 2014). In California, the Trinity County Resource Conservation District has been managing a stewardship agreement on the "Weaverville Community Forest," comprised of 12,000 ac (4856.2 ha) of the Shasta-Trinity National Forest and 1,000 ac (404.7 ha) of the BLM's Redding Field Office lands (Frost 2014). Their objective is to develop and implement forest management activities that meet local objectives while addressing forest health concerns. The community plays a central management role, recruits skilled local workers to accomplish restoration activities, and contributes financial support by leveraging money from other federal and state partners to help fund new projects in the community forest (Frost 2014).

In another example on the Shasta-Trinity National Forest, the Watershed Resource and Training Center has filled a number of institutional voids to help accomplish

forest management activities while creating local jobs (Abrams et al. 2015). These include job training to create a skilled local workforce to engage in ecosystem management and forest restoration activities, running a work crew to accomplish fuels reduction on federal and private lands, monitoring of projects, developing new local wood processing infrastructure, helping the Shasta-Trinity to develop stewardship projects, developing a community wildfire protection plan, and leading interdisciplinary project planning teams. Despite the fact that some community-based organizations such as these have innovated to fill in the gaps left by declining federal agency capacity, there are legal and economic limits to what these organizations can accomplish, and they may also be limited by their own internal organizational capacity (Abrams et al. 2015). In all these examples, external organizations help provide funding and labor to accomplish work on federal forests that the agencies do not have sufficient budgets or staffing to undertake.

An important way in which economically healthy communities contribute to ecologically healthy forests is by having a skilled workforce and the business infrastructure needed to help federal agencies accomplish their management goals. As noted previously, declines in local wood processing infrastructure accompanied declines in timber production from federal lands in the NWFP area. Not only did this decline adversely affect some Plan-area communities, lack of local infrastructure for processing timber and small-diameter wood make timber sales and removal of small-diameter material that constitutes hazardous fuels less economical, creating a financial barrier to forest restoration. For example, Nielsen-Pincus et al. (2013) found that national forest ranger districts in Oregon and Washington that were within a 40-minute drive to a sawmill or biomass facility treated more overall hectares, and more hectares in the WUI, for hazardous fuels reduction than did ranger districts that were farther away. Ranger districts that were close to these facilities also incorporated more biomass into their treatments. These findings underscore some of the interdependencies between healthy forests and healthy communities in the NWFP area.

The Implications of Land Use and Ownership Changes for Forest Management

Summary—
Changes in land use and ownership, particularly those that involve conversions of forest land to low-density and urban development, are likely to remain a significant factor affecting the NWFP area owing to population growth in the region. Loss of forest land to development, associated fragmentation of the remaining forest land base, and accompanying changes in how remaining private forest lands are managed suggest that policymakers and managers cannot assume that the forest land surrounding federal lands will be the same in coming decades and available to contribute to NWFP objectives.

In addition to its significant area of federal and other public lands, the NWFP area includes a notable private land base. Nonfederal lands totaled more than 11 million ac (4.45 million ha) in 2009 in western Oregon, or about 57 percent of all land in the region (Lettman 2011). Sixty-five percent of nonfederal land in western Oregon was forest, with the remainder divided between mixed forest and agriculture, agriculture, and low-density and urban development (fig. 8-22). In western Washington, nonfederal lands totaled more than 10 million ac (4.05 million ha) in 2006, or about 65 percent of all land (Gray et al. 2013). Seventy percent was forest, with the remainder in mixed forest and agriculture, agriculture, and low-density and urban development (fig. 8-23). Significant private forest lands also exist in northern California (Waddell and Bassett 1996, 1997), with nonfederal lands comprising 48 percent of all forest land in NWFP-area counties in California (Christensen et al. 2015). Private forest lands, including both industry- and nonindustry-owned, often augment federal and other public lands in providing ecosystem services (Kline et al. 2004a), including habitat for at-risk wildlife species (Stein et al. 2010; see also chapters 5 and 7). However, private lands also often differ from federal and other public lands in their forest structural

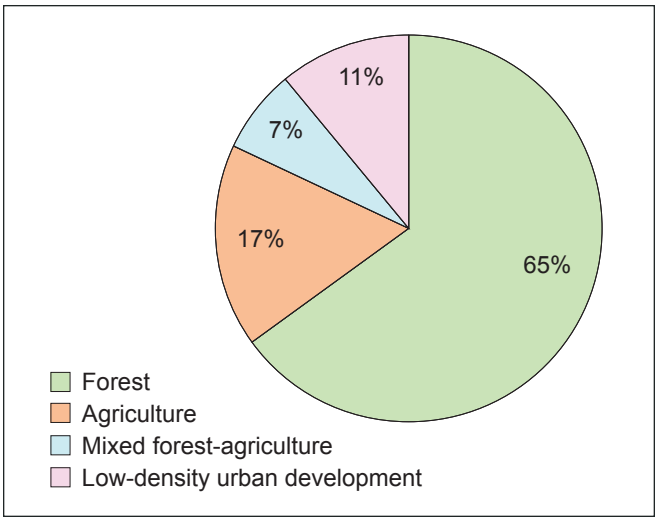


Figure 8-22—Land use of nonfederal lands in western Oregon (11 million ac [4.45 million ha]). Source: Lettman 2011.

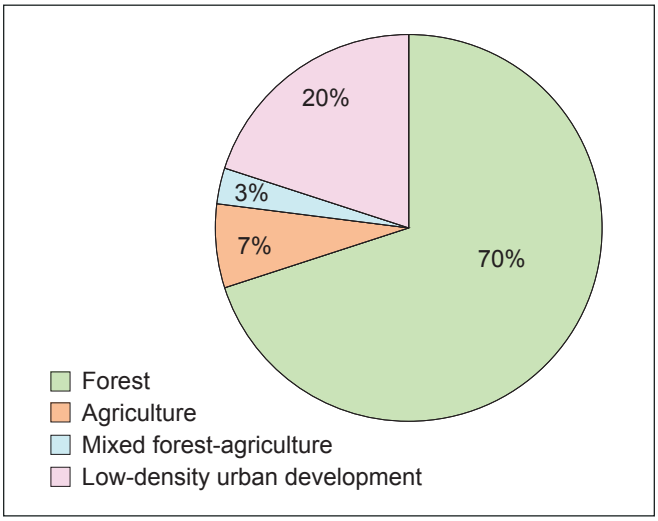


Figure 8-23—Land use of nonfederal lands in western Washington (more than 10 million ac [4.05 million ha]). Source: Gray et al. 2013.

attributes, with potential implications for habitat and other resource issues (Azuma et al. 2014). Although the public land area generally will remain constant for the foreseeable future, private forest lands are subject to possible conversions to other nonforest land uses, including agricultural, residential, commercial, and industrial development associated with population growth in the region. Federal and other public lands also can attract development on adjacent private lands, potentially leading to increased road densities, more human-caused wildfire ignitions, and greater demands for recreation, among other changes affecting federal lands (e.g., Azuma et al. 2013). The uneven distributions of ecosystems, ownerships and management activities across the NWFP area is one reason why it may be difficult to meet diverse biodiversity objectives on federal lands alone (Spies et al. 2007)

Forest land/agriculture conversions— Within the NWFP area, actual conversions of private forest land to agriculture (and vice versa) are limited. Forest land conversions to agriculture totaled 9,000 ac (3642 ha) from 1974 to 2009 in the entire state of Oregon, relative to a nonfederal land base of nearly 29 million ac (11.74 million ha), while conversions from agriculture to forest land totaled 3,000 ac (1214 ha) (Lettman 2011). Similarly, net conversions from forest land to agriculture totaled just 1,761 ac (713 ha) in western Washington between 1976 and 2006, out of a nonfederal land base of more than 10 million ac (4.05 million ha) (Gray et al. 2013). This stability between forest and agricultural land uses stems largely from the unsuitability of existing forest land for agriculture because of soils and topography, and the high income-earning capacity of lands currently in agricultural uses relative to forestry.

Conversion of private forest land to more developed uses— More prevalent are conversions of private forest land to residential, commercial, industrial, and other developed uses (fig. 8-24). Private forest land conversions to development in Oregon totaled 172,000 ac (69 606 ha) from 1974 to 2009, or about 2 percent of the nonfederal forest land statewide during this period, with 163,000 ac (65 964 ha) (95 percent of this total) involving conversions to low-density residential development, and the remaining 5 percent (9,000 ac) (3642 ha) involving urban development (Lettman 2011). These changes have been most prevalent in urbanizing regions along Oregon's Interstate 5 corridor (Lettman 2011).

Similarly, forest land development totaled 479,324 ac (193 976 ha) in western Washington between 1976 and 2006, or about 6 percent of the nonfederal forest land in western Washington. Of this total, 419,678 ac (169 838 ha) (88 percent) were converted to low-density residential development, and 59,646 ac (24 137 ha) (12 percent) to urban development (Gray et al. 2013). Population densities



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Figure 8-24—Conversion of private forest land to residential development, Oregon.

have more than doubled in the Puget Sound region in recent decades, contributing to significant urban expansion onto forest land (Alig and White 2007). In some northwestern Washington counties, population increase owing to net domestic migration was more than double the natural increase in population during the 1990s, with associated increases in forest land development (White and Mazza 2008). Land use data suggest that development has been increasing on private lands adjacent to federal and other public lands, particularly in selected counties of western Washington and on the eastern slope of the Cascade Range in Deschutes County, Oregon (Azuma et al. 2013).

National-level projections based on expected population growth suggest continued loss of forest land to development through 2030 in northern California and the Pacific Northwest, largely following national patterns of development near existing urban areas (Stein et al. 2005, 2009). Regional projections of future low-density residential and urban development on forest land in western Oregon through 2024 are fairly modest largely owing to Oregon's land use planning program, with most conversions involving the transition of low-density developed forest land to urban uses (Kline 2005b). In eastern Oregon, forest land development also is projected to be fairly modest through 2025, with most conversions involving low-density to largely urban transitions (Kline et al. 2007). In western Washington, forest land was projected to decline by 8 percent from 1997 to 2027, with most converting to urban development (Alig and White 2007). However, projections in western Washington do not consider the potential conservation influence of Washington's land use planning program (implemented in 1990), which early analysis is suggesting may be beginning to have some effect on slowing development on both forest and agricultural lands (Kline et al. 2014). Development is expected to be most prevalent in valleys near urban areas, based on analyses conducted for western Oregon (Kline at al. 2003) and western Washington (Kline et al. 2009). Similar patterns also are reflected in analysis of western Oregon and western Washington combined, with greater loss of forest land expected through 2040 in the Puget lowlands and

Willamette Valley relative to the Coast Range and Cascades regions (Lewis and Alig 2014). We are unaware of regional-level land use projections for northern California.

Forest land development largely results from market forces. Population growth and inmigration, rising incomes, and economic growth over time combine to increase demands for land in developed uses (Kline et al. 2004a). Demands also increase with people's lifestyle choices when, for example, people relocate to rural areas or desire second homes in scenic forest settings. When demands for developed land uses increase, forest landowners may be able to earn more by selling their land than they can by maintaining it as forest (Kline et al. 2004a). When these market forces are at play, some loss of forest land to development is inevitable. Research also suggests that these trends can influence the degree to which forest landowners continue to perceive forestry and forest ownership as a worthwhile endeavor (Creighton et al. 2016). The combined influence of various socioeconomic factors on land use change largely has been confirmed in the Pacific Northwest from econometric land use modeling and analysis conducted at the county level (e.g., Parks and Murray 1994) and at finer spatial scales (Kline 2003; Kline and Alig 2001; Kline et al. 2001, 2003, 2007, 2009). Additionally, fine-scaled models, based on geocoded point data (e.g., Gray et al. 2013, Lettman 2011), suggest that location and natural amenity factors also play a role. Land use modeling for western Oregon, for example, found a positive correlation between development and the proximity of land to the Interstate 5 corridor and the Pacific Coast (Kline and Alig 2001, Kline et al. 2001). Analysis for the eastern slope of the Oregon Cascades found a positive correlation between development and the presence of scenic mountain views (Kline et al. 2007).

In general, conversions of forest land to development in both Oregon and Washington have been more common on private nonindustrial lands than on industry-owned lands (Lettman 2013). The area of timber industry-owned forest land has remained fairly constant in both Oregon and Washington since the mid-1970s, while the area of forest land in each state owned by nonindustrial owners has declined by 6 percent and 10 percent, respectively (Lettman 2013). We are unaware of studies addressing forest land development in northern California. Analysis and projection of future changes in forest land ownership has been hampered by a lack of data describing land ownership over time that spatially and temporally aligns with land use data sets developed for the region (e.g., Gray et al. 2013). Thus, knowledge of anticipated changes in land ownership tends to derive from predictions about which land ownerships are most likely to be involved in projected future land use changes (e.g., development), rather than predictions about potential future changes in ownership. For example, landscape-level modeling and projections for the Coast Range physiographic province of Oregon has suggested that forest land development could reduce industry-owned forest land by 6 percent, and nonindustry-owned forest land by 35 percent by 2096, with the greatest reductions near urbanizing Portland, Oregon (Johnson et al. 2007). Such reductions generally are not as likely to involve the most commercially productive industry-owned timber lands in the region, largely because of their relative geographic isolation from urbanizing locations where development will be prevalent owing to greater proximity to urban areas and transportation corridors (Kline and Alig 2005).

In addition to concern about the loss of forest land to development and its potential ecological impact, are concerns about how development often brings greater numbers of homes into dry, fire-prone forest types, expanding the WUI. In addition to the various land-use projection efforts previously mentioned (e.g., Kline et al. 2003, 2007, 2009), which can be used to anticipate future expansion of the WUI within the Plan area, are other regional and national efforts to define the current WUI and anticipate its future growth (e.g., Hammer et al. 2007). Such expansion likely will present future challenges to public land managers who will need to consider how to expend limited wildfire management funds to meet potentially competing objectives, including managing for ecological integrity and resilience to climate change, and habitat for species such as the northern spotted owl versus mitigating wildfire risk to homes.

Timber investment management organizations and real estate investment management trusts—
A growing interest nationally in recent years involves the seeming rise in forest land ownership of timber investment management organizations (TIMOs) and real estate

investment trusts (REITs), as they purchase forest parcels previously held by more traditional timber industry owners. Forest policymakers, for example, question whether TIMOs will continue to manage their holdings for long-term timber production versus eventual development (Lettman 2013). Whereas timber industry owners are perceived by policymakers as focused solely on securing an expected flow of timber revenue over the long term via active forest management, TIMOs and REITs are perceived as less committed to solely managing forests over the long term, and more amenable to other ways of generating income, including development (Lettman 2013). The NWFP area, however, has seen little research regarding how prevalent these forest land owners have become in recent years, their potential future trends, and whether and how their management of forest land holdings might change. Although TIMOs and REITs have been involved in several large acquisitions of previous industrial forest land in both Oregon and Washington (Lettman 2013), what this means for future management of such holdings as well as longer-term forest land ownership trends within the Plan area remains uncertain. Additionally, given that TIMOs and REITs typically do not own and operate wood processing facilities, it is conceivable that their increased forest land ownership in the Pacific Northwest could be accompanied by increases in log exports. Such changes potentially could increase the importance of federal timber harvests in supporting timber-related economic activity within the region.

Land use planning—
An additional and potentially significant influencing factor in both the pace and pattern of forest land development within the Plan area is land use planning, which restricts developed uses on private lands to promote efficient land use and secure various conservation benefits. Oregon's land use planning program—often cited as a national model for statewide planning (Kline and Alig 1999)—has provided a measurable degree of protection of forest and agricultural lands since its inception in 1973 (Gosnell et al. 2011), with an estimated 1.4 percent of the private forest land base saved from development by 1994 that otherwise would have been developed without land use planning in effect (Cathcart et al. 2007, Kline 2005a). Land use projections suggest that the Oregon land use planning program will continue to conserve forest land in the future, totaling 315,000 ac (127 476 ha) (4.4 percent) between 2004 and 2024 (Kline 2005b). Although less studied than Oregon's land use planning law, research suggests that Washington's land use planning program also has had some effect at reducing development of private forest land since its implementation in 1990 (Kline et al. 2014). To our knowledge, land-use planning effects on conserving forest land in California have not been examined. Additional public land use policies, including most notably preferential property tax assessment, also likely influence land use changes within the Plan area, but we are unaware of any studies addressing these.

Land use change and fragmented forests—
Secondary to the direct impact that development can have on reducing the total area of forest land is the role it plays in fragmenting remaining forest land. For example, as the area of forest land in western Washington has declined, it has become more fragmented, with greater edge to interior portions and smaller patch sizes (Gray 2013). Forest fragmentation can have implications for wildlife habitat and other ecosystem services, as well as influence how remaining forest lands are managed. For example, forest land development has been linked to loss of forest cover and associated declines in coho salmon populations in rivers feeding the northern Puget Sound (Bilby and Mollot 2008), as well as degradation of stream conditions and fisheries generally owing to declines in vegetation and increased area of impervious surfaces (Morley and Karr 2002). Azuma et al. (2014) suggested that even small amounts of development can lead to meaningful changes in forest conditions on both private lands and lands adjacent to federal and other public lands, including increases in invasive species.

Increased use of fine-scale spatial land use modeling (e.g., Kline et al. 2003) versus county-level models (e.g., Parks and Murray 1994) in recent years has enabled greater consideration of how future development is likely to affect specific ecosystems and habitats. For example, development in western Washington is expected to be more prevalent on level or moderately sloped lands and nearer to existing urban areas (Kline et al. 2009). Similar patterns are projected in western Oregon, with development expected

to have a greater impact on oak woodland habitat along the Willamette Valley perimeter than on the coniferous forests of the western Cascades and Coast Ranges (Kline and Alig 2005). In the Coast Range physiographic province of Oregon, development is expected to occur more frequently on gently sloping valley bottoms (Spies et al. 2007), including high intrinsic-potential coho salmon streams (Burnett et al. 2007). On the eastern slope of the Oregon Cascades, projected development is expected to adversely affect habitat connectivity for mule deer, potentially impeding animal movement for winter foraging (Kline et al. 2010). National-level analysis has identified significant numbers of at-risk species on corporate-owned lands in select watersheds in coastal areas of northern California, southern Oregon, and Washington (Stein et al. 2010).

Forest fragmentation resulting from development also has been found to be accompanied by changes in how remaining private forest lands are managed. Research from western Oregon found that increasing building densities on private forest land were associated with lower forest stocking rates as well as reduced precommercial thinning and tree planting following harvest (Kline et al. 2004b). This contrasts with similar research conducted for eastern Oregon, which suggested that development had not significantly influenced private forest management owing largely to the relatively lower rates of development, among other factors (Kline and Azuma 2007). Modest rates of forest land development throughout western Oregon are projected to lead to additional reductions in active forest management for commercial purposes at least through 2054 (Kline and Alig 2005). Such changes are thought to arise, in part, from forest fragmentation (or parcelization), which breaks up large forest parcels into smaller parcels for development, thereby increasing the cost of active forest management. Additional research suggests that private landowners of smaller forest land parcels tend to manage less for commercial timber production and more for recreation, aesthetics, and other passive-use values (Kline et al. 2000a, 2000b). There also is emerging evidence suggesting that private forest landowners may have different perspectives and approaches to managing wildfire risk than do federal land managers (e.g., Charnley et al. 2017). Such changes in private landowner objectives and perspectives potentially offer opportunities for enlisting private landowners in landscape-level conservation and wildfire management efforts, possibly through financial incentives, education, and technical assistance (Fischer et al. 2014; Kline et al. 2000a, 2000b).

Research Needs, Uncertainties, Information Gaps, and Limitations

The science synthesis presented in this chapter is necessarily limited by information gaps stemming from lack of available science to adequately answer the guiding questions. Here we identify research needs that could help fill some of these gaps.

The Wood Products Industry

There is increasing recognition that federal forest management, especially forest and watershed restoration, should be done at the landscape scale and across land ownerships to ensure better outcomes. Concurrently, there is recognition that forest management and the production of ecosystem services take place within complex social-ecological systems (chapter 12) in which management outcomes are influenced by both social and ecological conditions, which are linked and which interact to influence one another. Further, these social-ecological systems are characterized by complexities such as time-lagged effects, tipping points that yield dramatic changes over short periods of time, and spatial connectivity. Much of the landscape-level modeling conducted within the Plan area is now decades old or has not fully accounted for the linked social-ecological system dynamics that influence forest management. New research that recognizes and quantifies these dynamics, and that simulates landscape-level management over long time frames, is needed to better understand potential futures and tradeoffs in the production of ecosystem services under alternative management regimes within the Plan area. Such research could provide insight into whether the availability of federal timber for harvest will continue to change in coming decades, and how federal timber production might affect other values associated with federal forests.

Global competition, technological change, consumer demand, and other factors unrelated to federal timber supply all influence wood products manufacturers in the Plan area. In Oregon, there has been recent interest among policymakers and the business community in mass-timber buildings as a potential new market for wood products manufacturers. Mass-timber buildings (which are often multistory and use large panels and columns constructed from wood rather than concrete or steel) are proposed, or under construction, in Portland, Oregon, and an Oregon manufacturer has begun producing mass-timber panels. Additional research is needed to identify products for which wood products manufacturers in the Plan area may have a competitive advantage, given the realities of global markets for commodity wood products such as dimension lumber and structural panels.

Community Socioeconomic Well-Being

Land managers have expressed interest in how socioeconomic well-being in the Plan area has changed since the NWFP was implemented. In this chapter, we have described general trajectories of change in forest communities, characterizing these trajectories according to certain archetypes. We do not know how many communities in the Plan area fall into each type, the geographical distribution of different community types, or the extent and nature of hybrid types ("multifunctional") communities, although typologies have been developed and mapped at the county scale. Existing studies that rely on a small handful of indicators from secondary data sources, such as the U.S. Census, are insufficient for fully understanding change in the region, and how it may be linked to federal forest management as one driver of change. An assessment of community types in the Plan area could help managers better understand how communities have been changing, and how management actions could be tailored in different places to provide different types of local community benefits. Adding to this, NWFP socioeconomic monitoring during the first decade provided a rich characterization of the impacts of the Plan on rural communities, and how they were adapting to changes in federal forest management. NWFP socioeconomic monitoring during the second decade focused on change at the county scale, and relied solely on secondary data from existing sources. Community studies that include primary data gathering directly from community residents would provide a much richer understanding of how socioeconomic well-being in the Plan area has changed over time, and its links to federal forest management. Currently, there is a paucity of community-level studies from NWFP-area communities.

Forest Service Contracting

Climate change promises to further complicate the relationships among wildfire, federal spending, and community benefits. On the one hand, communities with higher levels of fire suppression contracting infrastructure may benefit economically from increases in fire frequency and extent, owing to increased economic activity associated with more fire suppression. On the other hand, increasingly nationalized and mobile fire suppression response means that local fire suppression capacity (e.g. trained crews and equipment) may be elsewhere when a fire strikes, and therefore unable to support local suppression efforts (thus requiring dispatch to call upon crews from outside the local area). Additionally, communities may experience economic challenges in the months following a wildfire despite an initial increase in economic activity associated with firefighting (Davis et al. 2014, Nielsen-Pincus et al. 2014). Forest-specific climate adaptation strategies for the region identify the need for active management to make forests more resilient to wildfire and climate-change effects, and undertake other stewardship activities (chapter 2) (Spies et al. 2010, Whitely Binder et al. 2010), all of which imply potential contracting opportunities for local communities. The lack of historical analysis of forest restoration and fire suppression contracting leads to many uncertainties in understanding the future of such contracting work, or the linkages between restoration and fire suppression contracting. Much of the research to date has focused either on very specific geographies and case studies, or on more regional data and trends. In addition, the challenges facing restoration contractors and fire suppression contractors differ, not only in the contracting and dispatching protocols, but also in the scale at which the work is conducted.

Additional research focused specifically on understanding the businesses that engage with federal agency contracting (restoration service, timber sales, and fire suppression) would provide a more comprehensive understanding of the overlap and linkages between these businesses, as well as the communities to which they are connected and their local impacts.

Within the confines of timber sale and contracting requirements, the Forest Service has a number of innovative tools available to enter into partnerships, agreements, and stewardship contracts with private businesses and nongovernmental organizations. These innovative tools can be used to accomplish a variety of natural resource projects, produce a range of ecosystem goods and services, and bolster the performance of both the agency and the cooperating entity. Much of the recent research on the use of innovative tools in the Pacific Northwest has taken place in dry forests, east of the Cascades. Additional research is needed within the NWFP area on how the connections between the Forest Service and local communities can be strengthened through the use of such tools. In addition, the Plan area has been a source for experimentation with new models of natural resource governance (Montgomery 2013), including models in which community-based organizations fill in for gaps in federal capacity (Abrams et al. 2015). It remains to be seen how the evolution of these new institutional arrangements will affect contracting activities and the spatial distribution of benefits from Forest Service contracting.

Biomass

Much is still unknown regarding the potential for biomass energy production and related ecosystem service work to support rural communities in the future. Doing so will depend on the details of renewable energy, climate change, and ecosystem service-oriented policies and markets. Various climate change mitigation or adaptation initiatives may provide incentives and support for forest biomass production and use. For example, programs to increase the production of energy from non-fossil-fuel sources could increase demand for forest-based biomass materials and outputs. However, uncertainties remain regarding the carbon benefits of forest biomass energy (Hudiburg et al. 2011, Nechodom et al. 2008, Ter-Mikaelian et al. 2015), raising the possibility that biomass may not continue to be favored as part of a low-carbon energy portfolio. Further, the feasibility of biomass as a complement to forest stewardship and as a contributor to rural development is challenged by current harvest, transportation, and processing costs and the low demand for biomass materials; this scenario could change with new markets, subsidies, or biomass-based products (Crandall et al. 2017). Research is needed to better understand the full suite of costs and benefits associated with biomass energy development under different market and public policy scenarios, and to understand where and under what conditions biomass harvesting may help to complement other forest management activities or contribute to a low-carbon energy matrix. Additional research could also help to clarify how the interactions of various energy and non-energy policies influence the development of biomass businesses (Abrams et al. 2017, Becker et al. 2011b).

Nontimber Forest Products

Nontimber forest products on federal forests support community and household well-being by providing income-earning opportunities in the formal and informal economic sectors, strengthening individual and community social capital, facilitating intergenerational ecological knowledge transfer, and enabling NTFP practitioners to develop stronger connections with nature and improve their mental and physical health. Research conducted in the previous two decades has begun to reveal some of the diverse and complex ways in which NTFPs contribute to human well-being, but there is much more to be learned (fig. 8-25). Specifically, we know very little about even some of the most basic social, economic, and ecological aspects of NTFPs, such as:

1. Who is harvesting NTFPs and what are their motivations for harvesting these products? To what extent do urban, as well as rural, residents participate in NTFP-related activities?
2. Where are harvesters getting NTFPs from and how much are they actually harvesting?
3. How does the spatial and temporal distribution of NTFP activities vary within and across seasons?



Rebecca McLain

Figure 8-25—Much remains to be learned about the harvesting of even the most important nontimber forest products in the Northwest Forest Plan area, such as wild mushrooms and firewood.

4. What are the cumulative impacts of agency regulations such as large-scale area closures, permit requirements, seasonal restrictions, etc. on NTFP livelihoods?
5. What are the ecological impacts (positive and negative) of NTFP harvesting? And what are the impacts of different vegetation management and restoration practices on NTFP species and livelihoods? What active management approaches can be adopted to enhance the productivity of different NTFPs, while also producing timber?
6. How is climate change likely to affect the location, quantities, and qualities of NTFP species? What adaptive measures can be taken to ensure the viability of NTFP livelihoods in the face of changing climatic conditions?
7. What do informal and formal NTFP value chains look like, and how are benefits distributed along those value chains? How do permit prices align with the costs incurred by harvesters?
8. What methods exist or could be developed for measuring the contribution to community well-being of NTFP activities taking place outside the market place, and how can these be adapted for research on NTFP activities in the Plan region? How can the recreational, cultural, and provisioning values of NTFPs best be assessed?

Additionally, most of the research on NTFPs in the Plan region has focused on the "big three"—floral and holiday greens, wild edible fungi, and huckleberries. No studies have been done of firewood, which provides the bulk of NTFP revenues on many national forests and serves as a heating source for many rural residents. Little is known about the native seed and transplant industries, which play a major role in restoration on both federal and private lands. Likewise, little is known about the social and economic aspects of medicinal plant gathering on federal forests in the NWFP region, yet the medicinal plant industry is one of the largest and fastest growing NTFP sectors.

The biggest gains in knowledge about NTFPs in the NWFP region and the people who rely upon them for their livelihoods, enjoyment, and cultural traditions were made between 1990 and 2010, thanks in large part to the Pacific Northwest Research Station's interdisciplinary applied research program focused on improving understanding of the social, economic, and ecological aspects of NTFPs. A key take-home message from that experience is that building and strengthening partnerships, both across academic disciplines and among scientists, managers, and NTFP harvesters/buyers, is likely the key to the development of a program of NTFP research that can enhance socioecological resiliency and community well-being in the NWFP region.

Recreation

Recreation opportunities on federal forests support the well-being of local communities by providing leisure opportunities for local residents and by attracting visitors who spend money in local communities during their recreational trips. Research is generally clear on what communities can do to promote greater visitor spending, such as providing lodging opportunities, restaurants, and recreation services. There is limited research within the Plan area on how federal forest resource conditions and management influence recreation use and recreation behavior of local residents and visitors. More research is needed to understand how management actions across the landscape, and at important resource destinations, influence how people use forests for recreation.

Ecosystem Services

Given the degree of contentious debate that motivated the NWFP and that has been inspired by it over the years, it is surprising that little analysis has addressed the potential net co-benefits associated with the Plan. Specifically, what has the NWFP meant in terms of water quality, outdoor recreation, and habitat for species other than the spotted owl? Quantifying these possible net co-benefits, even approximately, might offer additional information with which to more fully evaluate the long-term effects of the Plan. Future research could be directed toward characterizing how the NWFP has influenced various ecosystem services, building on case studies and approaches in development (e.g., Kline and Mazzotta 2012, Smith et al. 2011).

Additional research could be directed toward further evaluating the degree to which various policy instruments, including direct payments, tax incentives, and ecosystem services markets, could be used to provide incentives to private landowners to conduct actions that pursue NWFP goals on private lands, augmenting current efforts on federal lands. In the early 2000s, for example, there was significant excitement about the expected development of markets for nontimber ecosystem goods and services that are produced from forests (e.g., carbon storage, water quality improvements) (e.g., Kline et al. 2009). However, achieving these expectations has been spotty within the NWFP area, in part because to effectively implement them, such markets require new or tighter environmental regulations restricting actions that damage ecosystem goods and services, making such markets difficult to establish (Kline et al. 2009). Despite limited success thus far, the presence of a carbon market in California and other cases in Oregon and Washington provide some promise that such markets can provide additional revenue streams from private forests. But how, and if, public forests can contribute to carbon markets and other ecosystem service markets remains largely unknown. Use of other landowner compensation mechanisms, such as direct payments and tax incentives, to advance NWFP goals on private lands arguably have received less attention by environmental advocates, but offer similar promise. Key research needs regarding compensation mechanisms of any type include evaluating the degree of difficulty in their implementation, and evaluating the potential returns in terms of the net ecosystem services benefits gained.

There also are opportunities for improving knowledge concerning the use of nonfederal funding to finance forest restoration on federal lands. Existing research demonstrates examples of supporting forest restoration projects that lead to watershed improvements (e.g., McCarthy 2014). The Pacific Northwest accounts for the majority of high-biomass forests nationwide, and federal lands account for nearly half of the regional total (Krankina et al. 2014), suggesting possible opportunities related to protection and stewardship of sequestered carbon should carbon markets be developed in the region and be open to participation by federal lands. The development of these potential financing opportunities will depend upon, among other factors, supportive public policies and organizational capacity at multiple scales (Davis et al. 2015, Kline et al. 2013). Exactly how such financing approaches can operate on public forest lands, how much additional revenue such approaches could provide toward forest restoration on federal lands, and how the revenue derived from these approaches should be distributed to benefit both people and forests are areas in need of further research.

Land Use Change

Given the impact that housing and other development could have on the amount and condition of remaining private forest land, analysis of the implications that such development could have for whether NWFP goals can be met in the future would seem warranted. In many cases, private lands likely augment public lands in providing various types of habitat, depending in part on the degree of development present. Most analyses have treated land use as an "either-or" proposition—land is considered either forest or developed. Increasingly, however, we are likely to see growing fragmentation of privately owned forest lands, with housing and other development interspersed "among the trees." Such development can have a variety of effects on habitat and ecosystem services, including effects on spotted owls, depending on how private landowners choose to manage their lands—whether for timber or largely for environmental amenities such as aesthetics, recreation, and habitat. For these reasons, development and its influence on landowner decisions could be a significant social process influencing the Plan area in the future. We see value in maintaining a research program that examines land use change and its effects on habitat and other NWFP goals, and that analyzes the effects of various policies that can be used to influence land use change.

Conclusions and Management Considerations

This chapter discusses how the NWFP, among other social and economic factors operating at multiple scales, has affected rural communities in the Plan area, and how they have changed since the Plan was implemented. It also highlights many of the ways in which federal forest management contributes to community socioeconomic well-being, and vice versa. The chapter is based on a set of guiding questions, several of which federal forest managers in the Plan area identified as being of interest. Given the statutory and policy foundation for considering socioeconomic well-being in federal forest management, a number of relevant management considerations based on the literature synthesized in the chapter are identified here.

Management Considerations

Wood products production remains important. Increased use of alternative silvicultural methods and expanded restoration treatments could increase federal timber production to maintain local wood processing infrastructure and the forestry workforce and support investments in new wood products markets. Historically, timber production was the central way in which federal forests in the NWFP area contributed to community socioeconomic well-being. The supply of timber from federal forests has dramatically declined post-NWFP. That decline, coupled with broadscale changes in the wood products industry, has altered this important connection between federal forests and communities. How to meet the NWFP goal of producing a predictable and sustainable supply of timber in the future to contribute to community socioeconomic well-being remains an important and continuing management challenge. Federal forests contribute roughly 10 percent of the regional timber supply today, reflecting current social acceptability and management approaches. Efforts and plans to pursue alternate management strategies focused on increased use of alternative silvicultural methods, and expanded restoration treatments could increase the volume of federal timber produced compared to recent outputs. How any increased federal forest harvest volume would influence the wood products industry and private forest land in the region is complex, however, and also is heavily affected by market and industry conditions outside of local control. Increased federal timber supply may be especially important in locations in which it provides the means to maintain local wood processing infrastructure and a forestry workforce, where federal agencies are the primary owner of local timberlands, or where the local forest products industry is attempting to expand into new wood products markets or to produce niche products.

Most timber harvested in the Plan area comes from private lands. Understanding how social, economic, and environmental variables influence timber production from private forests is important because it supports the business infrastructure needed for timber sales and restoration treatments on federal lands. In many places

within the Plan area, the capacity to undertake forest restoration on federal lands depends on the presence of mills to buy timber products generated through restoration projects (which can help pay for restoration work through stewardship contracting), and the presence of a contract forestry workforce to do the work. The lack of mills to buy material is currently more of a challenge east of the Cascade Range, and the need to retain existing infrastructure west of the Cascades is critical for supporting forest restoration. With federal timber harvests declining in recent decades, forest managers and policymakers may want to consider the capacity of private forest lands to continue to supply the bulk of timber to mills within the NWFP area. Production from private forest lands is important because management of federal forests, in many cases, depends on having a market for logs to fund other restoration activities and on supporting the workforce to do that restoration. Challenges facing the productivity of private forest lands in some locations include reduced private investment in forestry, the potential for wildfire, insects, and disease, and the management goals and decisions of private forest owners. To what extent will private forest lands continue to be available for economically viable harvest in the future? Can private forest lands sustain current or increased timber harvest levels in a manner that is ecologically sustainable? Will the increasing number of more-urban-minded forest owners have any interest in harvesting? Answers to these questions will have implications for the ability of federal forests in the Plan area to meet their timber production and forest restoration goals.

Local communities could benefit more from jobs associated with forest restoration if the predictability and accessibility of restoration contracting opportunities improve and if stakeholders build social agreement on biomass harvesting and processing projects. Finding ways to create forest restoration jobs that local residents can capture will help build skills, capacity, and infrastructure needed to support management activities on federal forests, including fire suppression response, and will promote both healthy forests and healthy communities. The opportunities for local communities to benefit from forest management are strongly conditioned by factors such as the existing workforce, the processing capacity in the community, and the structure of work contracts. To promote more beneficial linkages between rural communities and their nearby public lands, agencies could consider structuring contracts in ways that make them more accessible to local communities. For example, they could consider the effect of restoration contract size and scope on local contracting capacity, and provide restoration contracts in a variety of sizes to support business diversity. Community capacity to participate in the restoration economy is not only a function of the structure of individual contracts but also of the consistency and predictability of contracts over time. Using a variety of tools may help build a predictable, sustainable program of restoration and biomass use work that will help support investments in contracting and processing capacity.

The harvesting and processing of biomass materials may also help deliver economic benefits from restoration work, but biomass production has often been controversial and economically challenging in the NWFP area. To improve the opportunities for positive outcomes, working closely with community members and other key stakeholders to build agreement on biomass harvesting and processing projects is important. Consideration of local benefits as a contributing factor to such projects may help build social agreement.

Forest management decisions affect access to and use of NTFPs and people's ability to benefit from harvesting them. Thus it is important to consider the social and ecological tradeoffs involved when making decisions that affect NTFP management. The key to supporting a robust and resilient NTFP sector in the Plan region is to recognize that many of the informal aspects of that sector enhance community and household well-being. By providing low-cost income-earning and provisioning opportunities, the NTFP sector can provide the flexibility that some individuals and households might need to survive times of crisis or improve their quality of life during better times. NTFP activities that take place outside the market also function as social-ecological glue, linking people to each other and strengthening human-nature connections. When developing forest management policies and regulatory frameworks, agencies may wish to consider how they will affect the informal economic activities associated with NTFPs, and weigh carefully how the ecological benefits of large-scale area closures for commercial NTFP harvesting and increased formalization stack up against the costs of decreased economic resiliency and a weakening of social connections.

Community economic benefits from federal forest-based recreation are greatest when visitors take overnight trips. Developing recreation opportunities that encourage overnight stays and align with visitors' desires will help local communities benefit from recreation spending. Recreation visitor spending is a significant driver of economic activity in many forest communities within the NWFP area. The key factor in explaining how much recreation visitors spend in local communities during their trip is whether the visitor spends the night (either in a public campground or private lodging). Visitors who spend the night away from home spend an average of 5 to 8 times as much as visitors who are in the area for the day only. Communities seeking to generate the greatest amounts of visitor spending locally would do well to focus on efforts that (1) increase the likelihood visitors will spend the night there, and (2) support businesses that supply the types of services, goods, and experiences that recreation visitors desire.

Policies and programs are needed to incentivize private forest landowners to produce desired ecosystem services and to help them benefit from doing so. Local communities, including private landowners, may stand to benefit from emerging markets in ecosystem services. Similarly to forestry and restoration work, however, the nature of these benefits will depend upon how market access is structured. To promote these benefits, managers and policymakers could consider local community needs in the development of ecosystem service markets, and provide opportunities for local businesses and landowners to benefit from restoration, carbon sequestration, and other stewardship activities. For example, habitat improvements on private forest lands likely could be enhanced by targeting incentive programs or technical assistance toward forest landowners whose own objectives include habitat protection.

Development of private forest land raises questions about society's ability to benefit from forests, and will affect ecological conditions and processes across land ownerships. Anticipating its implications is important for federal forest management decisionmaking. Private forest land development and accompanying changes in forest management are an inevitable outcome of social and economic forces. Forest land development raises three main concerns: (1) how does it affect our ability as a nation to produce sufficient forest commodities, (2) how does it affect the many ecological values (e.g., biodiversity) and ecosystem services we desire from forests as open space, and (3) how does it affect our capability to reduce wildfire risk in the WUI? Potential ecosystem services impacts from development are less certain. Low-density and urban development of forest lands undoubtedly have some adverse ecological consequences as forest lands are converted to residential and other developed uses. However, less intensive management of remaining private forest lands also could alter ecological characteristics in unanticipated ways, adversely affecting habitat for some species while improving habitat for others. Evaluating net ecosystem services impacts resulting from increasing development of forest landscapes will require anticipating how resulting changes in private forestry are likely to affect ecological conditions and processes, and their associated ecosystem services. Such studies have been fairly limited in the Pacific Northwest.

When developing communication and outreach strategies to help communities adapt to fire-prone landscapes, tailor them to community type; different community types will have different opportunities and challenges associated with wildfire adaptation. Timber harvesting is no longer the only focal federal forest management concern from a socioeconomic standpoint, as it was when the NWFP was developed. Two decades later, wildfire management has risen to become another important management concern for communities located near federal forests. A number of social scientists have conducted research about what factors drive community adaptation to fire-prone landscapes, and how to build community capacity to address wildfire risk (see McCaffrey et al. 2013). Paveglio et al. (2015b) suggested that strategies to build community capacity to address wildfire risk will depend on community type. They develop a four-part typology of WUI communities that includes formalized suburban communities, high-amenity/high-resource communities, rural lifestyle communities (these last two are consistent with the amenity trajectory), and working landscape/resource-dependent communities (consistent with the production trajectory). They suggest that communities sharing similar characteristics

are likely to encounter similar challenges and opportunities in adapting to wildfire risk. Thus, agencies and others seeking to assist WUI communities become more resilient to wildfire could develop communication and outreach strategies tailored to each community type. Paveglio et al. (2015b) detailed what some of these might be.

When possible, drawing on local community resources to help fight wildfires (e.g., equipment, labor) could improve fire suppression response and help communities capture fire suppression dollars. Regarding fire-related jobs, given the erratic nature and small windows of demand for wildfire contracting, most businesses and workers need to perform other activities when they are not working on fire crews. As a consequence, local contracting capacity for fire suppression may be concentrated in particular regions, at least in part because there is other work for businesses to do when they are not fighting fires. This means that local capacity for fire suppression may be unequally distributed across the region, and concentrated in pockets where restoration work has historically existed. Related to this, the mobile and national nature of fire suppression means that local businesses trained in fire suppression will often be dispatched to fires outside their local community. Consequently, the ability of communities to capture fire suppression dollars locally may be reduced because firefighters (and fire camp support services) spend money on lodging, food, gas, and other supplies in the locale where they are fighting the fire. No matter where a fire occurs, firefighters will bring some of the income they earn back to their home areas. But, with such a necessarily mobile workforce, some firefighter earnings will be spent while on deployment to fires. This finding suggests that when fire resource needs and dispatch procedures allow for it, linking local fire suppression response capacity to less mobile resources (e.g., local fire districts, other fire suppression resources not signed up for national or regional deployment) might improve both local response and economic capture.

Working with communities to help mitigate negative climate change impacts will contribute to community well-being. Adaptation to climate change is another key concern for community socioeconomic well-being. This is not a purely technical exercise; it entails consideration of a multitude of social values and economic activities. Working with local community members to identify forest resources and economic activities potentially at risk from a changing climate, and considering management approaches that address these impacts, are ways that agency managers may help mitigate the impacts of climate change on communities.

Conclusions

Rural communities are not all alike, forest management policies and practices affect different communities differently, and the social and economic bases of many traditionally forest-dependent communities have changed in the years since the start of the NWFP. Better understanding and consideration of the economic development trajectories of different communities will help identify forest management activities that best contribute to their well-being. Providing a diverse set of benefits from federal forests may support communities in their efforts to diversify economically, and help build community resilience to future change.

Additionally, local relationships are important. Building constructive relationships with place-based nongovernmental organizations and other entities that are working to help communities become more resilient to external stressors can contribute to community resilience, for example by helping communities capture the economic benefits from forest management activities. The stressors affecting communities include changes in federal forest management policy, markets for forest products, development, wildland fire, and climate change. These same organizations may also be able to contribute resources and capacity to help address unmet needs on National Forest System lands, including (but not limited to) maintaining trails and other recreational infrastructure, filling gaps in planning capacity, building local business capacity to undertake forest restoration, raising funds to pay for forest management work, and leading collaborative forest planning efforts. Healthy forests and healthy communities are linked; thus it is in the interest of federal forest management agencies to contribute to community socioeconomic well-being, and it is in the interest of local communities to contribute to the capacity of agency managers to accomplish forest management work.

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Participants map their favorite destinations in the Mount Baker–Snoqualmie National Forest, Washington, during a human ecological mapping workshop.
Photo by Lee Cerveny.

Chapter 9: Understanding Our Changing Public Values, Resource Uses, and Engagement Processes and Practices

Lee K. Cerveny, Emily Jane Davis, Rebecca McLain, Clare M. Ryan, Debra R. Whitall, and Eric M. White[1]

Introduction

The Northwest Forest Plan (NWFP, or Plan) signified a movement away from intensive focus on timber management that was common through the 1980s and toward an ecosystem management approach, which aims to conserve ecological conditions and restore natural resources while meeting the social, cultural, and economic needs of present and future generations (Brussard et al. 1998). The NWFP emerged in response to expanded scientific knowledge about forests and shifting public values about resources and their management. An important goal of the NWFP was to protect forest values of late-successional, old-growth, and aquatic ecosystems. These may include amenity values (scenery, quality of life), environmental quality (clean air, soil, and water), ecological values (biodiversity), public-use values (outdoor recreation, education, subsistence use), and spiritual values (cultural ties, tribal histories) (Donoghue and Sutton 2006). This synthesis looks at the latest research on many of these forest values and adds to our thinking about how the NWFP has contributed to their protection.

Since the NWFP was instituted, the social context of the Plan area has changed. The social dimension of natural resource management in the NWFP is dynamic and inherently complex, resembling what some have referred to as "wicked problems" (Head 2008, Weber and Khademian 2008) or resource challenges that are unstructured (where it is difficult to identify causes and effects), crosscutting (multiple stakeholders, across jurisdictions, social complexity), and relentless (with no final solution). These wicked problems are often characterized by a high degree of uncertainty and potential for conflict, with little agreement on the solution (Weber and Kahdemian 2008). Effective management of wicked problems in the NWFP area requires significant resources, strong social networks, and collective engagement of actors (agencies, institutions, and individuals) in diverse policy arenas within the planning area (Weber and Kahdemian 2008).

At the same time, U.S. society has become polarized by both ideology and vocal partisanship, which have been linked to economic insecurity in the postindustrial era, and the potential for shifting power relations among sociocultural groups, including gender, ethnicity, and religion, referred to as "cultural backlash" (Inglehart and Norris 2006). Collaborative management and expanded emphasis on public processes that engage diverse stakeholders where objectives are transparent and sideboards are visible can help navigate the terrain of wicked problems. However, there is no guarantee that these efforts will result in an outcome that is widely embraced. Still, a process that generates mutual understanding, leads to informed decisions, incorporates new knowledge, and recognizes diverse uses and values would be a step forward.

Also since the NWFP was developed, scientists have explored and embraced new conceptualizations of ecosystems and ways to understand their benefits to people. Resource governance increasingly has adopted a framework of ecosystem services—the conditions, processes and components of the natural environment that provide tangible and intangible benefits to sustain and enhance human life (Daily 1997). Scientists and forest managers are updating their thinking about the variety of forest benefits

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that serve society and developing ways of measuring and comparing a diverse array of tangible and intangible benefits. As managers seek strategies for more integrated and holistic resource management using an ecosystem services approach, the importance of considering an array of public values (including aesthetic, recreational, spiritual, and heritage) becomes paramount.

Scientists increasingly recognize that conservation initiatives are more likely to lead to better informed decisions when ecological and social elements are integrated (Charnley 2006) (see chapter 12). Socioecological systems (SES) science recognizes the inextricable linkages between human societies and ecological systems (Berkes et al. 2000), and that ecosystems are embedded in levels of social organization (Brondizio et al. 2009). Halliday and Glaser (2011) considered an SES to be "a system composed of organized assemblages of humans and non-human life forms in a spatially determined geophysical setting" (2011: 2). Changes to social systems, such as population dynamics, market shifts, or changes in structural relations among natural resource institutions, can affect the natural environment. Conversely, changes to the ecological system, such as fire, flood, or diminished forest health, can affect human-nature interactions and settlement patterns (Gunderson and Holling 2002, Machlis et al. 1997). The social component of the SES refers broadly to property and access rights; land and resource tenure systems; resource knowledge systems, including local and traditional ecological knowledge; subsistence uses; worldviews; values; and perceptions about the environment (Berkes et al. 2000). An SES encompasses a variety of agencies and actors as they interact with the natural environment at multiple scales in ways that are dynamic, complex, and continuously adaptive (Folke et al. 2005, McGinnis and Ostrom 2014). An understanding of public values is essential to understand the complex influences of social values and choices on ecosystem uses and condition (Ives and Kendal 2014).

By thinking of the NWFP area as an integrated SES, with a complex web of interactions, forces, dynamics, and elements, we can begin to recognize and address major shifts in that system and understand their corresponding effects on the natural and social environment. This system includes public and private lands, governing agencies (federal, state, tribal), communities of place (municipalities, counties), and communities of interest (stakeholders, user groups). We recognize that the social dimensions of the Plan area influence how ecological goals are established, pursued, and met or not met (Lange 2016, Spies and Duncan 2012).

A science synthesis of the Plan area is not complete without a comprehensive understanding of the region's complex social ecology, particularly with regard to public values, citizen engagement, and governance of federally managed lands. Governance is a term widely used in political science and public administration to describe formal and informal processes, decisionmaking norms, and interactions among institutions involved in a collective problem (Hufty 2011). Governance may be undertaken by governments, tribes, legal corporations, multilateral commissions, collaborative groups, boards of directors, or social organizations. Governance explains how rules, norms, and decisions are structured, maintained, regulated, and monitored. Governance can be accomplished using a variety of tools, including laws, rules, markets, social norms, contracts, collaborative agreements, and public-private partnerships, as well as through symbols, maps, and language (Bevir 2013). In this chapter, we discuss governance as a formal process managed by government institutions like the U.S. Forest Service, primarily through laws and regulations. We also refer to "collaborative governance," which describes the contribution of collaborative groups, which engage federal, tribal, state, and municipal governments, citizen groups, and corporations in deliberation over common resource problems.

Public values, attitudes, and beliefs about forests and the management of forest resources are not fixed, but can shift over time, owing to a multitude of complex factors (e.g., economic, political, social, cultural) (Manfredo et al. 2003, Vaske et al. 2001). Changing demographics related to urbanization, amenity migration, or regional population shifts in response to economic opportunities all can alter the makeup of a population and result in a potential shift in environmental values, beliefs, and behaviors, as well as in the kinds of connections people have to place (Gosnell and Abrams 2011, Jones et al. 2003). Public uses and outdoor

experiences in national forests and other federal lands also evolve in response to emerging consumer trends, economic factors, new technologies, or changes to geophysical or climate conditions (Cordell et al. 2002, Tuan 2013). In addition, the ways that citizens engage in natural resource management and share their views with land management agencies have changed, as people express a desire to be involved in decisionmaking about public lands (Stern and Dietz 2008). American politics since the 2000s has been characterized by increasing partisanship, identity politics, and ideological divides that have pulled people apart and presented mounting challenges to public lands management (Abramowitz and Saunders 2006, Iyengar and Hahn 2009). Emerging collaborative structures that attempt to bring together multiple agencies and stakeholders to deliberate and plan for resource management have become prevalent (Emerson and Nabatchi 2015).

Public land management agencies are finding new ways to measure and evaluate the variety of benefits that ecosystems provide. The concept of ecosystem services has developed more over the past 10 years in resource management as a useful framework. The ecosystem services framework assigns economic and noneconomic values to ecological functions, allowing policymakers to evaluate ecosystems using comparable metrics (Carpenter et al. 2009). The MEA (2005) framework describes four categories of ecosystem services: supporting, provisioning, regulating, and cultural. Ecosystem services featured prominently in the National Forest System land management planning rule, which guides how forest management plans for each national forest are developed (USDA FS 2012). The new planning rule is historically significant in that it signals a shift toward valuing resources more broadly (using the ecosystem services framework) as well as a greater emphasis on public engagement, which recognizes the importance of public values, attitudes, and beliefs. This is especially relevant for the NWFP, which exists as amendments to 17 forest plans that are due for revision.

One goal of the NWFP was to provide a "balanced and comprehensive strategy for the conservation and management of forest ecosystems, while maximizing economic and social benefits from forests." An updated understanding of these complex dynamics related to humans and their myriad interactions with public lands in the NWFP area is an essential component of this chapter, particularly with regard to public lands. This chapter illuminates how public perceptions, attitudes, beliefs, and values regarding forests and their economic and social benefits may have changed over the past 20 years. While chapter 8 speaks to socioeconomic ties between communities and forests, this chapter identifies what we know about shifting values, place meanings, outdoor recreation trends, and ways of public engagement. The focus of chapter 9 falls into the basket of "cultural ecosystem services," (also referred to as cultural services) (Costanza et al. 2014). Cultural services include benefits gained through spiritual enrichment, outdoor recreation, religious or spiritual value, reflection, learning, sensory enhancement, and socializing, as well as place-based benefits such as identity, cultural heritage, and sense of place (Chan et al. 2012, Klain and Chan 2012, MEA 2005, Satterfield et al. 2013) and often emerge as a result of enduring relations between people and a landscape over many generations (Fagerholm et al. 2012).

Several chapters in this volume address other aspects of the sociocultural aspects of the SES, with many points of articulation with chapter 9. Chapter 8 focuses on the socioeconomic well-being of rural communities, the role of forest industries, and implications for private landowners in the Plan area. The discussion of recreation's contributions to rural economies in chapter 8 can be considered alongside discussion of recreation trends in chapter 9. In addition, both chapters touch on notions of trust and its importance for effective resource governance. For an indepth discussion of challenges and opportunities related to environmental justice, poverty, and resource access in the NWFP area, see chapter 10; for discussion of tribal resource governance, resource use, and indigenous knowledge systems, refer to chapter 11. As we consider elements of public involvement and collaboration in this chapter, it may be useful to inquire whether existing governance mechanisms promote participation from underserved communities. These discussions can be considered alongside findings related to collaboration in this chapter. These points of overlap are intentional and desirable to fully understand the SES as an integrated whole.

Guiding Questions

A goal of SES science is to better understand the social context in which ecological goals are identified and achieved. The questions below were given to the chapter 9 science team by managers. The authors used these questions to frame chapter contents and relied on available literature to address and respond to these questions.

- What does social science tell us about how stakeholders' attitudes, beliefs, and values have changed over the past 20 years? How are these attitudes, beliefs, and values associated with resource management (recreation, resource use, protection)?
- How have stakeholders' relationships to the landscape and natural resources changed in the NWFP area?
- What value do people place on cultural ecosystem services from public lands, including recreation?
- What has been learned about the importance of valuing place?
- How have public uses and interactions with forests and grasslands changed over the past 20 years?
- What are the drivers that shape public uses of forest lands for recreation?
- How have recreation values and uses changed in the past 20 years?
- How does the body of science inform sustainable recreation?
- What strategies are effective in engaging communities and the public in the NWFP area?
- What kinds of collaborative groups and processes are engaged in the NWFP area?
- How is collaborative forest management changing?
- What elements contribute to successful collaboration in forest management? What examples exist of successful collaboration?
- How much has collaboration contributed to achieving objectives in resource management and socioeconomic well-being?

Two additional topics were added later by the science team to address the specific themes considered of importance to understanding the scientific basis of forest planning and management. These topics included a discussion of trust as well as social acceptability of various harvest practices. We structured the chapter into seven subsections: public values, attitudes, and beliefs; valuing place; cultural ecosystem services; outdoor recreation; trust; involving the public; and agency-citizen collaboration. Each subsection deals with a set of topics that contribute to the questions asked and concludes with a brief summary. The chapter concludes with an overview of research needs, uncertainties, and information gaps, as well as a discussion of management considerations.

The study team used standard social science perspectives rooted in geography, anthropology, sociology, environmental psychology, and public administration. It was not our intent to collect primary data, but rather to synthesize existing literature in these five topic areas assigned to this chapter. We relied on the best available social science to highlight current knowledge about these important topics. For some topics, there is little or no empirical research conducted in the Plan area. Authors drew from case studies, dissertations, or technical reports when peer-reviewed publications for a given topic were not available. We focused foremost on scientific findings relevant to the Plan area. However, we did include a few seminal works which offered theoretical or methodological contributions or relevant research results from other parts of North America to demonstrate a trajectory of inquiry with bearing on the Plan area. Data synthesized here are based on scientific publications and case studies that occurred since the previous NWFP science synthesis in 2006 (Haynes et al. 2006), except in cases when current research was not available.

Key Findings

Public Values, Attitudes, and Beliefs

Understanding values, attitudes, and beliefs has become increasingly important in environmental decisionmaking and natural resource governance (Allen et al. 2009). Recognizing how and why people value different aspects of ecological systems potentially can allow resource managers to gain awareness about how different forest management goals and strategies may be viewed by the public and potentially understand the roots of conflict among stakeholders. Values inform how people interact with the landscape and

engage with conservation issues (Brown and Reed 2012). Values are known to predispose attitudes, management preferences, and behaviors. Thus, values can indicate whether proposed activities or goals in a plan would be socially acceptable and to whom (Allen et al. 2009, Fulton et al. 1996, Vaske and Donnelly 1999). By understanding public values, land managers will be better equipped to reach informed decisions (Tarrant et al. 2003).

Understanding values, attitudes, and beliefs— Values are most commonly understood as enduring beliefs about the world that are often formed in childhood and serve as guideposts for desirable actions (Rohan 2000, Rokeach 1973, Schwartz 1994). Values are "modes of conduct" or end-states of what is desirable (Manfredo et al. 2004). Two types of values are discussed by natural resource social scientists. "Held values" represent an embedded human characteristic that shapes the judgments people make about the world and the subsequent actions they take (Bengston and Xu 1995, Rokeach 1973). Held values are associated with desirable goals, standards, guidelines, or criteria that help people decide what is right or wrong, worthy, or undesirable (Schwartz et al. 2012). "Assigned values" can be attached to a specific object or physical place in the world, as well as to intangible concepts (i.e., an economic system or political institution) whereby a person attempts to denote relative worth to an object or place on the landscape (Bengston 1994, Brown 1984, Rokeach 1973). Both held and assigned values are important for land managers because they have been shown to predispose people to certain attitudes toward forest management practices and certain patterns of resource use and other environmental behaviors (Fulton et al. 1996).

The cognitive hierarchy model provides a logical structure for understanding the relationship between values, attitudes, and beliefs, and how these in turn influence human behaviors and actions (Dietz et al. 2005, Rokeach 1973, Vaske and Donnelly 1999) (fig. 9-1). Originally developed by Rokeach (1973), the model was fleshed out more fully by Fishbein and Ajzen (1975) as the "Theory of Reasoned Action" and later the "Theory of Planned Behavior" (Ajzen 1991, Ajzen and Fishbein 2005).

The cognitive hierarchy offers a reasoned conceptual framework that allows social scientists to explore the relationship between values, attitudes, and goals for forest management (Brown and Reed 2000). The components of the model include beliefs, value orientations, attitudes, intentions, and behaviors (box 1). Beliefs are statements of a person's understanding of the world; "they are facts as an individual perceives them" (Dietz et al. 2005: 346). Beliefs are a person's judgment about what they consider to be true or false. They can be shaped by science, feelings, experiences, intuition, or social norms (Zinn et al. 1998). Value orientations are the aggregation of beliefs about a particular issue or topic (Allen et al. 2009). Values are not directly measured, as they are often difficult to express, but social psychologists do measure value orientations as the basic set of beliefs (Fulton et al.

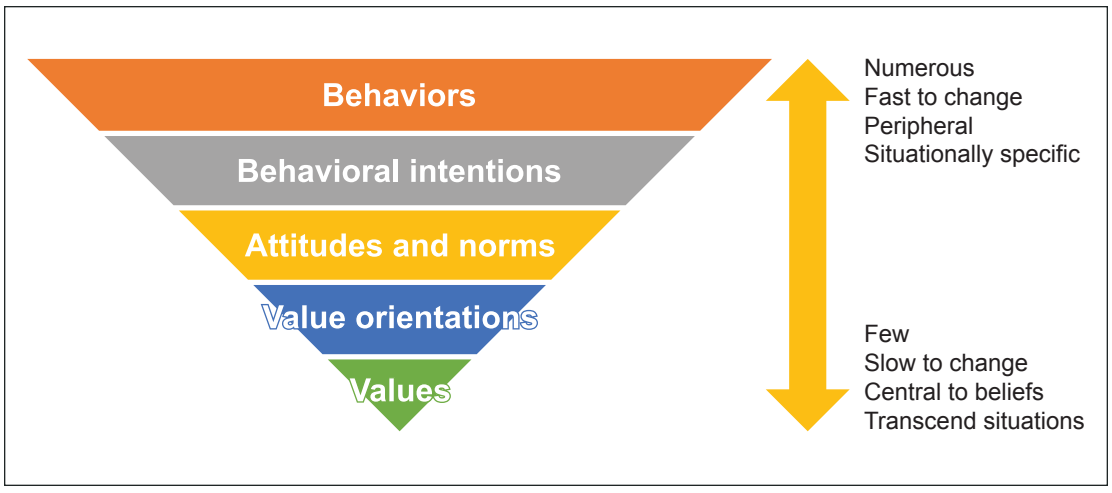


Figure 9-1—Cognitive hierarchy model of human behavior. Source: Adapted from Fulton et al. 1996.

Box 1—Key Definitions

Values: Enduring, consistent principles, often formed at an early age, about the important elements in life, including, what is good or bad; desirable or undesirable (Manfredo et al. 2009) (e.g., inclusiveness, justice, integrity, equality).

Value orientations: Set of beliefs about nature and the environment (Fulton et al. 1996). (e.g., orientations toward nature, human's role in the environment, public land management).

Beliefs: Judgments about what is true or false and what attributes are associated with someone or something, or the consequences of an action. (Ajzen 2002). (e.g., beliefs about land management agencies, forest conditions, or effects of actions).

Attitudes: Learned tendencies to react favorably or unfavorably to a situation, conditions, people, objects or ideas (e.g., level of support for an agency's actions; preferences for particular activities or actions).

Intentions: Convictions, aims to act in a particular way.

Behaviors: What people do, actions they take (e.g., participate in environmental activism, voting, stewardship behaviors, recycling, littering, outdoor recreation use, consumptive use of resources).

Norms: Implied or explicit rules or guidelines that regulate behavior and prescribe what people do (Stern et al. 2000). Norms can be individual (personal guidelines) or social (societal expectations).

1996, Rokeach 1973). Beliefs form the basis for attitudes. Attitudes are statements of people's positive or negative evaluations of a specific object or situation and are typically expressed as likes or dislikes, or preferences (Hoult 1977). Attitudes stem from values and also from lived experiences that shape a person's typical response or approach to something. They reflect one's dominant personality traits (e.g., optimistic vs. pessimistic; internal responsibility vs. external responsibility) (Ajzen and Fishbein 1975). Environmental attitudes have shown to be more predictive than values for understanding management preferences. The relationship between values, beliefs, and attitudes has been explored in many studies in natural resource settings (Bright et al. 2000, Fulton et al. 1996, Vaske and Donnelly 1999).

Fishbein and Ajzen (1975) set out to develop a framework that could predict intentions (the aim of a particular action) and behaviors (actions people take in nature, and may include stewardship, recreation, or consumption of forest resources). In their Theory of Reasoned Action, their focus is on antecedents to behavior, including beliefs about the consequences of a specific behavior and generalized attitudes (favorable or unfavorable) about a specific behavior (Fishbein and Ajzen 1975). For example, the behavior of riding motorized vehicles off developed roads would depend on a person's understanding of how that action affects the biophysical and social environment as well as overall attitudes about off-highway vehicles. They also introduce the concept of normative beliefs and subjective norms. The normative beliefs are judgments held by others about the appropriateness of a particular behavior. The subjective norm is a combination of beliefs about the existence of social norms and individual motivations to comply with norms (Ajzen 2000). The interaction among beliefs, attitudes, intentions, and behavior is shown as a feedback loop, whereas when a particular behavior (behavior X) is performed, this affects one's normative beliefs about what is appropriate, which is guided by social norms, which then shapes intentions (fig. 9-2). The next iteration of the model, the Theory of Planned Behavior, added a component of individual agency or power, noting how the role of an individual's perceived control over their behavior can affect behavioral intentions (Ajzen and Fishbein 2005).

Values, attitudes, and beliefs can affect human intentions and actions (behaviors), but other factors play a role, including norms. Another concept used commonly in natural resources settings, particularly with emphasis on understanding pro-environmental behavior, is the

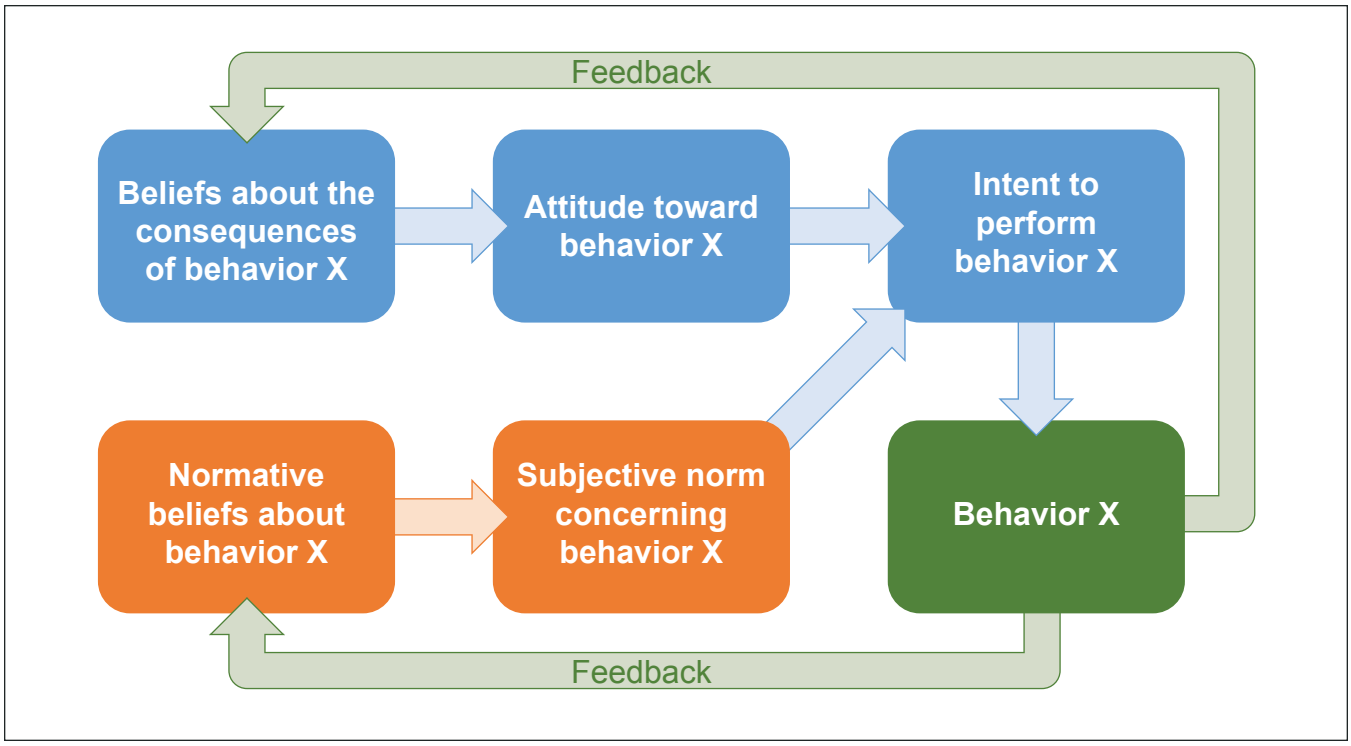


Figure 9-2—Theory of reasoned action (Fishbein and Ajzen 1975).

values-beliefs-norms (VBN) theory of environmentalism (Stern 2000). The VBN theory has been successful in explaining different types of environmental actions (Stern et al. 1999) and the acceptability of social or environmental policies or actions. This theory suggests that values do not directly predict behavior, but are indirectly implicated through beliefs and norms (de Groot et and Steg 2008, Steg and Vlek 2009). The idea is that values affect behavior indirectly by activating personal norms (moral obligations to perform a particular action). Personal norms are activated when someone acknowledges that (a) not acting pro-environmentally will lead to negative consequences, (b) when someone feels personally responsible for those negative outcomes, and (c) they believe their own efforts will help to mitigate the problem or minimize consequences (taking responsibility). One should first be aware of problems caused by the relevant behavior before considering to what extent one personally contributes to the problems and whether one could possibly be part of the solution, which in turn determines the extent to which personal norms are activated. Values thus influence the extent to which one is aware of the problem, but also may predict variables about how they respond to the problem (de Groot and Steg 2008). Our awareness of those norms influences or fine tunes our ultimate actions (Stern 2000).

Steg et al. (2014) discovered four value types important for understanding beliefs, norms, intentions, and behaviors: hedonic (concern for achieving personal needs or exerting minimal effort), egoistic (concern for costs and benefits for the individual), altruistic (concern for human welfare), and biospheric (concern for quality of nature and the environment). Biospheric and altruistic values were found to promote pro-environmental attitudes and behaviors (Stern and Dietz 1994). In contrast, egoistic and hedonic values were negatively related to pro-environmental attitudes and behaviors. Those with altruistic and biospheric values are likely to be more aware of the problem, while awareness is lower with those who have hedonic and egoistic values (de Groot and Steg 2008). Whitmarsh and O'Neill (2010) learned that self-identity as an environmentalist is a significant predictor of behavior, especially in combination with values, attitudes, and beliefs. Yet, others have shown

that self-identity has a minimal effect (Rise et al. 2010). More research is needed to show whether self-identity as an environmentalist is a useful variable.

Recent studies of values have combined perspectives from cultural anthropology with systems theory. Anthropologists have long suggested that values are relatively stable and enduring and are developed through collective processes of socialization (schools, religious organizations, traditions, etc.) and that are shared with communities, cultural groups, or societies (Kenter et al. 2015, Kluckhohn 1951, Schwartz 2006). Values do not exist alone, but are deeply embedded in our social institutions, governments, collective behaviors (cultural practices), and the media (Schwartz 2006). Values exist at multiple levels and locations throughout our socioecological system and are mutually reinforced (Manfredo et al. 2017). One's individual values may guide one's actions or determine one's membership in a particular organization, but that organization reflects and reinforces the shared values deeply embedded in the social system. For values shift to occur, multiple entities at various levels of the socioecological system would need to be engaged (Manfredo et al. 2017). This systems theory framework views values as resistant to rapid change, but recognizes that major socioecological events, such as mass migrations resulting from changing environmental conditions (Kitayama et al. 2010), modernization (Inglehart 1997), or urbanization (Manfredo et al. 2009) can result in a gradual shift in values (Manfredo et al. 2009, 2017). New research, such as that offered by Dietsch et al. (2016), is needed to explore the influence of macro-level organizations on one's values and the ways that shared values emerge.

We know that values can evolve during processes of deliberation and discussion, where mutual learning takes place among people who have different backgrounds and experiences (Daniels and Walker 2001). Deliberation allows participants to consider their own arguments and the assumptions behind them, hear the perspectives and experiences of other participants and understand the reasoning behind their views, evaluate various positions, and reach informed decisions. Deliberation results in social learning (Cundill and Rodela 2012). Deliberation through organized workshops and stakeholder engagements can lead to exposure to different perspectives and result in new insights and knowledge about how people value natural resources (Steyaert et al. 2007). Deliberative processes are useful for identifying values that are difficult to pinpoint (Kenter et al. 2016a). Collaborative groups, public engagement opportunities, and other processes can result in individual and group learning. Efforts to engage citizens in collaborative and deliberative processes are discussed later in this chapter.

Exploring environmental values and attitudes— Environmental values have been measured in a variety of ways. Table 9-1 features several approaches in the literature that are the most common. This is not meant to be an exhaustive list, and there are new approaches to measuring environmental values, attitudes, and beliefs that are not included here, because they have not been widely used.

Many scholars measure "value orientations," which are sets of values that link together based on a common orientation to nature and the environment. Environmental value orientations are clusters of interrelated values that reflect an overall relationship between humans and the environment (Fulton et al. 1996, Vaske et al. 2001). Many classification systems have been used to explore value orientations. Xu and Bengston (1997) classified values into instrumental (the usefulness of forests as the means to a further end, such as logs for housing or recreation use for people); and noninstrumental (forests are valuable in themselves), which Moore (2007) also calls intrinsic values. Stern and Dietz (1994), Schultz et al. (2005), and others used three value categories: egocentric (self-oriented), altruistic (public good), and biospheric (for nature itself) to predict environmental behavior. A widely used framework of value orientations used by Vaske et al. (2001) identified anthropocentric (utilitarian) and biocentric *(*nature centered) (Steel et al. 1994). Later studies added a third orientation, moral/spiritual/aesthetic*,* which also encompasses sacred values and heritage values as well as bequest values (Bengston et al. 2004). This category of values includes both religious values as well as spirituality that relates to people's respect for natural forces, as well as a spirituality that exists without humans (Proctor 2009). Winter and Lockwood (2004) developed a natural area scale, which included intrinsic, use, and non-use values.

Table 9-1—Various approaches to exploring environmental values

Values approach	Goal	Tools or methods	Relevant studies
Value orientations	Quantifying values and classifying respondents into similar groups based on their orientations to the natural environment	Various Likert scales	de Groot and Steg 2008, Dietz et al. 2005, Fulton 1996, Steel et al. 1994, Stern and Dietz 1994, Stern et al. 1995, Xu and Bengston 1997
New Ecological Paradigm, also known as "New Environmental Paradigm"	Measures anthropocentric and biocentric orientations to the natural environment	15-item scaled survey	Cordano et al. 2003, Dunlap 2008, Dunlap and van Liere 1978, Dunlap et al. 2000, Stern et al. 1995
Natural area values scale	Measures values relevant to natural areas, including intrinsic, use, non-use, recreational, and aesthetic	20-item scaled survey	Ford et al. 2012, Winter and Lockwood 2004
Values suitability analysis Values compatibility analysis	Evaluates consistencies between land management prescriptions and public values	Numerical rating system	Brown and Reed 2012, Reed and Brown 2003
Public values of forest	Predicts public values based on forest outputs, amenities, and protection	12-point scaled survey	Tarrant et al. 2003
Landscape values mapping	Shows what values are associated with places on the landscape using maps	Maps and other spatial tools	Alessa et al. 2008; Brown and Kyttä 2014; Brown and Reed 2000, 2012
Valued attributes of landscape scale	Emphasis on the value of site attributes (natural, social, experiential, cultural, productive)	Measures 26 value attributes	Kendal et al. 2015
Deliberative Value Formation Model	Based on the notion of shared values. Use of a deliberative process to generate learning and values shift.	Value orientation scales and deliberative process	Kenter 2016; Kenter et al. 2016a, 2016b

Value orientations provide the foundation for specific attitudes toward forest management (McFarlane and Boxall 2000, Steel et al. 1994, Tarrant and Cordell 2002). Environmental value orientation scales approaches distinguish between anthropocentric (oriented to human well-being) and biocentric (oriented to ecological well-being). Others identified an ecocentric orientation that emphasizes ecosystems (Surmeli and Saka 2013). Value orientations can often predict attitudes toward forest management practices and support for natural resource policies, although particular circumstances can override values, such as a person's unique relationship to a particular setting or if their income depends on the decision outcome. Individual motivations sometimes override value preferences. While some of these studies have successfully shown that people hold shared sets of values, they have not been able to explain why distinct stakeholder groups (e.g., fishermen and biologists) holding the same set of value orientations exhibit divergent behaviors.

Studies have shown that some factors can predict attitudes toward management outcomes. One of the most consistent predictors of values is gender. Several independent studies have shown that women tend to favor biocentric (noneconomic) values more often than men, although the differences are small in most cases (Kellert and Berry 1987,

Steel et al. 1994, Tarrant et al. 2003, Vaske et al. 2001). Other linkages have been found between value orientations and the visual impacts of resource management (Tindall 2003), perceived threats to forest health (Abrams et al. 2005), and participation in activism directed at the forest sector (McFarlane and Hunt 2006). Working in Australia, Ford et al. (2009) showed that the public's acceptance of clearcutting was related to their value orientation. Those with stronger "use values" (timber production) were more likely to find clearcutting acceptable than those with stronger "intrinsic values" for nature. In Canada, Tindall (2003) also found that those with a biocentric orientation tended to support policies aimed toward resource protection and view commercial forest practices as unsustainable, and its visual impacts unacceptable. Steel et al. (1994) conducted a study in Oregon about whether value orientations predict public attitudes toward various forest management practices. They observed that respondents with an anthropocentric values orientation support resource use for economic gain, and view forest management as sustainable and its visual impacts acceptable (Steel et al. 1994). From their work on public acceptance of clearcutting in Australia, Ford et al. (2012) learned that a person's aesthetic experience in nature is filtered by values and that this experience directly shapes their attitudes toward management actions.

Clement and Cheng (2011) used a random household survey (response rate 34 percent) in Colorado and Wyoming to explore values and attitudes toward forest management, and preferences for specific management activities (logging, oil and gas drilling, and off-highway vehicle use) in three national forests. Overall, respondents scored highest on the values "aesthetic," "recreation," and "biodiversity." Statistical analysis showed that both values and attitudes influenced management preferences. Specifically, they found that certain values were more prevalent in classifying respondents for each management issue. Understanding one's values was helpful in predicting responses to management preferences. Respondents that shared similar value orientations sometimes held different and even opposing policy preferences (Clement and Cheng 2011), which suggests that values and attitudes/preferences are most powerful when examined together. For example, those with stronger values in "recreation" and "economic" were positively correlated with oil and gas leasing. Interestingly, the same two values also correlated positively with sport hunting and fishing and negatively with wilderness designation. They also found that those who ranked recreation, economic, historical, and cultural values high are more comfortable with forest treatments to reduce wildfire risk. This approach is a useful example of how to tease out the relationship between values, attitudes, and management preferences. Results show that members of the public have a range of values and may share many in common, while holding different management preferences.

The New Ecological Paradigm (NEP), also referred to as the New Environmental Paradigm, is another widely used scale that measures environmental attitudes along a **biocentric** to **anthropocentric** continuum. The original scale developed in 1978 used 12 items and measured along three facets of internalized beliefs and values: beliefs about humans' ability to upset the balance of nature, recognition of limits to growth, and beliefs about humanity's rights to rule over nature (Dunlap and van Liere 1978). The scale was later updated and renamed to constitute a 15-item scale that measured values along five facets: beliefs that humans affect the balance of nature, beliefs that humans are causing harm to the environment, beliefs that humans are not exempt from constraints of nature, beliefs that the Earth's resources are limited, and beliefs that humans have the right to modify and control the environment (Dunlap 2008, Dunlap et al. 2000). Respondents agreed or disagreed with statements related to each facet to develop a score for each facet and an overall NEP score. In a meta-analysis conducted in 2009 (Hawcroft and Milfont 2010), the authors found 69 distinct studies (52 in the United States) that used NEP in 36 countries. Despite its widespread use, Hawcroft and Milfont (2010) found a lack of empirical and theoretical integration in studies that used NEP to measure environmental attitudes. Partly this is due to variations in the implementation of NEP (differences in sample size and context). Others who tested the validity of NEP found variation among the five facets, with the most reliable being the scale measuring the "balance of nature." Moreover, they found that the five subscales were more useful than the cumulative NEP score

(Amburgey and Thoman 2012). Still, it is not clear that the NEP scale is adequately measuring environmental attitudes.

The Natural Area Values Scale has been used primarily in Australia. This approach identifies five factors (intrinsic, use, non-use, recreational, and aesthetic) (Ford et al. 2012, Winter and Lockwood 2004). Values suitability analysis (also called values compatibility analysis) is an approach that evaluates the extent to which public values and attitudes are consistent with agency management actions. Brown and Reed (2012) determined where all-terrain vehicles (ATV) could occur within a national forests that would not compromise other values. These data helped land managers establish areas that were compatible with ATV use and areas that would require tradeoffs with other forest uses. Acknowledging distinct values sets and their compatibility with management actions is useful, but in many cases, resource users have conflicting values. Collaborative learning processes can raise awareness of values to the surface and acknowledge the tradeoffs among values that exist, achieving solutions that reflect a multiplicity of coexisting values (Daniels and Walker 2001).

The Public Values of Forest Scale (Tarrant et al. 2003) is a survey based on a 12-item scale that considers three factors: outputs (timber, roads, raw materials, range, recreation), amenities (quiet, education, aesthetics), and protection (clean water, fish and wildlife, endangered species). The survey was found to have predictive validity for discerning values among demographic variables and in predicting attitudes toward wilderness. Understanding attitudes is helpful, yet one's attitudes do not necessarily predict whether one accepts a particular management approach or outcome, which can be influenced by contextual conditions and learned behaviors (Oreg and Katz-Gerro 2006).

Landscape values mapping (LVM) is an approach used to understand what values people attach to places on the landscape (Brown and Reed 2000). The LVM approach is used to capture values across a landscape for use in planning and decisionmaking (Brown and Reed 2009, Raymond and Brown 2006). The approach understands humans as cognizant actors who experience the landscape directly through their senses, and assign meaning to places based on these experiences (Zube 1987). Brown and Reed (2000) built a landscape values typology derived from work of Rolston and Coufal (1991). They defined 13 landscape values: economic, learning, historic, cultural, future, intrinsic, spiritual, therapeutic, subsistence, life supporting, biodiversity, recreation, and aesthetic, and asked respondents to place colored dots on a map for each value. Brown and Reed (2000) validated their landscape values typology by demonstrating that each landscape value represented a discrete construct, and that the values could not be organized into higher order factors. The study also showed that respondents were as likely to select noncommodity values (aesthetic, spiritual) as commodity values (economic, subsistence). The assigning of landscape values to a map requires that the respondents recall their direct experiences or the images from stories told about these places and the meanings generated by these experiences, which are influenced by held values.

LVM has been applied in a wide variety of countries, spatial scales, and sociocultural settings and has achieved some level of standardization through replication (Alessa et al. 2008; Beverly et al. 2008; Brown 2006, 2012; Brown and Raymond 2007; Brown and Weber 2012; Clement and Cheng 2011; Fagerholm et al. 2012; Nielsen-Pincus 2011; Reed and Brown 2003, Reed et al. 2009; Sherrouse et al. 2011). The landscape values typology is commonly used in conjunction with spatial attributes mapping (Brown 2004) where participants have options to assign multiple values across a landscape (using points or drawing shapes). Across the studies, there has been fairly consistent application of the original 13 landscape values, with some customization to suit sociocultural or biophysical conditions. For example, in Alaska and Washington, the value "subsistence" was used because of the cultural, political, and economic importance of food gathering as a cultural practice (Alessa et al. 2008, Cerveny et al. 2017). Another value that has been sometimes added is "wilderness," which is appropriate in Euro-American settings, but is less meaningful in non-Western societies (Brown and Alessa 2005). Several studies employing the landscape values typology have included "special places" as an additional mapped feature, often designated with a special symbol ("X") and described using narrative description. (See Brown and Kyttä [2014] for a comprehensive overview of existing public participation geographic information systems studies).

The Valued Attributes of Landscape Scale represents a tool that measures the value of site attributes, features, or properties (Kendal et al. 2015). Site attributes may be understood as natural, social, experiential, cultural, or productive. This scale uses a standardized approach that can be compared across groups of people and in diverse landscapes (Kendal et al. 2015). The approach is an attempt to bridge held values (core values) and assigned values (attached to places or objects). More tests are required to establish the reliability of this approach.

Values are known to shift or change in response to new learning and deliberative engagement (Manfredo et al. 2017). The Deliberative Value Formation Model (DVF) is built upon the idea that group interactions and deliberative processes can result in new learning that results in a shift in values (Kenter et al. 2016a). Through deliberation, people can learn from each other and gain practice in forming reasoned opinions and evaluating arguments, resulting in new knowledge and insights (Steyaert et al. 2007). In group processes, members can express their views, reflect upon their own opinions as well as others, share experiences, and engage in meaningful debate (Kenter et al. 2016a). The DVF approach integrates deliberation with structured valuation to inform both individual values and group values (Kenter et al. 2016a). The model is based on an understanding of shared values, or those values held in common as communities, societies, and cultures (Kenter et al. 2015). The model has been tested in studies focused on monetary valuation and ecosystem services (Kenter 2016, Kenter et al. 2016b), as well as deliberative decisionmaking by communities for marine-protected areas (Ranger et al. 2016). Although different, these studies all showed the emergence of shared values among deliberative groups. DVF has not been tested in the NWFP area to date, but represents a promising approach, particularly given the preponderance of collaborative groups engaged in shared learning about resource management, discussed later in this chapter.

Each of the approaches described above and presented in table 9-1 have potential value or application to attempts to manage resources in the Plan area. Some approaches, such as LVM, which highlights the public's connection to landscape and places at various scales, have already been used extensively in the Plan area, as this chapter describes below. We note later in the chapter that longitudinal social values data for the Plan area would be useful for understanding if or how the social context may be changing since the inception of the NWFP. Approaches that use surveys to measure value orientations and a sampling scheme that allows for a representative sample would illuminate the range of value orientations throughout the Plan area and enable comparisons between urban and rural communities, among different counties, states, or subregions, or by demographic factors.

The diversity of stakeholder values, attitudes, and preferences associated with land management are a source of ongoing difficulty for resource managers. Assessing the range of social values orientations and attitudes toward forest management goals held by the public and how these values may be changing is important to inform resource management decisions. Yet, as studies have shown, stakeholders can share common attitudes or beliefs, but possess different sets of values, while some constituents who disagree about forest management practices may share common values. The relation to place can be a factor, as studies have shown differences in attitudes among stakeholders who have a specific knowledge or keen interest in a particular ecosystem, place, issue, or activity (Ford et al. 2009, Seymour et al. 2011). Understanding the relation between values and attitudes and behaviors will help resource managers understand the implications of actions and decisions on various stakeholders.

Changing relationships to the landscapes and resources in the NWFP area—

Over the past 12 years, very few studies have been conducted in the NWFP region that relate to environmental values, attitudes, or beliefs about forest management practices. National studies in value orientations and environmental attitudes demonstrate a shift away from commodity values and toward a mix of resource production and protection (commodity and noncommodity), sometimes referred to as "green drift" (Klyza and Sousa 2010, Sousa 2011). Few such studies have been conducted in the Plan area in recent years, and those that have been published are summarized below.

Beliefs about the ecological value of old-growth forests began to change in the 1970s as new science revealed important information about forest structure and composition (Spies and Duncan 2012). Steel et al. (1994) compared Oregon residents (n = 872; 75.7 percent response rate) with a national sample (n = 1,094; 68.4 percent response rate) to understand value orientations and attitudes toward forest management. The study found that respondents both in Oregon and the national sample held biocentric values more so than anthropocentric values. The study also found that respondents in the national sample held stronger biocentric views compared to Oregon residents. In other words, overall, the U.S. population leaned more toward valuing nature for the sake of nature than valuing the human use of nature. The study also found that the national sample universally opposed traditional resource management (regardless of values orientation), whereas in Oregon, primarily those with biocentric orientations opposed traditional forest management practices while those with anthropocentric values were more likely to favor policies that promote jobs and rural communities (Steel et al. 1994). These studies show that regional differences in value orientations exist.

Another study in the NWFP area showed that variations can exist at the county level. Dietsch et al. (2016) explored wildlife conservation values in Washington state (n = 4,183) in relation to wolf management. The goal of the study was to understand the relationship between modernization (urbanization, wealth, and education) and wildlife value orientations. Wildlife values were measured on a scale that examined degrees of mutualism (prioritizing the needs of wildlife) and domination (prioritizing human needs). The study found a positive association between modernization and mutualism and a negative association between modernization and domination at the county level, but variations existed among counties, with some areas exhibiting more domination values and others with a mix of values. This implies that setting influences values. In particular, counties in northwest Washington had a higher prevalence of mutualism than other regions, with the exception of one county (Shelton), which had a lower level of mutualism. Meanwhile, counties in eastern Washington had the lowest support for mutualism. Yet, one county in eastern Washington had strong support for mutualism, demonstrating that variation is not entirely based on regional setting. These results suggest that a variety of value orientations exist throughout the region.

In 2013, the Oregon Values Project, cosponsored by Oregon State University, surveyed more than 9,500 Oregonians about their beliefs related to various issues, including the environment (DHM Research 2014). Study results have not been published in peer-reviewed journals, and it should be noted that no response rate was reported and a quota sampling scheme was used (DHM Research 2014). Survey results indicated that 57 percent of Oregonians believe that environmental protection should be prioritized even at the risk of slowing economic growth, although there were variations statewide with 62 percent of metropolitan Portland respondents favoring environmental protection, compared to 50 to 54 percent in other parts of Oregon. Statewide, 35 percent said that economic growth should be given priority, even if the environment suffers. Responses also varied regionally, ranging from 30 percent in metropolitan Portland to 49 percent in eastern Oregon. Again, these results show variation in conservation attitudes among regions within a state. The study also inquired about support to increase timber harvests in forest stands that were described as "dense and overcrowded." Statewide, 53 percent were in favor of timber harvest in overcrowded stands, but responses ranged with less support from Portland (48 percent) and more support in other parts of Oregon (60 to 67 percent). It is possible that the wording of this question, framing the forests as "overcrowded" influenced responses. Still, findings suggest uniquely rural and urban patterns in values related to the environment.

One study in the NWFP area investigated public attitudes toward policies that favor environmental preservation or economic opportunity on public lands. Williams et al. (2017) explored public attitudes toward forest management in the Mount Baker–Snoqualmie National Forest, an urban-proximate forest in the northwest Cascade region. Respondents (n = 1,796) participated in an online survey and in community workshops, answering a series

of questions about the importance of 26 forest management goals on a five-point scale. Water quality, wildlife habitat, clean air, aesthetics, and human-powered recreation were in the top five management goals, compared to wood (ranked 18th), energy (19th), and mining (24th). The study found few significant differences in management preferences between rural, suburban, and urban respondents. In a different study, which also featured a participatory mapping component identifying special places and resource interactions, responses of urban and rural residents were compared (McLain et al. 2017a). The study found that special places identified by urban residents were scattered throughout the entire national forest, while rural residents identified special places close to home. Resource uses among urban and rural residents were largely similar; however, rural residents were more likely to use the area for hunting and gathering foods, while urban residents were more likely to engage in active recreation (McLain et al. 2017a). While this study did not explore values, the results suggest different orientations to forests and their use.

Landscape values mapping and public participation geographic information systems (PPGIS) have been used to understand public values in the NWFP area. Brown and Reed (2009) used random household surveys of area residents to explore landscape values using a 13-item scale in three Oregon national forests in the Plan area: Deschutes/Ochoco (n = 1,916; 11.8 percent response rate), and Mount Hood (n = 1,350; 11.4 percent response rate). Based on the frequency of responses, they found the top five values to be consistent in all three forests: developed recreation, primitive recreation, aesthetic, wilderness, and biodiversity. Economic values were ranked seventh (Deschutes/Ochoco) and eighth (Mount Hood) (Brown and Reed 2009).

McLain et al. (2013a) studied landscape values for residents of Washington's Olympic Peninsula using a community workshop approach that included 169 respondents who were recruited using key informants and a snowball approach. Eight community workshops were held. Collectively, respondents identified 880 mapped places and labelled each with a primary landscape value from a list of 14. The most frequent "primary" landscape value assigned was **recreation** (56 percent), followed by **economic**, **aesthetic**, and **home**. When secondary values were combined with the primary values, recreation remained the most prominent value, followed by aesthetic and economic (Cerveny et al. 2017). These results suggest a balance of commodity and noncommodity values associated with this particular region.

We also looked at studies conducted in regions adjacent to the Plan area to understand values, attitudes, and beliefs. Hamilton et al. (2012) conducted a household survey of 1,585 northeast Oregonians and compared findings to a national sample (no response rates reported.) Although outside the Plan area, these results provide some insight into the views of rural residents in other parts of the state. This study asked respondents to rank management goals and found that northeastern Oregon residents were more likely than Americans nationwide to prioritize jobs and "use of forest resources" over resource conservation. Respondents also were more likely than the national population to believe that conservation practices and environmental rules that restrict development had negative effects on their local community. Moreover, in prioritizing a list of environmental problems facing their community, northeastern Oregonians identified "forest jobs" over a multitude of resource issues, including wildfire, insects, population growth, forest fragmentation, global warming, and overharvesting (Hamilton et al. 2012). Working in the Inland Northwest region, which includes eastern Oregon, Nielsen-Pincus (2011) conducted a household survey (n = 767) that also used an LVM approach to explore values attached to public lands. The study determined that the most important values were recreation, aesthetic, and economic. These results are similar to those found by McLain et al. (2013a) and demonstrate the mix of values that acknowledge forests for their recreation and scenic benefits, but also value income and employment opportunities associated with forests.

Changing relationships to the landscapes and resources outside the NWFP area—
Changes in environmental values in the NWFP area and the Pacific Northwest may be understood in the broader context of changes in American values. In the 1990s, scholars

documented a paradigm shift in American public attitudes toward forest management away from a focus on economic values, outputs, and commodities, and toward more diverse values that include noneconomic values, especially protection of ecosystems and aesthetic values (Bengston and Fan 1999, Brown and Reed 2000, Brunson and Steel 1996, Manning et al. 1999, Rolston and Coufal 1991, Tarrant and Cordell 1997). These studies suggest that survey respondents favor a balance of protection and production in forest management. In a national study, Bengston et al. (2004) relied on computer-assisted media analysis between 1980 and 1990. The authors observed a decline in the expression of **anthropocentric** values and an increase in **biocentric** value expressions.

Shields et al. (2002) surveyed North American households and found that respondents were strongly oriented toward environmental protection, and nonconsumptive services were rated as more important than consumptive goods and services. Another study explored national forest policy decisions through the mid-1990s and noticed a shift toward greater ecological sensitivity, attributed to the success of environmental organizations disseminating information to legislators (Burnett and Davis 2002). Studies conducted in other regions of the United States, taken collectively, shed light on trends in the NWFP area, especially given the dearth of empirical studies in the NWFP area. Several studies in other parts of the country echo these national trends. Brown and Reed (2000) surveyed Alaskans and found that the most important values were aesthetic, recreation, life sustaining (ability to provide air and water), and biological. Manning (1999) found that rural Vermonters living near a national forest were more likely to identify aesthetic, ecological, and recreational values over economic values. Bliss et al. (1997) found that the public favored a balance of values but leaned heavily toward environmental protection. Collectively, these studies suggest a broader shift in American public values. Still, as Rentfrow (2010) noted, regional clusters of environmental values and beliefs exist, and caution should be exercised in conveying national trends.

A variety of studies conducted in rural, resource-dominated regions throughout the United States and Canada may shed light on value subsets of the NWFP area. It often is assumed that urban residents have a more biocentric values orientation, while residents of rural, resource-based communities are more anthropocentric. Recent studies have proven that these divisions are not clear cut. Racevskis and Lupi (2006) found that timber-dependent communities in Michigan did not uniformly fall into an anthropocentric orientation of commodity production and utilitarian use. Also, urban residents did not express a strong preference for resource protection. This diversity may be explained by inmigration of new residents with biocentric orientations into resource-dependent regions. McFarlane et al. (2011) studied forest-dependent communities in New Brunswick and uncovered a wide range of values in both rural and urban communities. Residents of forest-based communities did not always prioritize economic benefits over the natural environment, and urban communities did not always prioritize resource protection. Nadeau et al. (2008) found that urban residents in New Brunswick had strong ties to rural forest lands through family connections, woodlots, and second homes.

Amenity migration also may be associated with localized shifts in values. Jones et al. (2003) in a national study learned that urban residents are drawn to amenity-rich areas to improve their quality of life. This migration diversifies value orientations and increases potential for conflict. Smith and Krannich (2009) found more similarities than differences in environmental values among new and long-term residents in amenity-rich places in the Rockies. Fortmann and Kusel (1990) studied California communities and found that migrants to amenity-rich areas with biocentric orientations shared values with a subset of existing residents whose voices had been previously dominated by more anthropocentric views. The new arrival of urban residents led to increased conflict as long-time residents with biocentric views became more outspoken. These studies on amenity migration and shifting values present mixed results but reinforce the notion of regional variation in value orientations and attitudes. Although these studies occurred outside the NWFP area, several cities in the NWFP are facing growth in amenity migration, and results from these studies can inform our overall understanding.

Changing values around forest harvest practices— Over the past three decades, a number of studies have explored public response to forest treatments and the acceptability of various harvest practice (see Burchfield et al. 2003; Ford et al. 2009; Kearney 2001; Shindler et al. 2002, 2004). Social acceptability refers to public judgments about the appropriateness of a given management action, policy, practice, or resource condition (Allen et al. 2009, Brunson 1996). When there is a lack of public acceptance of a policy or management action, it is likely to fail or lead to conflict (Shindler et al. 2002, Wondolleck and Yaffee 2000). Social acceptability includes both individual beliefs about what is right and social norms of what is appropriate (Allen et al. 2009). Shindler et al. (2004) have identified several important themes associated with social acceptability. Social acceptability is (a) a dynamic process, (b) a result of multiple factors (ecological knowledge, prior experience, place attachment, risk perception), (c) context dependent (what is acceptable in a neighboring county may not be acceptable in my backyard), (d) process-dependent (if the process is more transparent, there is likely to be greater acceptance), and (e) based on the degree of trust among the public in land management agencies (Shindler et al. 2002, 2004).

An abundance of early research explored the scenic qualities associated with landscape treatments (See Ribe 1989 for a complete review.) This work continues with focus on alternative siviliculture treatments (Ribe 1989, Shelby et al. 2003) and scenic beauty as an indicator of social acceptability (Gobster 1996). Despite the power of visual images, judgments based on scenery can be influenced by the degree of ecological knowledge, environmental communication, and individual value orientations (Brunson and Reiter 1996). Acceptability judgments about forest harvest treatments were linked to how sites appear once practices have been implemented, how the natural characteristics of sites might change, the level of trust in information offered, perceived community benefits, and citizen engagement in the process (Olsen et al. 2012, Shindler and Collson 1998). Trust appears to be critical to social acceptability. Trust can be both broad based (trust in an agency to manage resources and serve public interests) and project based (trust that the project will not cause undue harm to the environment or change in resource use) (Ribe 2013). The public can be influenced by local political narratives and debates, perceptions of trust and justice, and fears about potentially adverse effects of management (Ford et al. 2009, Tindall 2003). Ribe (2013) emphasized that resource managers design forest treatments that express visible stewardship and public education in a way that broadens understanding of ecological aesthetics (naturalistic treatments). Existing studies about forest perceptions deal primarily with visual aesthetics and are not focused on social acceptability based on management goals, such as restoring ecosystem health.

In one NWFP study, perceptions of scenic beauty were compared among respondents grouped based on their orientation to resource conservation. Ribe (2002) used images of coastal mountain ranges to evaluate perceptions of scenic beauty as they corresponded to management acceptability among three groups: those favoring resource production, those favoring resource protection, and moderates. Respondents in Washington and Oregon (n = 1,035) rated photographic images for scenic beauty and acceptability, using fixed categories ranging from "very beautiful" to "unattractive" to label scenes based on their subjective perceptions. The authors found that all respondents (regardless of values) determined "very beautiful" scenes to be acceptable. Participants with views that favored resource production had lower standards for what is acceptable to them and what is beautiful, compared to those favoring resource protection. Those favoring resource production were more likely to perceive "unattractive" scenes as acceptable.

The potential effects of timber harvesting on ecosystems historically has been a focus of public attention and some contention in the NWFP area (Brunson et al. 1997). As Ribe (2006) observed, research on harvest practices has historically considered timber harvesting and forest preservation as two ends of a continuum (Manning et al. 1999) or positioned clearcutting against other types of forest treatments (Bliss 2000). A growing body of work has focused on what non-clearcut harvests look like and how the public responds to these treatments. New types of forestry, including ecological forestry (chapter 3 and described below) have gained momentum in the past 10 years, providing an array

of options to harvest some trees in a stand in a way that sustains ecosystem function (Franklin et al. 2007). Ford et al. (2009) provided simulations of various harvest types along with information about logging plans and outcomes in Tasmania. They found environmental value orientations to be the most reliable predictor of perceptions of acceptability, with "protectionist" respondents finding clearcuts least acceptable, and selection harvests most acceptable and "productionist" respondents having the reverse pattern.

Research has shown that clearcutting is not an acceptable management strategy for a large portion of the public in the United States (Bliss 2000), and specifically in the Pacific Northwest (Ribe and Matteson 2002). This lack of support for clearcutting was also evident elsewhere (Clement and Cheng 2011). Hansis (1995) surveyed residents of northwest Oregon and southwest Washington and found general opposition to clearcutting practices, with particular opposition by women, urban residents, educated residents, and those with a liberal ideology. Meanwhile, Ribe (2006) used photographs of forest treatments to evaluate the social acceptability of various forest treatments (19 scenarios) that included combinations of age, harvest intensity, retention pattern, and down wood level. Respondents were shown four photographs per treatment type and asked to rate treatments for scenic beauty, service to humans, service to wildlife, and overall acceptability. A survey (n = 272) of western Oregon residents was conducted with the photo elicitation. The study revealed that 9 of the 19 forest treatments were of "conflicted acceptability," including all three treatments involving old-growth forests. Results also showed widespread opposition to clearcutting and some acceptance of retention harvests and forest thinning. This methodology, adapted from Ford et al. (2007), has been used in several other studies in the Pacific Northwest, with similar results (Ribe 2009, Ribe and Matteson 2002, Ribe et al. 2013).

Meanwhile, Abrams et al. (2005) conducted household surveys (stratified random sample) in Washington and Oregon studying the relationship between self-ascribed environmental or economic priorities and two variables: the acceptability of forest management practices and perceived threats to forest heath. They analyzed surveys from 492 respondents (51 percent response rate). They found that selective thinning was generally accepted by most respondents, regardless of their prioritization of policies in favor of environmental preservation or economic opportunity. Respondents with a pro-environmental viewpoint perceived human-caused factors (overharvesting, motorized vehicle use, road building, and fire suppression) as the greatest threats. Those who supported jobs and employment opportunities over environmental preservation saw naturally occurring processes (disease, wildfires) as the greatest threats.

Olsen et al. (2012) studied public opinions of alternative management strategies in the McKenzie River watershed of western Oregon, specifically disturbance-based management (DBM). The study included surveys (n = 230) of the "local attentive public" who had shown past interest in forest management issues based on attending public meetings or other events. Overall, support for DBM was mixed in the study population. The authors found that members of the public had varying degrees of knowledge about landscape-level disturbance processes or concepts, with most having low to moderate levels. In addition, they observed low levels of confidence in the information provided by agencies, and trust levels of local officials appeared to be higher than trust levels in the agency as a whole. Study participants worried that national level policies and directives would affect their communities. They also had fears about DBM being used to harvest old-growth forests. The authors suggested that transparent decision-making processes and public engagement opportunities that feature clear discussion of the risks may increase support for forest treatments.

Although outside the NWFP, a study of perceptions in the Rocky Mountains supports this trend (Clement and Cheng 2011). In a study of three national forests in Colorado and Wyoming, the researchers found that support for mechanical thinning treatments depended largely on management goals associated with those treatments. There was support for logging when it was done to protect human life and private property, to remove dead trees or insect-infested trees, or to improve wildlife habitat. However, there was less support for logging for commercial profit or for

clearcutting as a management technique. These results are important because they emphasize the need for clear communication of management goals to public audiences.

Although few in number, these studies suggest that residents of the NWFP area embody a range of views related to the social acceptability of timber harvest and that these views are based on their values as well as connections to place. Although it appears that the public in the Plan area does not generally support clearcutting as a management strategy, there does appear to be potential for public support for alternative harvest strategies, such as DBM (Olsen et al. 2012), especially when efforts to expand public knowledge and share accurate information are included in the management effort. It also appears important that any harvest strategy avoid old-growth forests and old, large individual trees.

***Ecological forestry*—**Ecological forestry represents a recently emerging framework for attacking the "wicked problems" associated with forest conservation and management (Weber and Khademian 2008). The framework uses a systems approach that recognizes the interlinkages and mutually modifying processes among various entities to create a networked system. The framework also relies on ethical guidelines for managing forests around ecological objectives (Franklin et al. 2007). The approach recognizes forests as dynamic systems adaptive to new conditions and that exist as one part of a broader landscape that is managed (by multiple actors) to achieve various objectives (Batavia and Nelson 2016). This approach assumes a socioecological standpoint, acknowledging humans as part of the ecosystem and the need for integration of social and ecological elements.

The goal of ecological forestry is to sustain healthy and productive forests, retain native species, and provide a range of ecosystem services (Batavia and Nelson 2016). This goal is met by "managing forests in ways that bring them closer … in structure, function, and composition to healthy, natural forests at all stages of successional development" (Palik and D'Amato 2017: 51). Ecological forestry strives to mimic the effects of natural disturbance and succession processes, which includes retaining some elements of the existing stand (Batavia and Nelson 2016). Ecological forestry is based on (a) continuity of forest structure and function between pre- and postharvest systems; (b) structural and compositional complexity biodiversity, and spatial heterogeneity at a variety of scales; (c) carefully timed treatments based on understanding of ecological processes; and (d) planning forest management with understanding of the broader context at the landscape scale (Palik and D'Amato 2017).

Traditional forestry was based on utilitarian or anthropocentric views of forests as producing benefits for human use and consumption (Nocentini et al. 2017). Although research in this area is ongoing, presumably the ethic of ecological forestry would lean toward a biocentric orientation with timber output being a byproduct of more holistic landscape management. This approach also acknowledges humans as active ecosystem participants with specific wants and needs including a broad range of ecosystems services that forests provide. Batavia and Nelson (2016) argue that "ethics need to be institutionalized in the routine practice of natural resource management" (2016: 8). Ecological forestry also emphasizes the integration of social and ecological elements, which makes understanding of values, attitudes, and beliefs important. The framework recognizes the need for multiple actors to be coordinated and engaged around the task of integrating ecological, social, and economic sustainability and developing an ethical framework (Nocentini et al. 2017). Ecological forestry has been proposed in the NWFP area (Franklin et al. 2012); however, the practice has received limited testing, and few known studies, with the exception of Olsen et al. (2012), have evaluated the social acceptability or public attitudes toward these treatment practices. More work in this area is needed to understand the potential applications of ecological forestry in the Plan area.

Summary—
Differences in stakeholder values and attitudes are at the root of many forest management conflicts. Building consensus among stakeholders with different sets of values often is difficult and time-intensive. Values can change over time in response to major societal changes. Values and attitudes

differ among geographic regions, residential classifications (urban or rural), and proximity to public lands. Moreover, national values are sometimes perceived to be in conflict with local interests, which suggests the importance of understanding the multitude of values and attitudes. Findings show that the United States has experienced a measureable values shift since the 1950s that is related to a wave of policies diminishing the importance of utilitarian values and increasing the importance of experiential, aesthetic, and biocentric values. Ongoing monitoring of public values will enhance our understanding of what is important to people vested in the NWFP area. Awareness of these values shifts allows resource managers to consider public needs in planning and decisionmaking and allows managers to anticipate conflict and consider diverse communication strategies. Land managers who acknowledge the diversity of values, attitudes, and beliefs among stakeholders and socioeconomic groups at the appropriate geographic scale will be better equipped to understand characteristics of the social system and anticipate the need for change. Growing understanding of human-resource connections can strengthen relations between agencies and communities and contribute toward trust building.

Valuing Place

The NWFP's signature characteristic is its focus on ecosystem management, a management approach that is fundamentally place based (Williams et al. 2013). Place has increasingly been used as a concept in national forest planning and public engagement efforts (Farnum et al. 2005, Kruger and Williams 2007, Williams et al. 2013). The term "place" embodies both biophysical characteristics and sociocultural meanings that are critical to quality of life and social identity. This section describes current research related to place and lessons learned of relevance to forest planning and plan implementation in general, and to forest plan revisions within the NWFP area.

Defining place—

Places are not merely geographic locations but rather are produced when individuals and groups assign value or meaning to undifferentiated space (Tuan 1977). Places and the meanings that one attaches to them help people to make sense of the world and motivate the actions they take with respect to particular locales (Sack 1992). Sense of place, or "the perception of what is most salient in a specific location" (Cantrill and Senecah 2001: 187), is manifested in our views about the kinds of activities and uses we consider acceptable in that location.

The tools and conceptual frameworks for assessing and inventorying place meanings in natural resource settings are still in the early stages of development. Studies about the roles that place plays in environmental and land use management have examined the factors that contribute to the production of place (Ardoin 2014), the role of place in the formation and maintenance of self and group identities (Twigger-Ross and Uzzell 1996), the ways in which place meanings connect people to particular landscapes or ways of life (Davenport and Anderson 2005, Kil et al. 2015), and how place meanings are mobilized to support or contest land management or economic development objectives (Stokowski 2002). Places are multidimensional and produced through a melding of the individual and group histories, memories, values, and beliefs associated with a locale and its biophysical attributes (Ardoin et al. 2012, Cheng et al. 2003, Jorgensen and Stedman 2001, Stedman 2003).

It is generally understood that sense of place has three major elements: (1) a biophysical setting (array of physical features and amenities embodied in a particular place); (2) the individual meanings associated with the location, produced through a combination of individual personality traits and lived experiences; (3) and the sociocultural or shared meanings linked to that location (Smaldone et al. 2005). Of these, only biophysical features are relatively straightforward for land managers to assess and integrate into planning. Yet, the individual and cultural meanings associated with specific locations are equally important to understand if politically viable environmental policies and management actions are to be implemented under the revised NWFP or other management plans.

A place meaning is the significance that people assign to places (Davenport et al. 2010). Place meanings can be positive or negative, specific to an individual, or shared

within and across groups (Scannell and Gifford 2010). Place meanings are critically important to understanding people-place relationships, which in turn influence whether policies and management actions will have broad-based acceptance among interest groups and the general public. Assessing place meanings, however, is challenging in part because although relatively stable, they are not static as individuals and groups respond to changes in their social and physical surroundings (Smaldone et al. 2005: 397; Williams 2002: 17). Over the past decade, social scientists have developed conceptual frameworks and practical tools that managers can draw upon to understand the type and intensity of connections that different segments of the public have with places in their management jurisdiction (fig. 9-3).

Key concepts: place attachment, place dependence, and place identity—

Place researchers often distinguish between three concepts linked to the notion of place (box 2): place attachment, place dependence, and place identity, with place dependency and place identity considered subcomponents of place attachment (Anton and Lawrence 2014). Understanding the difference between these three concepts is important for resource managers because they shape how different segments of the public are likely to respond to proposed policy changes, such as revisions to the NWFP as well as proposed management actions.

Place attachment is the process by which individuals or groups become connected, whether emotionally or for instrumental purposes, to a specific geographical location

Lee Cerveny



Figure 9-3—Observing the surf from the Siuslaw National Forest.

Box 2—Key Concepts About Place

Place attachment—people develop strong connections to a place based on repeated experiences and in-depth knowledge of that place.

Place dependence—people have places they rely on to provide services and products that sustain their livelihoods or lifestyles or provide desired experiences.

Place identity—people sometimes have places that have such deep symbolic meaning (cultural, historical, spiritual) that those places help define who they are in the world.

(Scannell and Gifford 2010). For groups, place attachment is considered "a community process in which groups become attached to areas wherein they may practice, and thus preserve, their cultures" (Scannell and Gifford 2010: 2). Empirical research on place suggests that strong positive person-place bonds can motivate individuals and groups to care for, protect, and defend particular places or types of settings (Eisenhauer and Kra 2000, Kil et al. 2014, Stedman 2002). Place attachment also is important because it is sometimes associated with negative social and environmental outcomes (Lewicka 2011, Yung et al. 2003). For example, strong attachments to place may lead to intense conflict between long-time residents and newcomers who bring with them very different ideas about what uses and activities are desirable for that place (Hurley and Walker 2004). Indeed, the conflicts over timber that led up to the NWFP arguably were partly struggles between two groups with very different, but equally strong, attachments to place. Proctor (1995) described how disagreements in the early 1990s between loggers and environmentalists were linked to their very different experiences and connections with the Pacific Northwest forest landscape. A regional socioeconomic assessment of the impacts of the NWFP found that feelings of a loss of cultural identity were common among residents in rural Oregon and Washington communities that had been heavily affected by the shift in forest management practices brought about by the NWFP (Charnley et al. 2008).

Studies of place attachment among transient residents and tourists indicate that even short-term visitors can develop strong attachments to places such as seasonal homes, parks, or natural areas (Lewicka 2011). Evidence is mixed, but overall, it appears that visitors with stronger local social ties or who visit more frequently develop stronger place attachments (Lewicka 2011). People can become attached to places that they have only heard about or imagined, a concept that Kruger (2008: 2) refers to as "existence attachment." Just as people can have an "existence value" (a willingness to pay to ensure someplace exists even though they have never visited) for resources, so too can people develop attachments to places they have never visited (Kruger 2008). Attachment to places not visited has important management implications for NWFP implementation as it points to the need for land managers to take into account the place meanings of stakeholders who do not use an area, as well as those who do.

Place dependence has to do with the "importance of place in providing features and conditions that support specific goals or desired activities" (Ujang and Zakariya 2015: 712), and is related to how well the physical characteristics of a place fulfill an individual's goals and needs (Scannell and Gifford 2010). The better the conditions at a place meet a person's needs or goals, the more attached that person is likely to be to that particular location. The degree to which an individual is place dependent also hinges upon how well the quality of a place they are currently using compares with the quality of potential substitute places (Smaldone et al. 2005). However, the **meanings** associated with the physical features of a place may be what cause people to value that place rather than the features themselves (Stedman 2003). Changes in biophysical features as a result of forest management actions or policies may trigger strong negative reactions among those segments of the public for whom that particular suite of biophysical characteristics is imbued with deeper meaning.

In some circumstances, bonds to places or settings are so strong that those places become intimately bound up with the person's or group's core sense of self (i.e., personal or social identity), a phenomenon known as **place identity** (Proshansky et al. 1983). Place identity is closely linked

with the symbolic meanings of place rather than its utilitarian values and "is based on the notion that places serve various functions in identity development that promote a sense of belongingness" (Davenport and Anderson 2005: 628). In situations where the symbolic meanings of place are spiritual in nature, such places are sometimes viewed as sacred in the eyes of those for whom they have spiritual meaning. In the late 20th century, so-called old-growth forests of the Pacific Northwest became imbued with religious meaning for many Americans (Lee 2009, Proctor 2009), and efforts to protect what many people had begun to see as sacred forests arguably contributed toward policies such as the NWFP.

Droseltis and Vignoles (2010) described the distinction between place attachment and place identity, a subset of place attachment, as the difference between a place where someone feels "at home" (place attachment) and a place that one feels is a fundamental part of one's self (place identity). When individuals identify with a place or have a particularly strong attachment to it, place disruptions, or changes in the fit between place meanings and its physical and social characteristics, may lead to feelings of severe anxiety and loss (Devine-Wright 2009, Proshansky et al. 1983, Stedman 2002, Twigger-Ross and Uzzell 1996). Denial, detachment, and taking part in place-protective actions, such as forming protest groups or signing petitions against proposed changes, are among the strategies used by individuals and groups to cope with threats to place meanings (Devine-Wright 2009). The resource conflicts associated with the development of the NWFP are just one example of the intense social tensions that can emerge when place identities are threatened. Proactively identifying which places (or types of places) are likely to trigger large-scale place identity crises if they are fundamentally changed through forest management actions is one strategy that managers could use to reduce the likelihood of major land use conflicts and intense polarization. Like social identities, which are generally relatively stable but which can change under some circumstances for some individuals (Amiot et al. 2015, Carlsson et al. 2015, Cohen and Sherman 2014, Miller and Caughlin 2013, Perozzo et al. 2016), place identities tend to be stable but can change as individuals and groups have new experiences or engage in dialogue with others for whom a place has different meanings (Coen et al. 2017, Wheeler 2017).

Salience, or the "probability that an identity will be activated in a situation" (Stets and Burke 2000: 229), is an important concept in social identity theory that has implications for how place identity can provide the seed for constructive collaboration as well as conflict (Bryan 2008). Social identity is "a person's knowledge that he or she belongs to a social category or group" (Stets and Burke 2000: 225). Characterization, another important social identity theory concept, is "what an individual or group perceives another individual or group to be" (Wondolleck et al. 2003). All individuals' social identities are derived from membership in multiple categories (Stets and Burke 2000). Which social identity is salient for an individual or group depends on the social context, or the degree to which an individual perceives that a social category they have characterized themselves as fits with reality (Turner 1987). As described earlier in this section, geographical context can serve as the basis for social identity, with place identity arising from the link between groups of individuals and specific locales (Proshansky 1983, Wondolleck et al. 2003).

Social identity theory further suggests that "conflict derives in part from social group comparisons in which in-groups portray themselves (identity) more positively and out-groups (characterization) more negatively" (Bryan 2008: 54), processes known respectively as identity or characterization framing (Wondolleck et al. 2003). Identity and characterization framing can be used to describe the roles that an individual plays without assigning judgment, to draw connections with others, or to distinguish one's self or one's group from others (Wondolleck et al. 2003). The Quincy Library Group is a place-based collaborative planning group that emerged in California's northern Sierras in the 1990s in response to a major reduction in timber harvested on federal lands. The Quincy Library Group helped shift participants' salient identities from the previously conflictual identities of "logger," "environmentalist," or "Forest Service employee" to a common identity

linked to place, i.e., "resident of Plumas County" (Bryan 2008). A similar process of identity reframing where "us vs. them" moved toward "we" occurred in the Applegate Valley of southwestern Oregon during the same period (Rolle 2002).

Place-making is a political process (Manzo 2003, Yung et al. 2003) and some natural resource conflicts are as much struggles about place meanings as they are about how those resources should be allocated (Cheng et al. 2003). When place meanings are threatened by prospective land management actions, groups or individuals whose identities are tied to them may try to defend those meanings or create new ones (Hurley and Walker 2004, Manzo 2003). Through the process of place creation and maintenance, individuals and groups promote their values and beliefs about what landscapes should look like, what activities should take place where, and who belongs (or does not belong) in particular places (Cheng et al. 2003). Understanding the dynamics of the politics of place can provide managers with insights on the fundamental issues underlying natural resource conflicts and facilitate the development of natural resource decisionmaking processes that are less contested (Austin 2004, Kemmis and McKinney 2011, Yung et al. 2003).

People often use symbols, myths, and narratives as tools for supporting or resisting place claims (Cheng et al. 2003, Stokowski 2002). Such techniques typically rely on the "moral language of ecology or community" (Williams 2002: 21). To understand conflicts over place meanings—and take a step toward potentially finding solutions to those conflicts—it may be helpful to pay attention to the language and stories that different stakeholders use to create and maintain place meanings (Stokowski 2002, Yung et al. 2003). During the past two decades, collaborative forest management groups operating in the NWFP region have provided new venues where stakeholders with diverse interests can create shared meanings and common ground as to what activities are considered acceptable in particular locations (Moseley and Winkel 2014). However, Yung et al. (2003) point out that in contexts of intense resource conflict, multiple and incompatible senses of place often lie at the heart of the conflicts. In such contexts, creating shared meanings will be challenging, and in some cases, impossible. Managers may find it useful to develop the capacity to identify when collaborative management is likely to be a successful strategy for creating shared meanings and when other strategies are called for. A rich body of research on place-related concepts has emerged over the past 20 years. However, examples of how place-related concepts have informed the design and implementation of planning processes or how data regarding place meanings, attachment, identities, or dependence have been used in planning or management processes are rare.

Public participation GIS and how "place" connects to participatory mapping—

During the past decade, public participation GIS (PPGIS) has increasingly been used as an approach for collecting data about place attachment, place dependence, place identity and other place-related constructs (McLain et al. 2013b). PPGIS links computerized mapping technology with broad-based public participation processes to generate spatial data about human-environmental connections. The discussion of LVM studies earlier in this chapter focuses on how PPGIS has been used to study values. However, PPGIS can also help clarify understandings of place meanings (McLain et al. 2013b: 652). Maps created from these data show how place meanings are distributed across the landscape, and spatial analyses can help identify how place meanings are related to certain habitat types, landforms, or other biophysical features (Brown and Brabyn 2012). These tools could be useful to land managers to improve their understandings of the types and intensity of place meanings that different segments of the public associate with forested landscapes.

In the United States, PPGIS is typically structured as a data collection process, with the goal of expanding the opportunities the general public has for providing input into environmental planning processes (Brown et al. 2014). However, in some contexts—primarily in developing countries and among indigenous peoples in industrialized nations—PPGIS is structured so that mapping participants have an opportunity to design the mapping process, analyze alternatives, and empower individuals to have a voice in decisionmaking (Sieber 2006). Public participation GIS

has been used to identify places where social and ecological hotspots are co-located (Alessa et al. 2008), measure changes in place values over time (Brown and Donovan 2014), and understand place meanings associated with forested ecosystems (Gunderson and Watson 2007, Lowery and Morse 2013). However, national forests have been slow to adopt PPGIS (Brown 2012). Brown (2012) attributed the lack of interest in PPGIS on the part of the U.S. Forest Service to organizational culture and regulatory barriers, including the lack of directives calling for the collection of data on place meanings, lack of capacity within the agency to collect and analyze such data, uncertainty about whether such data are considered scientifically valid, and the difficulty of getting approval from the Office of Management and Budget (OMB) for collecting such data.

Place-based planning—

Interest in place-based planning emerged in the late 20th century as resource management shifted from single-species or dominant-use management toward integrated and holistic systems approaches aimed at managing for a diverse set of ecological and human values (Potschin and Haines-Young 2013, Williams et al. 2013). Lowery and Morse (2013: 1423) defined place-based planning as "a process used to involve stakeholders by encouraging them to come together to collectively define place meanings and attachments." Other scholars view place-based planning as a process that fosters social learning and adaptive management at the scale of the place of interest to the community engaged in planning (Cheng and Mattor 2010, Farnum et al. 2008). The degree to which place-based planning tends more toward information gathering or more toward social learning and participatory adaptive management differs considerably. Most PPGIS efforts fall into the information-gathering category (McLain et al. 2013b); forest collaborative planning processes focus more on social learning (Davis et al. 2017).

Place-based planning is site-specific and takes into account both social and biophysical contexts (Potschin and Haines-Young 2013, Yung et al. 2003). Place-based planning differs from locally based participatory planning in that place-based planning focuses around a particular geographical area or place but may include nonlocal participants, such as members of regional or national interest groups (Moseley and Winkel 2014). Yet places do not exist in isolation from each other (Flint 2013). Consequently, place-based planning must factor in the socioecological connections that link bounded places to the broader realm in which they are situated (Flint 2013). This might take the form of establishment of a regional or national group composed of participants who are also active in planning at more local levels, and which therefore provides opportunities for the sharing of planning or management priorities and socioecological knowledge across scales (Flint 2013).

Place-based planning acknowledges "the multiple relationships people have with geographic locations, relationships that encompass livelihood and economics, **and** values, symbols, emotions, history, and identity" (Yung et al. 2003: 856). To identify these multiple uses, values, and meanings, placed-based planners purposefully set up opportunities for stakeholders coming from multiple perspectives to engage in constructive dialogue with each other (Kruger 2008). Through the conversations that take place between stakeholders, place-based planning reveals the diversity of meanings that people attach to different parts of the planning area. Moreover, through dialogue about those place meanings, participants can engage in place-making, which in some situations may enable them to create a "shared image of place" (Patriquin and Halpenny 2017: 5). Even when place-making is not the goal of place-based planning, knowledge of which meanings are associated with which geographic locations can help managers identify when proposed management actions are likely to be contentious and how management actions might be structured so as to minimize the likelihood or intensity of conflict (Yung et al. 2003). It is important to recognize that the participatory nature of place-based planning will likely create expectations among the public that their recommendations will be incorporated into decisions; these expectations need to be acknowledged and managed (Bruña-Garcia and Marey-Pérez 2014, McCall 2003).

Cheng and Kruger (2008) describe a place-based planning project on the Grand Mesa, Uncompahgre, and Gunnison National Forests in which a multi-stakeholder participatory mapping approach was used. The working

groups first expanded the range of management options on the table by developing thematic landscape units, categories of land that included a much broader set of values and uses than were included in the forests' traditional management units. The thematic units were places that participants identified as being significant for a combination of social and ecological reasons, and which took into account the special or unique features of those areas as well as future conditions participants envisioned for those parts of the landscape. The themes varied from natural conditions only to permanently altered areas. Maps were used as a starting point for dialogue, and mapping exercises were structured around stakeholder-derived categories, which revealed interdependencies in uses and values at landscape scales (Cheng and Kruger 2008). Although the process provided opportunities for social learning, some stakeholders felt that meaningful participation was hindered by the management framework imposed by the U.S. Forest Service. Moreover, the use of technical language during the meetings functioned as a barrier to widespread participation. And, some stakeholders accustomed to issues-based planning resisted the idea of place-based planning (Cheng and Mattor 2010).

Issues-based planning focuses attention on outputs of individual uses (i.e., timber production, wilderness, recreation, wildlife habitat), and stakeholders organize their participation in planning around "protecting and increasing the output of their favored uses while opposing the output of other uses that are perceived to interfere with their own uses" (Cheng and Mattor 2010: 397). In contrast, place-based planning focuses on acquiring a broad-based understanding of the meanings associated with particular parts of the landscape and managing so as to maintain or create a particular sense of place (Cheng and Mattor 2010). Presumably through the process of place-based planning, participants revise their expectations as to what outputs can be derived from the planning area. However, a report on forest restoration occurring as a result of the Quincy Library Group planning process mentioned earlier in this chapter found that timber production goals fell short of what the timber industry participants in the group had hoped to achieve (Pinchot Institute for Conservation 2013). A more detailed discussion about the challenges of place-based collaborative planning is provided later in this chapter.

Another challenge associated with place-based planning is the difficulty in scaling locally successful planning processes up to regional and national scales (Potschin and Haines-Young 2013). Moreover, local-level data required for planning are often inadequate or unavailable (Potschin and Haines-Young 2013). Additionally, place-based planning can be costly in terms of the time and resources needed to involve a diverse set of stakeholders in deliberative planning processes over a sustained period (Cheng and Mattor 2010). In the NWFP area, the most salient examples of place-based planning are the forest-level collaborative planning groups that have emerged since the mid-1990s (Moseley and Winkel 2014). Many of these collaboratives emerged out of a desire to find common ground through creating a shared sense of place, partly as a means to reduce tensions perceived as unproductive. The collaboratives and their relationship to the NWFP are described in greater detail later in this chapter.

Studies about place in the NWFP region—
We located several studies that focused on or incorporated elements of place and place-based planning from the NWFP area conducted since 2003. Using a psychology-of-place approach, White et al. (2008) looked at the relationship between place identity and place dependence on visitor perceptions of ecological, social, and depreciative impacts (i.e., littering, vandalism, dumping garbage) linked to recreation activities in the Molalla River Corridor Recreation Area and Table Rock Wilderness in western Oregon. They also looked at the relationship between the length of time visitors had been coming to the area and the intensity of their place identity and place dependence. They found no association between place identity or place dependence and perceptions of recreation-linked social, ecological, or depreciative impacts. However, individuals who had been coming to the recreation area longer had higher levels of place identity and, to a lesser extent, place dependence. Specifically, White et al. (2008) found that visitors' sense of place identity increased by 7 percent on the five-point scale used in the interviews for every additional year they had been coming to the site. One important implication of this study for forests in

the NWFP area is that longer term recreation users (and likely other types of forest users as well) are likely to have stronger attachments to particular locations, and are likely to react negatively to any management actions that change those places unless they have a voice in the planning processes that lead to those changes.

Rudestam (2014) examined links between sense of place, regional identity, watershed perceptions, and water-use behavior in the Willamette River basin. She found that landowners consistently described the water supply as being limited and scarce, belying the region's reputation for excessive rain. Although most interviewees articulated deep connections to water in the Willamette basin, few were willing to change their water-use behavior. A take-home lesson for planners is that strong place attachments are not necessarily associated with actions that improve the ecological conditions at a particular location, and that other incentives may be required to encourage ecologically beneficial behaviors.

Cheng and Daniels (2003) looked at how geographic scale and ways of knowing about watersheds are linked in place-based collaborative planning venues in the McKenzie River valley. They found that participants in the watershed group working at a smaller geographic scale were much more place oriented than their counterparts that covered a larger area. They concluded that people know places in multifaceted ways, and the scale at which a collaborative group operates affects place knowledge. However, because participants differed between the two groups, the extent to which the study's observed differences in place orientation can be attributed to scalar differences rather than differences in participants is unclear.

One of the challenges of place-based planning is the mismatch between traditional administrative boundaries and the way in which people inhabit places. Farnum et al. (2008) describe an effort by the Willamette National Forest to develop a set of place-based planning units corresponding to three geographic scales: an overarching "social resource unit" made up of three "human resource units," each of which in turn was composed of several "community resource units." The project was undertaken as a proactive step toward identifying community priorities, but the data and analytical tools it produced were never integrated into the forest's planning or assessment processes. The authors attribute this to a combination of factors, including managers' reluctance to accept anthropological data as "scientific," loss of support for the project owing to leadership turnover, and the lack of planning directives calling for this type of analysis. Brown and Reed (2009) also identified a serious gap in the U.S. Forest Service's capacity to incorporate data about place meanings into its planning processes. Given that place meanings can significantly affect whether forest policies and management actions are viewed as socially acceptable, filling this gap in agency capacity would be one way to reduce controversy and build stronger partnerships and collaborations. The discussion of agency capacity in chapter 8 helps to illuminate the challenges and opportunities that exist to build partnerships.

McLain et al. (2013a, 2017b) conducted a study that mapped meaningful places on the Olympic Peninsula. The authors found that east-side residents on the Olympic Peninsula differed noticeably from west-side residents in how they mapped their meaningful places (McLain et al. 2013a). The west-side residents drew much larger polygons, often covering entire watersheds, while east-side residents typically used smaller polygons, points, or lines, to mark places. The authors speculate that the differences in the sizes and shapes of meaningful places reflect differences in how the two groups connect with and use the landscape, as well as topographical differences. The mapping study also revealed social identities linked to residents' relationship with place, particularly in the western part of the peninsula, which has historical roots in the timber industry (McLain et al. 2017b).

Todd (2014) collected data on meaningful places from Olympic Peninsula visitors. Intercepts were done at major trails, campgrounds, and visitor centers as well as on the ferries. Todd's research showed that the visitors' meaningful places tended to be located in Olympic National Park. In contrast, the places marked by residents in McLain et al.'s (2013a) study were heavily concentrated on the Olympic National Forest or on state trust lands. Todd also found that less-frequent visitors tended to map fewer places, and the places they mapped were generally limited to the major

tourist destinations. More frequent visitors and locals mapped more places and covered a broader geographic range. These results suggest differences in stakeholder connections to the area based on visitation frequency and residency.

McLain et al. (2017a) explored special places and associated resource uses on the Mount Baker–Snoqualmie National Forest as part of a study in support of travel management planning (USDA FS 2015c). Among other findings, this study showed that special places for rural residents tend to be more concentrated close to home, while urban residents identified special places with more geographic diversity. Resource uses were similar between urban and rural residents, with hiking being the predominant activity; however, urban forest visitors were more likely to engage in strenuous recreation (mountain biking, backpacking, climbing) while rural residents were more likely to be involved in hunting and berry picking, which are important both for food, lifestyle, and recreation (McLain et al. 2017a).

The projects by Farnum et al. (2008), McLain et al. (2013a, 2017a), and Todd (2014) resulted in the development of methods useful for identifying the range of ways that people connect with particular landscapes, information that can help guide forest planning and management actions. However, the process by which this information is then considered and incorporated will ultimately determine whether tradeoffs are acceptable and conflict minimized. Todd (2014) showed that residents and visitors have very different relationships to their landscape, underlining the importance of ensuring that efforts to inventory place meanings are structured in ways that capture place meanings from a broad spectrum of forest users. Moreover, McLain et al. (2017a) noted differences in landscape connections between urban and rural stakeholders.

Brown and Reed (2009) observed that differences in locations of special places differed depending on familiarity with the forest, whether the respondent worked in the forest products industry, and membership in an environmental organization. They concluded that the location of special places differs by subgroups, and recommended the use of multiple data collection approaches (Internet, mail survey, meetings). Barriers they identified to the use of LVM in forest planning included (a) lack of directives specifically mentioning collecting data on landscape values and special places, (b) costs associated with conducting surveys, (c) difficulties with getting approval from the OMB to administer surveys, (d) unfamiliarity of Forest Service personnel with this approach, and (e) uncertainty about whether LVM data will stand up in court.

Regional studies of place and place-based planning— Given the small number of studies falling within the NWFP area, we also examined studies that took place in the broader region. These include one study from eastern Washington, one from the region where Idaho, Oregon, and Washington intersect, and one from the Sierra Nevada region of California.

Nielsen-Pincus et al. (2010) drew on psychology of place theory to examine whether place identity and place attachment differed between local and absentee property owners in three rural counties in northeastern Oregon and northern Idaho. They found the models could not distinguish between place dependence and place attachment and concluded that at landscape scales, the two may be indistinguishable. Their study also showed that place identity was slightly stronger among local landowners when compared with absentee landowners, but not enough to be meaningful. Findings suggest that place identity is likely more influenced by self and social identity than by day-to-day experiences. For place attachment, their analyses showed that the number of months spent in the place each year was more important than the amount of time spent in residence. This study points to the value of ensuring that planning processes are structured in ways that include long-term seasonal residents, as well as year-round residents.

Donovan et al. (2009) captured the full range of landowner and stakeholder views about the landscape in the Palouse region of eastern Washington, and overlaid the resulting maps on ecological and land cover GIS layers. They asked participants to assign one value to each mapped location, but found that participants resisted this restriction, wanting to assign multiple values, which is consistent with previous findings, that multiple factors draw people to a place (Cerveny et al. 2017, McLain et al. 2013a). The values mapped fell into two distinct clusters: (a) historical/cultural/agriculture/private land; and (b) outdoor recreation/natural

diversity/scenic views. Donovan's study points to the importance of using methods that can capture and adequately describe a range of place meanings. Practically, this implies that few places have just one meaning, even for individuals, and that it may be the suite of meanings that needs to be maintained in order for management actions to be socially acceptable, rather than just a dominant meaning.

Brown (2013) piloted a Google Maps™ values mapping application on the Sierra, Sequoia, and Inyo National Forests in northern California, using both a LVM survey and volunteered data. Outreach targeted diverse stakeholders, including a conservation group, forest industries organization, and resource managers. Brown et al. (2014) also asked respondents to map acceptable and unacceptable forest uses. Comparing survey data from randomly selected households with Web link respondents, Brown et al. concluded that the volunteer-Web mappers had mobilized to ensure that their values were strongly represented, concluding that PPGIS practitioners should not assume that the data received through open Web links are representative of the general public's views (Brown 2013, Brown et al. 2014).

Collectively, these studies have important implications for forest plan revisions in the NWFP area and subsequent implementation: (1) place meanings are likely to differ for different subgroups of the public (i.e., visitors, residents, rural, urban), (2) methods used to collect place-related data differ in terms of the types of publics that they are likely to reach, (3) use of multiple data collection approaches can help to diversify participation, which allows a broader range of place meanings to emerge, (4) institutional barriers exist within the Forest Service (and likely within other land management agencies as well) to the collection and use, and long-term storage of social science data, and (5) challenges in the agency's ability to collect and use place-based data may hinder the agency's capacity to develop socially acceptable policies, plans, and management actions.

Summary—
People have the capacity to derive symbolic meanings and develop emotional ties with outdoor places. Place meanings, whether derived through stories, histories, or experiential knowledge, have implications for forest ecosystem management. The positive power of place motivates people to engage in forest stewardship projects, planning processes, and collaborative groups. The variety of place meanings held by diverse stakeholders suggests the need for broad-based public engagement processes. Because place meanings are dynamic and constantly being renegotiated, a public engagement process that emphasizes multiple ways of gathering information about place meanings and that is deliberately designed to reach out to a broad spectrum of the public is far more likely to capture the range of meanings than processes that rely on only one approach.

Cultural Ecosystem Services

Ecosystem services describe the wide range of benefits that forests and landscapes provide to people and that help to sustain human life (Brown et al. 2007). Ecosystem services provide a comprehensive and holistic framework for considering and evaluating multiple resource benefits (MEA 2005). The significance of ecosystem services for resource governance in the United States is becoming increasingly evident. A presidential memorandum issued in 2015 directs all federal land managers and regulatory agencies to use an ecosystem services framework for planning, policymaking, and decisionmaking (OMB 2015). Consideration of ecosystem services also is mandated in the national forest planning process under the 2012 forest planning rule (USDA FS 2012). Ecosystem services is a category for consideration in the forest assessment phase, although studies of early adopter forests demonstrate an uneven treatment of the ecosystem services principles (Ryan et al., in press). For more discussion of ecosystem services, see chapters 8 and 12.

Key concepts—
The Millennium Ecosystem Assessment (MEA) defined cultural ecosystem services as "the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences" (MEA 2005: 5). Many of these human benefits are intangible, such as spiritual benefits, cultural benefits, symbolic benefits, or heritage benefits

(de Groot et al. 2010, MEA 2005). Cultural ecosystem services are the products of people's interactions with landscapes and ecosystems (Chan et al. 2011, Fish et al. 2016). They are shaped by direct human perceptions and senses (Braat and de Groot 2012) and are further shaped by human values, norms, and beliefs (Fish et al. 2016). Cultural ecosystem services can inspire "'deep attachment" between communities and landscapes (Chan et al. 2011) and serve as points of entry for public involvement processes related to ecosystem management (Daniel et al. 2012).

Cultural ecosystem services (also referred to as "cultural services") have proven to be challenging to operationalize and measure (Hernández-Morcillo et al. 2013). Analysis of cultural ecosystem service indicators has found that some are more readily captured, such as education and recreation, while others are more difficult to quantify or are often conceptualized inconsistently (de Groot et al. 2010, Hernández-Morcillo et al. 2013). Efforts to assign value to both tangible and intangible aspects of cultural services have been fraught with challenges; new methods of operationalizing cultural services are sought (Daniel et al. 2012, Hernández-Morcillo 2013, Plieninger et al. 2013). Cooper et al. (2016) observed that aesthetic and spiritual values are frequently mentioned in MEA reports as important, but there has been very little research to explore how these values may be best characterized, operationalized, quantified, or measured (fig. 9-4). Cultural services are rarely considered in ecosystem



Keith Routman

Figure 9-4—Dawn on the Hoh River, Washington.

services assessments, or if they are included, they often are given a cursory treatment (Feld et al. 2009). Some cultural services are considered vague and difficult to capture or quantify. And, cultural services are not always singular, but are intertwined or "bundled" with other services. As Klain et al., 2014) noted, Pacific salmon have cultural value as well as provisional value to Northwest coast indigenous people. They can be quantified based on price, but this ignores the spiritual value of salmon (Klain et al. 2014). Because of the lack of conformity of cultural services to a reliable metric, there has been a tendency to relegate cultural values to an afterthought, which has impacts for stakeholders who rely on ecosystems for a variety of cultural benefits (Chan et al. 2011). New studies are investigating ways to capture cultural services (Bryce et al. 2016, Daniel et al. 2012). Cultural services should not be overlooked because they play an important role in building public support for ecosystem management (Plieninger et al. 2013). An analysis of ecosystem services that does not fully maximize the measurement of cultural services is incomplete.

Managing for cultural services—

The MEA framework provides a useful template for land managers to consider the vast array of ecosystem benefits and to prioritize benefits for their management unit. The identification of cultural services as a critical component of that framework encourages even greater attention to the less "tangible" benefits associated with forest ecosystems, which often get overlooked in the planning process or when identifying forest management objectives and targets. The research on cultural services is emerging, and there have been some attempts to develop a management framework (see Fish et al. 2016).

Several studies have explored how PPGIS can be used to explore cultural services for use in land and resource planning (Brown and Fagerholm 2015, Brown et al. 2012, Bryan et al. 2010; Klain and Chan 2012, Plieninger et al. 2013, Raymond et al. 2009, Sherrouse et al. 2011). Mapping stakeholder preferences provides understanding of how cultural services attach to places on the landscape (Fagerholm et al. 2012). Klain et al. (2012) found that it was much more common to identify areas that were associated with tangible values (recreation, cultural heritage, aesthetics) than intangible values (spiritual, sense of place, identity). Recreation values are often associated with developed recreation facilities, just as cultural heritage values can be evaluated by the number of heritage sites in a landscape and scenic areas can be used as a proxy for aesthetics. However, it may be more difficult to operationalize concepts like "social identity" or "sense of place," which are typically measured through qualitative investigations. More research is needed to understand the distribution of cultural services across landscapes and implications for resource managers. Potentially, PPGIS would be useful to explore cultural services spatially.

A useful framework for investigating cultural ecosystem services was developed by Fish et al. (2016), who created four categories of cultural ecosystem services: **environmental spaces** (localities, places, landscapes where people and nature interact); **cultural practices** (symbols, signs, interpretation, and other expressions about the relations between people and nature); **cultural benefits** (areas where human health and well-being are linked to interactions between people and forests, such as spirituality, inspiration, freedom); and **cultural goods** (or services), where the interaction between people and nature result in market transactions or other exchange that results in income or other benefit (e.g., guiding, tourism, sporting events, festivals). This framework may be useful for exploring the diverse human connections of forests in the NWFP area.

The Forest Service has begun to use an ecosystem services framework to describe forest values (monetary and nonmonetary) provided by public lands (Deal et al. 2017). Forests using this framework have found it helpful to identify relevant ecosystem services for their forest, assess tradeoffs among services associated with proposed forest treatments and management activities, and engage partners who share mutual benefits from particular services (Deal et al. 2017). Several projects in the NWFP area incorporated an ecosystem services framework as a way

to assess benefits, develop metrics, and monitor outcomes for a particular planning area (Deal et al. 2017, Smith 2014, Smith et al. 2011). One project in the Big Marsh area of the Deschutes National Forest emphasized the tradeoffs between water quality, aquatic habitat, recreation activity, and mushroom harvest, to name a few (Smith et al. 2011). Another project involving active forest management on the Williamette National Forest engaged tribes to identify values associated with timber harvest, cultural heritage, recreation, wildlife, water quality, and harvest of special products (i.e., huckleberries, beargrass).

Two empirical studies explored public perceptions of ecosystem services in the NWFP area. Asah et al. (2012) investigated how people identify and construct forest ecosystem services in Deschutes County, Oregon. Results revealed that the public view of ecosystem services is similar to the MEA framework, with some notable differences. Although this framework categorizes mushroom picking and Christmas tree harvest as "provisioning services," local residents view these both as provisioning and cultural services, providing opportunities to nurture social relationships and develop forest connections. The study also revealed that respondents viewed the national forest lands as both a source of affordable housing (temporary residence) and as a hedge against urban sprawl (Asah et al. 2012).

In a related project, Asah et al. (2014) investigated perceptions of ecosystems benefits by the Confederated Tribes of Warm Springs. Respondents emphasized both provisioning services (especially fish, game, and plants) and cultural services (especially spiritual, aesthetics, and place attachment), with less attention to regulating and supporting services (Asah et al. 2014). They also described direct and indirect connections between provisioning and cultural services, whereby the gathering of provisions provides an opportunity to solidify ties among tribal members and strengthen intergenerational connections. Tribal members emphasized items as cultural services that are not featured on the original MEA list, including sense of place, sense of community, and political license to exercise historical tribal rights (Asah et al. 2014). More research in the NWFP area is needed to understand public perceptions of cultural services. Chapter 11 addresses many of the cultural aspects of forests and landscapes for American Indian tribes in the NWFP area.

Finally, in a study described earlier, Williams et al. (2017) used principal component analysis to create bundles or clusters of management preferences for residents of northwest Washington (n = 1796). Respondents were asked to evaluate the importance of 26 management preferences for the Mount Baker–Snoqualmie National Forest. The authors revealed six preference bundles: environmental quality, utilitarian, heritage, general recreation (hiking, scenic viewing), specialized recreation (mountain biking, equestrian, winter), and access/roads. The bundles were fairly consistent across sociodemographic categories and residential classifications (rural, suburban, and urban). Notably, some management preferences did not bundle, including nature study and food/fuel gathering. These bundles roughly coincide with the ecosystem service items described in the MEA (MEA 2005).

Summary—

Ecosystem services, and cultural services in particular, could be a very useful framework for land managers in the NWFP area to consider the diversity of spiritual, aesthetic, recreation, heritage, discovery and learning, and therapeutic benefits associated with forest settings. Currently, the agency emphasizes one aspect of cultural services, recreation benefits, which are discussed below. Recreation is quantifiable and measurable within standard agency practices. Also commonly considered are scenic resources and heritage sites, although budgetary and personnel constraints limit these functions. Other aspects of cultural services, like spirituality, solitude, wilderness therapy, and education, are managed but not actively tallied, which is a missed opportunity. A growing emphasis on cultural ecosystem services will allow resource managers to recognize the various benefits associated with a forest and stakeholder attachment to sets of benefits. The ecosystem services framework can be useful in identifying and measuring a full range of benefits and values assigned to forests and landscapes.

Outdoor Recreation

This section focuses on how society uses forests generally, and specifically within the NWFP area, for outdoor recreation and leisure. It addresses trends in who is recreating on forests and what they are doing, how technology and changes in leisure time are changing recreation patterns, and recreation sustainability.

Recreation is viewed as an important forest benefit and is a critical component of the cultural services model. Hiking, camping, and nature study are important activities that allow people to experience the benefits of forests (de Groot et al. 2006). Additional forest benefits include mental health and well-being, aesthetic encounters, cognitive development, and others (Chan et al. 2011) (fig. 9-5).

Recreation benefits of parks, forests, and public lands have been widely recognized (Nielson et al. 2007, Stein and Lee 1995). Numerous studies acknowledge the positive effects of nature exposure to human health and well-being (Bowler et al. 2010; Hartig et al. 2003, 2011; Karmanov and Hamel 2008; and others); and green spaces are important venues for promoting exercise that leads to improved health (Henderson and Bialeschki 2005). Recreation use is facilitated by the presence of built amenities (Donovan et al. 2016) and access, but also depends on ecological factors (Fuller et al. 2007). Various monetary and nonmonetary approaches have been used to characterize recreation values, most of which rely on knowing frequency of visitation, intensity of use, and visitor recreation spending (Stynes 2005).

Lee Cerveny



Figure 9-5—Hiker in the Mount Baker–Snoqualmie National Forest.

The 20th century was a prolific period for recreation research and assessment, especially in the latter half of the century, which saw the establishment of the Outdoor Recreation Resources Review Commission in 1958, as well as the establishment and findings of the President's Commission on Americans Outdoors in 1985. In the 21st century, the Federal Interagency Council on Outdoor Recreation, established in response to the America's Great Outdoors Report, continues the coordinated, multi-agency effort to better understand recreation and its management. Management issues and challenges faced by all of the federal land agencies have been the focus of recreation research over the past several decades. However, the National Park Service and the U.S. Forest Service's National Forest System (NFS) have received the greatest research attention. This section will draw primarily on research in the Pacific Northwest on national forest lands, but will also include broader studies of recreation trends and recreation behavior elsewhere in the United States and on other public lands.

Trends in outdoor recreation and visitation to national forests in the NWFP area—

The degree to which Americans are recreating outdoors generally, and on federal public lands specifically, has been the source of discussion in mainstream books, such as *Last Child in the Woods* (Louv 2005), as well as scientific literature (Pergams and Zaradic 2008, Stevens et al. 2014). Special attention has been given to the extent to which youth are recreating in nature and the implications for future attitudes about natural resources and recreation use. Although some (Pergams and Zaradic 2008, Stevens et al. 2014) contend that outdoor recreation on public lands has been declining, a number of researchers have disputed that notion, suggesting instead that visitation is flat to slightly increasing (Jacobs and Manfredo 2008; Larson et al. 2011; Siikamaki 2011; Warnick et al. 2010, 2013).

Visitation levels—

Studies based on data from the National Survey on Recreation and the Environment in the United States have found that the percentage of the population participating in outdoor recreation on public and private lands has remained relatively flat in recent years and is projected to remain that way in coming decades (Bowker et al. 2012, Cordell 2012, White et al. 2016). Future increases in the total U.S. population will overcome the steady, or even slightly declining, participation rates, so the total number of people recreating in the outdoors is projected to increase over time (Bowker et al. 2012). If potential climate changes are also considered in those projections, participation rates for undeveloped skiing and snowmobiling are projected to decline by 6 percent and 18 percent, respectively, but the general projection of greater number of participants in the future remains largely unchanged nationally. Within specific regions (e.g., the Northeastern United States), the effects of climate change on recreation use may be more pronounced, and the number of participants in some regions may decline markedly (Bowker et al. 2012).

Activities such as viewing nature, visiting developed sites (which includes developed-site camping and picnicking), and visiting interpretive centers are projected to have the greatest numbers of participants across the Nation (each having more than 200 million participants) in 2030 (Bowker et al. 2012, Cordell 2012, White et al. 2016). In addition, more than 100 million people are projected to participate separately in hiking, visiting primitive areas (primitive camping, backpacking, visiting wilderness areas), and birding. As is the case presently, most future participants in outdoor recreation are expected to be participating in general activities, such as hiking, picnicking, or viewing nature. Participation in specialized activities like undeveloped skiing (10 million participants), motorized snow use (11 million participants), horseback riding (16 million participants), and challenge activities (e.g., rock climbing—25 million participants) is projected to continue to be small in 2030 relative to participation in general activities (Bowker et al. 2012, White et al. 2016).

Long-term assessments of recreation use and activity patterns are made difficult by variations in measurement systems and the missions and monitoring resources of federal land management agencies. The National Visitor Use Monitoring (NVUM) program, used by the NFS to monitor recreation, has been in place since 2000, although pilot testing on some national forests started in 1996. Estimates of recreation use under NVUM are not

comparable to estimates under prior recreation monitoring systems used by the NFS. Further, comparisons of NVUM results for individual national forests can only reliably be made between two periods, 2005–2009 and 2010–2014, because of refinements to its methods after the initial 2000 to 2004 monitoring period and the 5-year sampling cycle of NVUM. The most recent visitation estimate for the NFS using data collected between 2011 and 2015 was 149 million visits. This visitation has been trending upward since 2010 (the earliest comparable year for analysis) with 2015 estimates about 4 percent greater than 2010 (USDA FS 2016b) (table 9-2).

Forest Service recreation monitoring indicates that use has been relatively stable over the last 10 years in the NWFP national forests. National forests within the NWFP area have received about 15 million recreation visits per year in recent years (USDA FS 2016b) (table 9-3). Day-use developed sites and the undeveloped (but nonwilderness) portions of national forests account for the greatest numbers of recreation visits. Recreation use in wilderness areas of NWFP-area forests is about 1 million visits per year. The difference in visit estimates between 2006–2010 and 2011–2015 cannot yet be interpreted as a trend because it is based on only two points in time and they are not statistically different.

Recreation use on NWFP-area national forests is consistent with the pattern of high participation in outdoor recreation by residents of the three-state region (California State Parks 2014, Oregon Parks and Recreation Department 2013, Washington State Recreation and Conservation Office 2013). The most recent statewide comprehensive outdoor recreation plans for Oregon and Washington found that more than 90 percent of state residents participate in some form of outdoor recreation (including activities such as hiking/walking, picnicking, camping, outdoor sports, and general relaxing) at least once a year. The statewide comprehensive outdoor recreation plan for California focused specifically on outdoor recreation that took place in parks and public lands (i.e., open space provided for natural environments and/or leisure opportunities), unlike in Washington and Oregon, but more than 90 percent of California's population reported using an outdoor park at least once in the prior year.

Table 9-3—Recreation use at national forests in the Northwest Forest Plan (NWFP) area by forest/site type for two recent periods[a]

Forest/site type	2006–2010	2011–2015
	Millions of visits	
All NWFP-area national forests	15.6	14.6
Site visits:		
Day-use developed sites	7.5	8.5
Overnight-use developed sites	2.4	2.0
Undeveloped areas	10.0	8.4
Wilderness	0.9	1.4

[a] Visitors typically complete multiple site visits during their visit to the national forest so the sum of site visits is more than the "all NWFP-area national forests" value.
Source: USDA FS 2016b.

Recreation activities—

Hiking, downhill skiing, and nature-related pursuits (i.e., viewing natural features, visiting nature centers, and nature study) are the most common primary recreation activities on national forests in the NWFP area (table 9-4). A primary recreation activity is defined as the single activity that prompted the recreation visit to the national forest. The relative popularity of those three activities is generally consistent with patterns of use on other national forests throughout the NFS. More specialized activities, such as cross-country skiing, camping, hunting, off-highway-vehicle (OHV) use, boating,

Table 9-2—Trend in visits annually to the National Forest System[a]

Year	FY 2006–2010	FY 2007–2011	FY 2008–2012	FY 2009–2013	FY 2010–2014	FY 2011–2015
			Millions			
Visits	143.6	145.5	147.5	146.7	146.8	149.0

[a] The National Visitor Use Monitoring Program runs on 5-year cycles. National-level visit estimates are calculated for these 5-year periods.
Source: USDA FS 2016b.

Table 9-4—Participation in primary recreation activities in Northwest Forest Plan (NWFP)-area national forests for two recent periods

Primary activity	NWFP area		National averages
	2006–2010	2011–2015	2011–2015
	Percent		
Hiking	18	25	24
Nature related	18	15	14
Downhill skiing	12	15	16
Hanging out/relaxing	7	6	5
Some other activity[a]	6	6	4
Fishing	7	5	6
Cross-country skiing	3	5	2
Hunting	4	3	5
Developed camping	4	3	3
Driving	3	3	5
OHV use	4	2	2
Boating	3	2	2
Biking	2	2	4
Other nonmotorized	2	2	2
Primitive camping/backpacking	2	2	1
Picnic	1	1	2
Snowmobile	1	1	1
No activity provided	2	< 1	1
Resort use	< 1	< 1	< 1
Horseback riding	< 1	< 1	1
Total	100	100	100

[a] Some outdoor recreation activities are not listed directly and would fall into the catagory of "some other activity" such as orienteering, geocaching, parasailing, and other forms of recreational aviation.
Source: USDA FS 2016b.

and bicycling are less common primary recreation activities on NWFP-area national forests. The patterns found for those specialized activities are also consistent with national-level patterns. The Plan-area forests differ slightly from national patterns in the share of visits that are nature related (a higher share of visits), and hunting and biking (smaller shares of visits). Within the Plan area, between the two NVUM periods, the share of visits with hiking or downhill skiing as the primary activity increased slightly, while the share of visits in nature-related activities decreased slightly. Those differences cannot yet be interpreted as trends because they represent only two points in time.

The patterns in recreation activities on the NWFP-area national forests are consistent with patterns in outdoor recreation activity of the general populations of California, Oregon, and Washington (California State Parks 2014, Oregon Parks and Recreation Department 2013, Washington State Recreation and Conservation Office 2013). Walking for pleasure is the most commonly reported activity in each state, with between 64 and 73 percent of residents of each state reporting walking for leisure at least once during the year. About 50 percent of the populations in each state report hiking on unpaved trails at least once during the previous year. More than half of each state's population

reported participating in general, nature-based recreation activities, such as sightseeing or picnicking. About half of Oregon residents and 40 percent of California and Washington residents reported that they had camped in a developed camping site in the past year. Participation in more specialized nature-based outdoor recreation activities, such as hunting, fishing, backpacking, biking, and freshwater boating, was generally reported by less than half, and typically less than one-quarter, of residents in the three states.

Research conducted elsewhere shows that volunteers can be motivated by a variety of factors, including the desire to expand public access and recreation opportunities, social engagement, and commitment to the environment (Bruyere and Rappe 2007, Lu and Schuett 2014, Propst et al. 2003). Volunteer organizations in the NWFP area have sizeable memberships and work closely with public land managers to identify mutually desired projects. Nationwide, reliance on partners and volunteers has played an important role in bolstering the capacity of national resource agencies, which face maintenance backlogs on recreation infrastructure (Seekamp and Cerveny 2010, Seekamp et al. 2011). The National Trails Stewardship Act of 2016 (P.L. 144-225) directs the Forest Service to expand volunteerism and partnerships further in support of trail maintenance. Volunteering and stewardship have also been studied in relation to place attachment, with stewardship in a forest or park generating stronger feelings of connection (Caissie and Halpenny 2003, Dresner et al. 2015, Ryan 2005).

Population aging and implications for forest visitation— Most recreation visits to NWFP-area national forests are by those between the ages of 30 and 60 (table 9-5). Those less than 20 years old account for about 17 percent of visits. For comparison, those under age 18 represented about 23 percent of the U.S. population in 2014 (U.S. Census) (Colby and Ortman 2015). In most cases, those visits from someone under the age of 16 likely involve family recreation with children. The age distribution of those recreating at NWFP-area forests is consistent with patterns on all national forests, although there are slightly more visits in the 20 to 40 age group in the plan area compared to the national pattern (table 9-5). Compared to the national median age of 37.7 in 2014, Oregon's residents are slightly older, Washington's residents are about the same age, and California's residents are slightly younger.

Table 9-5—Percentages of Northwest Forest Plan (NWFP) area and national recreation visits by age groups for two recent periods

Age group	2006–2010 NWFP	2011–2015 NWFP	2011–2015 National
	- - - - - - - - - *Percent* - - - - - - - - -		
Under 16	17	13	16
16–19	4	4	4
20–29	14	16	13
30–39	17	17	15
40–49	18	17	17
50–59	16	17	17
60–69	10	13	13
Over 70	3	4	5

Source: USDA FS 2016b.

The average ages of the populations of California, Oregon, and Washington are expected to continue to increase over time. Age is consistently found to be a factor in recreation participation and correlates with differing perceived barriers to participation in recreation (Bowker et al. 2006, Child et al. 2015). Considering outdoor recreation anywhere, not just on Forest Service land, those over 45 years of age participate in a smaller set of recreation activities than those who are younger and, as people age, they continue to reduce activity participation (Cordell 2012, White et al. 2016). Recreationists in age groups over 45 are most commonly participating in developed-site activities and viewing and photographing nature (table 9-6). Those over age 45 have moderate rates of participation in motorized activities, hunting, and fishing that decline steadily as they age. Older people are more likely to feel that personal health, safety, and disability are barriers to participating in outdoor recreation; younger people view the amount of leisure time, limited information about recreation opportunities, and lack of transportation as barriers to participating in outdoor recreation (Ghimire et al. 2014).

Table 9-6—Percentage of age groups 45 and older participating in outdoor recreation by site/activity type

Site/activity type	Age 45–54	Age 55–64	Age 65+
	- - - - - - - - - - - - *Percent* - - - - - - - - - - - -		
Visiting developed sites	81	75	62
Viewing and photographing nature	80	75	65
Backcountry activities (including hiking)	48	37	22
Motorized activities	37	27	17
Hunting and fishing	38	29	20
Nonmotorized winter activities	10	5	2
Nonmotorized water activities	22	15	7

Source: Cordell 2013, adapted from White et al. 2016.

Those under age 20 account for about 17 percent of the recreation visits on NWFP-area national forests (see table 9-5). That rate of outdoor recreation participation is generally consistent with what was found nationally. In a national study of the outdoor recreation behavior of those under age 20, Larson et al. (2011) found that the majority of children do spend time in outdoor recreation each week and that 62 percent spend at least 2 hours recreating outside daily. Of those under 20, those between 16 and 19 had the lowest rates of being outdoors for recreation: most of respondents at that age spent less than a half an hour outdoors daily (Larson et al. 2011). Hispanic youth had the highest rates of spending time in outdoor recreation. Across all groups, those under 20 were focused on general recreation in the outdoors, e.g., playing or hanging out (84 percent of participants); biking, walking, jogging (80 percent); and using electronic devices outdoors (65 percent). More specialized outdoor recreation activities such as wildlife viewing (31 percent), hiking/camping/ fishing (29 percent), and snow sports (9 percent) were reported by lesser shares of young participants (Larson et al. 2011). The greatest impediment to participating in outdoor recreation for those under 20 was interest in other activities, including using electronic media indoors. Issues with limited access, lack of transportation, or concerns about safety were cited as reasons for not recreating outdoors by less than one-fourth of those under 20 (Larson et al. 2011).

Work patterns and leisure time—

Lack of time has been identified as the key reason that some Oregon and Washington residents never visit national forests for recreation, or visit them less frequently than desired (Burns and Graefe 2007). Lack of time was also found to be a moderate impediment to youth participation in outdoor recreation generally (Larson et al. 2011). Time availability was identified as a much stronger factor in constraining recreation use of national forests than perceived recreation site characteristics or crowding (Burns and Graefe 2007). In the NWFP area, the median duration of a national forest visit is about 4 hours (table 9-7). However, that figure is influenced by the length of stay of those camping in national forest campgrounds. Excluding campground use, the median length of stay of visitors to Plan-area national forests is less than 3 hours for day-use sites and general forest areas, and less than 4 hours for those recreating in wilderness. The vast majority of recreation visits to Plan-area forests are short-duration

Table 9-7—Median duration of visits to NWFP-area national forests

Category	2005–2009	2010–2014
	- - - - *Hours* - - - -	
National forest visit (all sites)	4.5	4.1
Day-use developed sites	1.7	2.1
Overnight-use developed sites	44.2	41.8
Undeveloped areas	3.5	3.0
Wilderness	4.4	4.0

Source: USDA FS 2016b.

trips. The preponderance of short-visit durations is consistent with the patterns of high use in developed sites (where visits are likely focused on viewing natural features or a brief hike).

Sustainable recreation—

For natural resource management, broadly, sustainability is typically thought to relate to the capacity of the landscape (comprising human and natural systems) to provide desirable social, ecological, and economic outcomes now and into the future under current management. Research addressing the sustainability of recreation has largely focused on (1) the ability of the resource and managers to provide current recreation opportunities (especially winter recreation) in the face of a changing climate (e.g., Beaudin and Huang 2014, Buckley and Foushee 2012, Smith et al. 2016); (2) how alteration of environmental conditions through disturbance, recreation use, or resource management affects the conditions of recreation resources and user experiences (e.g., Brown et al. 2008, Cole 2013, Shelby et al. 2005, White et al. 2008); (3) how high use levels at recreation sites may change the behavior, experience, and satisfaction of visitors (e.g., Cole and Hall 2009, Fonner and Berrens 2014, Lawson et al. 2003); or (4) the social and economic conditions in recreation gateway communities and reliance of those communities on tourism for economic activity (e.g., Andereck et al. 2005, Frauman and Banks 2011, Kurtz 2010). Within the recreation scientific literature, perhaps the greatest attention has been paid to items 2 and 3. The scientific literature lacks a definition of "sustainable recreation," and integrated studies of recreation sustainability that look at a suite of sustainability factors. This lack of scientific research into sustainable recreation contrasts with the fairly extensive use of the term in management and policy directions in recent years. Unlike the focus of scientific literature, which is more broad, managers tend to view recreation sustainability in terms of capacity to provide desired recreation opportunities in the face of declining agency budget allocations and perceived greater recreation use.[2]

[2] U.S. Department of Agriculture, Forest Service [USDA FS]. 2016. Region 6 sustainable recreation strategy. Unpublished report. On file with: Lee K. Cerveny, U.S. Forest Service, Pacific Northwest Research Station, 400 N 34th Street, Suite 201, Seattle WA 98103, lcerveny@fs.fed.us. 20 p.

Visitor satisfaction with recreation site conditions and the recreation experience is a component of sustainable recreation. Oregon and Washington residents have rated recreation conditions on the national forests they visited most frequently at moderate to high quality (Burns and Graefe 2006). The highest quality rankings were given for the undeveloped characteristics of views, courteous and friendly staff, and safe sites with clearly posted rules and regulations. The lowest quality scores were given for availability of multilingual services, accessibility of uniformed Forest Service personnel, risk of vandalism and theft to vehicles, and assistance for people with special needs. However, even for those items, the most common quality ranking was "fair" (the second lowest rating on a scale from "awful" to "excellent"). In a separate study, Burns and Graefe (2007) found that 60 percent of households in Oregon and Washington with a person having a disability felt hampered in their ability to use national forests for recreation. However, 21 percent of those who felt national forests were not accessible for recreation also stated no interest in outdoor recreation (Burns and Graefe 2007). The conditions of roads and trails and conditions of facilities were rated as good to very good (Burns and Graefe 2006). Recreationists stated their perception of site quality was highest when there was (1) minimal litter, (2) a feeling of safety and security, (3) clearly posted rules and regulations, and 4) clean restrooms and toilets (Burns and Graefe 2006). The presence of litter, trash, or vandalism was the key factor in explaining recreationists' perceptions of recreation site quality and environmental condition at Bureau of Land Management recreation sites in the northwest Oregon Cascade foothills (White et al. 2008). Visitors who have visited those sites with litter over increasingly long time frames appear more sensitive to deterioration in site conditions (White et al. 2008).

Recreation and climate change—

Changing climate can change (increase or decrease) the availability and quality of recreation opportunities (Shaw and Loomis 2008). Changing environmental conditions that result from weather and climate patterns can affect the ability of people to participate in certain recreation activities with implications for quality of life and future public health

(White et al. 2016). Climate change models project warmer weather conditions for longer periods, which are expected to increase participation in summer and warm-weather recreation activities (Bowker et al. 2013, Farley et al. 2011). Temperature and precipitation changes directly change the availability and quality of recreation sites. Based on preliminary research conducted in the northern Rocky Mountains (Hand and Lawson 2018) and more generally (Shaw and Loomis 2008), it is understood that climate change can alter ecological conditions and may affect optimal recreation conditions. Recreation visitors are likely to engage in substitution as an adaptation strategy to climate change—substituting one location for another, changing the timing of their recreation visits, or shifting into new activities as opportunities for their favorite activities decline (Loomis and Crespi 2004). However, substitution may represent a net benefit loss, even when participation changes only subtly. For example, the substitute site may be more expensive to access, take more time to reach, or offer inferior quality. Studies conducted in central Oregon are underway and have identified certain recreation activities that may be more sensitive to a warming climate as well as implications associated with the possible expansion of shoulder seasons.

Summary—
Recreation visits are expected to grow in day-use settings and developed facilities. At the national level, the number of outdoor recreation visits will increase in the coming decades in accordance with population growth. The majority of outdoor recreation use is for general recreation activities, like hiking, viewing nature, visiting nature centers, viewing wildlife. Most recreation visits to national forests are relatively brief, lasting less than one-half day, and tend to occur at developed sites. These are important trends to consider when managers are asked to allocate resources to recreation facilities. The greatest barriers to outdoor recreation participation are lack of time and travel distance to national forests. Other barriers include concerns for personal safety, signage, and accurate information, all of which have positive effects on visitor perceptions of site conditions. Natural resource agencies like the Forest Service seek information about the ecological effects of recreation in efforts to promote sustainable recreation. Lack of conceptual development of what sustainable recreation means or tested sustainable recreation models or tools is inhibiting use of this concept in planning.

Trust

Trust is one of the key foundations of human social order and is viewed as critical for personal development, interpersonal relationships, mutual cooperation, and enduring institutions, such as governments, financial markets, and religious organizations (Lewicki et al. 1998). Humans operate in an environment often characterized by ambiguity, complexity, risk, and change (Lewicki et al. 1998). Trust and distrust are distinct emotional responses that allow individuals and entities to navigate uncertainty, manage efficiently, and survive.

Defining trust—
Trust is defined by early social psychologists as expressions of confidence in others' intentions and motives. Trust was understood as the sincerity of a person/institution's word (Mellinger 1956), and was seen as dependent upon the confidence that one's interests would be protected and promoted by another and with an agreement on full information sharing (Read 1962). Predictability was also seen as integral to the notion of trust (Deutsch 1958). Scholars later explored trust as an aspect of actual behavior, rather than as a primary motivation, understanding trust as one's hope of another's favorable behavior in a situation of vulnerability (Hosmer 1995). Regardless of their motivations, there is an expectation that, in a position of dependence, one will not injure or ignore the interest of another (Hosmer 1995). Lewicki et al. (1998) suggested that trust and distrust are best understood not as a binary construct in polar opposition, where trust is good and distrust is bad. Nor is trust/distrust viewed as an inverse relationship, where trust increases only when distrust decreases and vice versa. "There are elements that contribute to the growth and decline of trust, and there are elements that contribute to the growth and decline of

distrust" (Lewicki et al. 1998: 440). These elements are repeatedly modified through frequent human encounters and transactions. Because of the many layers and facets of human interactions, it is possible to both have trust and distrust for a person or entity simultaneously—trusting some aspects of the relationship, but not others. Understanding that trust and distrust can coexist has important implications for public engagement in forest management, in particular the critical importance of creating processes that are trusted.

Trust also should be understood with both attention to social context and recognizing it as a dynamic process (Lewicki et al. 1998). A person can trust an individual or agency in one sociopolitical setting but be wary of their performance in another setting. For example, an environmental advocate can develop a trusting relationship with a timber industry representative in the context of a small collaborative group focused on forest restoration, but this level of trust may change when the organizations appear in a large public hearing to deliberate a proposed timber sale. And, trust is dynamic and inconsistent. Trust can build and subside with each short-term interaction, which can influence the long-term trajectory of a relationship. For natural resource agencies, which often make decisions in the context of wicked problems, conflicting ideologies, and high stakes, developing processes and protocols that can be trusted is essential, even when trust can be elusive among various actors involved in those processes.

Trust as a topic in natural resource management— Trust has been a topic of investigation in scholarship related to natural resource management (Beierle and Konisky 2000). Trust between stakeholders has been characterized as a factor that shapes natural resource management outcomes (Cvetkovich and Winter 2003, Davenport et al. 2007, Stern 2008a). At its core, trust is a fundamental component of human relationships that suggests a party's acceptance of vulnerability related to positive expectations of the behavioral intentions of another party (Rousseau and Tijoriwala 1999). In the context of natural resource governance, scholars distinguish between various types of trust. Davenport et al. (2007) delineated two kinds of trust: "institutional trust" (trust in agencies to represent and serve the public) and "interpersonal trust" (trust based on personal relationships). Some scholars have focused on "rational trust," calculated based on an entity's predictable behavior, accountability, and reliability of performance (Hardin 2002, Stern 2008b). Others emphasize "social (or affinitive) trust," which grows based on shared experiences and enduring interactions (Braithwaite 1998, Cvetkovich and Winter 2003). Trust in natural resource agencies has been discussed in the context of "broad-level" trust in governing agencies to achieve goals of resource conservation and meeting public needs, and as "project level" trust, which emphasizes whether the agency can be trusted to successfully implement the project goals and minimize harm to the social and natural environment (Ribe 2013). For an agency to craft a socially acceptable management strategy, trust is important both at the broad level and the project level (Olsen and Shindler 2010).

Community-based collaborative groups, which are discussed later in this chapter, have emerged partly in response to perceptions of distrust between communities and public land agencies. In the context of collaborative management, Stern and Coleman (2015) developed a conceptual framework that identified four types of trust: "dispositional" (the predisposition of individuals to trust), "rational" (based on likeliness of predicted behavior as judged by prior performance), "affinitive" (based on shared values and developed through positive interactions), and "systems based" (transparent process, fair and just procedures) (table 9-8). They posited that the diversity of these four trust types within natural resource management contexts is important for successful outcomes. Stern and Baird (2015) used this framework to study variation of degrees and proportions of the four types of trust. They found that explicit attention to the development of three types of trust (rational, affinitive, and systems based) can enhance the efficiency and resilience of natural resource management institutions. They also found that when one type of trust is damaged, having other types of trust can buffer the loss (Stern and Baird 2015). These studies emphasize the importance of trust to the success of collaborative management and suggest the need for deliberate

Table 9-8—Varying interpretations of trust

Types of trust	Definitions	Citations
Institutional trust	Trust in agencies to represent and serve the public	Davenport et al. 2007
Interpersonal trust	Trust based on personal relationships	
Social trust	Trust among people that grows based on shared experiences and enduring interactions	Braithwaite 1998, Cvetkovich and Winter 2003
Rational trust	Based on predictable behavior, accountability, and reliability of performance	Stern and Baird 2015, Stern and Coleman 2015
Affinitive trust (similar to social)	Trust among people that grows based on shared experiences and enduring interactions	
Dispositional trust	The predisposition of individuals to trust (based on one's natural inclinations, values, experiences	
Systems-based trust	Derived from presence of fair processes; just procedures	

attention to fostering all four types of trust to maximize institutional resilience.

Recent studies have explored the relationship between values and trust in forest management. Although some suggest that the degree of institutional trust can influence the extent to which someone supports forest management actions, we do know that trust expands when agencies make decisions that reinforce an individual's values (Vaske et al. 2008). Trust can be built (and in many cases conflict reduced) through fair participation processes or transparent decisionmaking (Webler and Tuler 2000, Webler et al. 2001). In a comparative study among national forests in northern California, northern Florida, and Michigan, Winter et al. (2004) found a relationship between shared values and social trust in a study of fuel management strategies. In California, Winter et al. (1999) learned that trust predicted attitudes in the public's willingness to pay recreation fees. In their study of prescribed fire burning in Colorado, Vaske et al. (2008) used an approach known as "shared values similarity," which measures the degree of similarity among a set of environmental values (Cvetkovich and Winter 2003). They found that when values were held in common between the public and the land management agency, there was a greater degree of trust. They also learned that when social trust was improved, there was more support for land manager policies of prescribed burning and mechanical thinning. A lack of trust in governing agencies is cited as a primary barrier in natural resource planning (Lachapelle and McCool 2012) and can potentially lead to litigation or noncompliance (Stern 2008b).

Achieving trust among multiple conflicting parties in resource management can be challenging; still, there is an increasing recognition that trust can be fostered by direct public engagement or participation in a collaborative decision processes where deliberation is encouraged. For trust to flourish, processes should be inclusive, representative, transparent, and predictable (Beierle and Konisky 2000). In addition, trust can be aided by groups having clear objectives, outlined roles and responsibilities, and a tangible and enduring commitment from key partners.

Summary—

Natural resource institutions like the Forest Service often make difficult decisions in uncertain environments in which science is evolving and public sentiment is conflicted. The degree of trust established between public agencies, stakeholders, and communities is an important factor in public support for resource management decisions. Clear objectives, consistent communication, transparent processes, reasonable timelines, maintained commitments, and opportunities for candid deliberation can enhance institutional trust both at the project level and at the national level. Developing processes and protocols that can be trusted is essential, even when trust can be elusive among various actors involved in those processes.

Involving the Public

Public participation in federal agency land management planning processes is required by various laws, regulations, and policies, including the Multiple-Use Sustained-Yield Act of 1960 (MUSYA), National Environmental Policy Act of 1969 (NEPA) and the National Forest Management Act of 1976 (NFMA) (box 3). A national planning rule for the USDA Forest Service stipulates that public participation efforts must "…have significant potential to reach and involve diverse segments of the population that historically have not played a large role in NFS (National Forest System) planning and management" (USDA FS 2012). This contemporary emphasis on robust public participation in land management planning suggests new innovations, strategies, and methods of encouraging diverse public participation, which can generate trust among stakeholders and land managers. This section will review recent trends in public participation, including institutional constraints and best practices. Because peer-reviewed research on this topic is limited in the U.S. Forest Service's Pacific Northwest Region, this section will also include information from federal agency reports, doctoral dissertations, and standard texts in the field of public administration, conflict management, and collaboration.

Box 3—MUSYA, NEPA & NFMA Requirements

MUSYA requires that management "best meet the needs of the American people," by identifying the public's values and desires (US Congress, OTA, p.78).

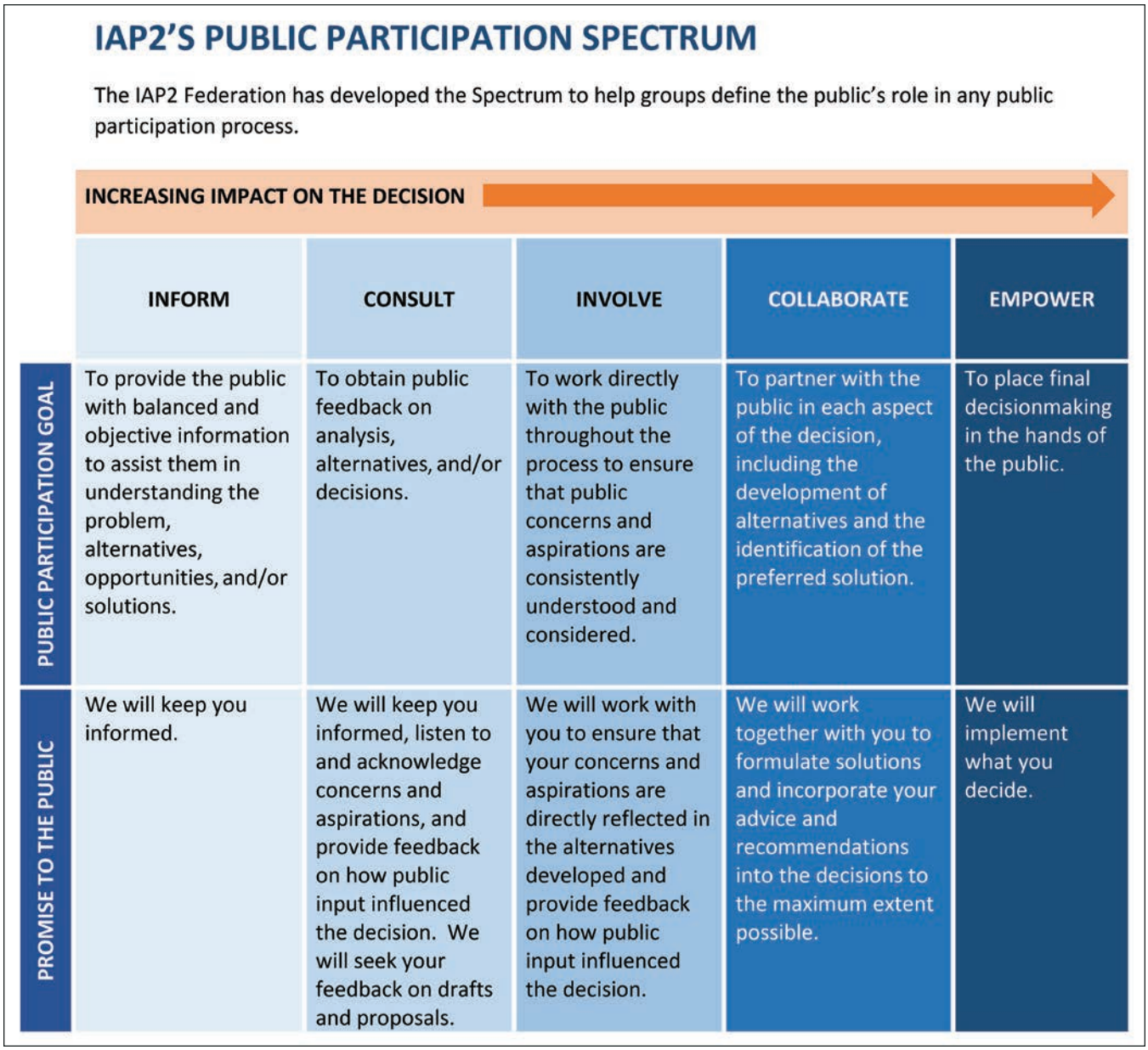
NEPA requires agencies to inform the public about the possible environmental impacts of their decisions, including the public as a participant in decisionmaking.

NFMA further reinforced the public's right to participate in Forest Service planning and decisionmaking.

Trends in public participation in natural resource management—

In 1969, Sherry Arnstein published the article, "A Ladder of Citizen Participation." Although dated, this article remains relevant as a way of describing different types of public involvement. At the core of Arnstein's argument is the premise that different types of public involvement are directly related to the different levels of power citizens have in determining outcomes (Arnstein 1969). The ladder is a metaphor for illustrating increasing levels of public influence in decisionmaking as one climbs each rung of the ladder. Lower rungs indicate nonparticipatory types of public involvement, such as education, while middle rungs allow participants to share information without assurance that a change in the outcome will occur (Arnstein 1969). The top rungs of the ladder provide increasing levels of influence in decisions affecting the outcome.

A key finding of Arnstein's work is the recognition that participation without a clearly defined public role (i.e., the type of participation, or identifying which "rung on the ladder") can lead to a meaningless or frustrating process for all involved. In 1999, the International Association of Public Participation (IAP2 2014) transformed Arnstein's "ladder" into a "spectrum." This decision-oriented, objective-driven, and values-based approach to public participation was designed to assist with selection of the appropriate level of public participation in any community engagement program (fig. 9-6). The spectrum seeks to "… legitimize differing levels of participation depending on the goals, time frames, resources and levels of concern in the decision to be made" (IAP2 2014). As described by the IAP2, the spectrum defines the **promise** being made to the public within each level of participation (2014). The arrow at the top of the diagram indicates that as one moves to the right, the level of participation and public influence in the decisionmaking process increases, similar to moving up the rungs of Arnstein's ladder. Note that while the spectrum covers the full range of public influence in a decisionmaking process, government agencies retain their decisionmaking authority in all instances and are ultimately



IAP2'S PUBLIC PARTICIPATION SPECTRUM

The IAP2 Federation has developed the Spectrum to help groups define the public's role in any public participation process.

INCREASING IMPACT ON THE DECISION

	INFORM	CONSULT	INVOLVE	COLLABORATE	EMPOWER
PUBLIC PARTICIPATION GOAL	To provide the public with balanced and objective information to assist them in understanding the problem, alternatives, opportunities, and/or solutions.	To obtain public feedback on analysis, alternatives, and/or decisions.	To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered.	To partner with the public in each aspect of the decision, including the development of alternatives and the identification of the preferred solution.	To place final decisionmaking in the hands of the public.
PROMISE TO THE PUBLIC	We will keep you informed.	We will keep you informed, listen to and acknowledge concerns and aspirations, and provide feedback on how public input influenced the decision. We will seek your feedback on drafts and proposals.	We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision.	We will work together with you to formulate solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible.	We will implement what you decide.

Figure 9-6—The International Association of Public Participation's [IAP2] Public Participation Spectrum.

responsible for their actions (Wondolleck and Yaffee 2000). Thus, government agencies are not authorized to use the "empower" end of the IAP2 spectrum. Bryan (2004: 882) put this into perspective: "While participants may challenge the decisions authorities ultimately make, they do not challenge their authority to make those decisions."

The IAP2's Public Participation Spectrum can assist with the selection of the level(s) of participation that defines the public's role throughout a forest plan revision effort. Importantly, the amount of effort required among the different spectrum levels can vary widely for both the agency and the public. Imperial (2005: 312) emphasized the importance

of judiciously identifying collaborative opportunities that add public value while minimizing transaction costs, and suggests that "public managers are…cautioned to use collaboration wisely. When used correctly, collaboration is an effective governance strategy. When used inappropriately, it can create more problems than it solves."

Thus, different phases of plan revision call for different levels of public involvement. For example, in the assessment phase of plan revision, a **collaborative** process could be designed to identify the benefits provided to people by a national forest. Here, the public works in conjunction with agency personnel to identify the unique places, roles, and contributions a national forest provides based on their preferences, interests, and values. English et al. (2004) emphasized the importance of eliciting values early on in public involvement processes and further acknowledged that to be effective, these processes "must be tailored to the place, the people, and the circumstances; there is no single recipe for success." Collaboratively identifying unique roles and contributions, early in the assessment phase of forest plan revision, can focus forest management on issues that people value most.

Alternatively, during the NEPA phase of plan revision, while the interdisciplinary team is conducting its analysis in compliance with the act, it may be appropriate to **inform** the public as a means of assisting them in understanding issues or alternatives. For example, following the 90-day comment period on the Inyo, Sierra, and Sequoia National Forest draft plans and draft environmental impact statements, the interdisciplinary team spent months analyzing comments, defining issues and resolutions, and preparing responses to comments in preparation for release of the final environmental impact statement and draft record of decision (USDA FS 2016a). During this time frame, little interaction with the public occurs. To fill this gap, a series of informational bulletins provided additional detail on topics of interest identified during the comment period (Long et al. 2014). In the case of the Sierra synthesis, the agency is not asking for public feedback, it is providing information to assist the public in understanding issues or alternatives. As Arnstein and others have found, the key is defining these various levels of public participation prior to initiating the plan revision, and being clear with the public about what their actual role will be, ensuring them a meaningful and robust participation process.

Newer research continues to support and refine Arnstein's work and that of the IAP2 (Carpini et al. 2004, Kelshaw and Gastil 2008, Lynam et al. 2007, Rowe and Frewer 2005). Rowe and Frewer (2005) developed a typology that further defines key concepts of public engagement within the IAP2 spectrum based on the direction information flows from the sponsor (i.e., Forest Service) to the public. This typology (Rowe and Frewer 2005) defines three key types of public engagement: public communication (e.g., **inform** on the IAP2 spectrum), public consultation (e.g., **consult** on the IAP2 spectrum), and public participation (e.g., **involve and collaborate** on the IAP2 spectrum). Specifically, Rowe and Frewer (2005) suggested that public communication characterizes information flowing from the agency to the public, public consultation from the public to the agency, and information flowing both directions as public participation. Another aspect of their research is the importance of aligning mechanisms, defined as processes, techniques, and instruments, to the appropriate level of engagement (Rowe and Frewer 2005). Carpini et al. (2004) focused their research on the mechanism of "face-to-face" meetings. They found that face-to-face communication is the single greatest factor in increasing the likelihood of cooperation among participants (Carpini et al. 2004). Kelshaw and Gastil (2008) differentiated face-to-face meetings among the different types of public engagement. For example, informational meetings fall into the "inform" level of the IAP2 spectrum, where the agency initiates conversation with the public. Alternatively, communication flows both directions in collaborative face-to-face meetings initiated by the agency and the public. Finally, Lynam et al. (2007:1) summed up the importance of applying the right mechanism to the right level of public engagement: "…picking the right tool does not guarantee that the data desired will be produced, but selecting the wrong tool does make success less likely."

As mentioned in the beginning of this section, NEPA requires federal land management agencies, including the Forest Service, to **involve** the public in agency planning processes (Brown and Donovan 2013, Hoover and Stern 2014). Hoover and Stern (2014: 174) argued that although "NEPA regulations do not specifically empower the public

to directly influence the NEPA process," the public generally becomes involved in these efforts to have a genuine impact, "…or **influence** on decisions that affect them or the public resources they value." They also acknowledged, "While there are minimum standards related mostly to the timing of involvement and disclosure, the NEPA process grants the implementing agency broad discretion regarding the form and nature of the public involvement process" (Hoover and Stern 2014: 175).

Given this considerable level of discretion, scholars have argued that understanding what motivates the behaviors and actions of key personnel, such as interdisciplinary team leaders as well as the public, has the potential to improve the public participation experience for both agency personnel and the public (Hoover and Stern 2014, Lipsky 1980, Yang 2005). According to Cerveny et al. (2011: 202), "The ID team leader is responsible for managing group interactions, synthesizing scientific findings, and coordinating analysis of alternatives." Hoover and Stern (2014) found that agency team leaders of planning processes across the Forest Service expressed a desire for greater public influence in planning processes through improved "substantive" input to management decisions rather than through objections and litigation. Stern and Predmore (2011) have characterized substantive comment as information that can improve management decisions, as opposed to comments based on opinions or conjecture.

The literature describes four broad and interrelated behavioral factors of participating publics related to their ability to gain influence in decisionmaking (Hoover and Stern 2014). These factors include values and desires, time, trust and prior experience, and the skill to provide comments (Beierle and Konisky 2000, Cheng and Mattor 2006, Creighton 2005, Germain et al. 2001, Halvorsen 2006, Smiley et al. 2010, Smith and McDonough 2001, Whitall 2007, Yang and Pandey 2011). Thus, in understanding and accommodating these inherent behavioral factors, Forest Service team leaders and decisionmakers can improve the public's level of influence in decisionmaking earlier in the planning process through improved "substantive" comment processes.

To identify key factors that either motivate or constrain an interdisciplinary team leader, Hoover and Stern (2014) conducted a qualitative case study analysis of interviews with Forest Service employees. Through their research, they found that the following four factors influenced interdisciplinary team leaders' (IDTLs') ability "…to go above and beyond the minimum requirements to facilitate public influence: (1) the IDTLs' personal beliefs and norms; (2) past and present experiences with the public; (3) the IDTLs' workloads; and (4) the influence of the decision maker" (Hoover and Stern 2014: 181). To enhance motivation of IDTL's, Hoover and Stern (2014) suggested that the agency may be able to improve employees' ability to cope with stress, assist in maintaining reasonable workloads, and offer training to effectively respond to public concerns about resource management.

The complexity of public participation in the 21st century—

Creating effective public involvement strategies is challenged not only by varying levels of public influence, statutory ambiguity, and consequent agency discretion, but also by socially dynamic systems (Brown and Donovan 2013) (box 4). Changes in demographic patterns are occurring most rapidly in the southern and western regions of the United States, with increasing numbers of young people and immigrants (Colby and Ortman 2015). Along with these changing demographic patterns are changing values and user preferences (Brown and Donovan 2013). Incorporating traditional and emerging values necessitates new methodologies for creating public involvement processes as required by the 2012 planning rule. This section highlights new research in the fields of dispute resolution, stakeholder and social network analyses, as well as public participation GIS.

Box 4—Whom Do You Ask?

Sample bias—The answer you get depends on whom you ask.

In a 2012 PPGIS case study in the southern Sierra Nevada, it was found that responses from a random sample of households preferred forest amenities over the stronger utilitarian values and consumptive use preferences of stakeholders who volunteered to participate in the study (Brown et al. 2013).

Seeking resolution through dialogue: The importance of framing and reframing—

As a science-based organization, the Forest Service has focused much of its attention on increasing the amount of technical information provided to the public as a means to increase understanding of complex environmental issues and associated risks. In other words, the agency uses a technical frame of reference to define and explain environmental issues. Nisbet (2009) and others have argued that this type of information is likely to reach a small audience of already informed and engaged citizens (Ho et al. 2008, Nisbet 2005, Popkin 1991). He further stated, "…the rest of the public either ignores the coverage or reinterprets competing claims based on partisanship or self-interest, a tendency confirmed across several decades by public opinion research" (Nisbet 2009: 14). Nisbet's argument illustrates how technical and lay populations frequently frame environmental issues differently. Framing involves "shaping, focusing, and organizing the world around us" (Gray 2003: 11). Gray (2003: 12) further explained that "through framing, we place ourselves in relation to the issues or events—that is, we take a stance with respect to them." Simply, a frame reflects what we believe is going on and how we see ourselves and others involved in what is happening. The process of framing then offers insights into why some environmental issues are difficult to resolve (Gray 2003).

Elliott et al. (2003) drew conclusions from eight case studies on how framing affects the potential for conflict resolution of intractable environmental disputes. They found that frames may not be permanent and can change through reframing activities (Elliott et al. 2003). In seven of the eight cases studied, they found that efforts were made to consciously reframe the conflict through public dialogue. Lengwiler (2008) found that the lay-technical divide could be transcended by reframing the dialogue within a wider socioeconomic context. In other words, by reframing the environmental issue within a wider socioeconomic context, laypersons have the potential to coalesce around a set of common concerns and effectively engage in problem-solving activities. Thus, they are not expected to become scientific and technical experts, nor are experts expected to compromise their role in solving environmental issues (McKinney and Harmon 2008). The goal, as stated by McKinney and Harmon (2008: 63), is "…to integrate expert and public knowledge and information to shape decisions that are scientifically credible, politically legitimate, and relevant to the problem at hand."

In another case study, Whitall et al. (2014) used interest-based problem-solving (IBPS) techniques to reframe environmental conflict in the Sierra Nevada ecoregion. Here "IBPS techniques were used to redefine the meaning ascribed to the ecological restoration of the Sierra Nevada ecoregion from two differing points of view. Techniques included focusing the conversation on **why** these individuals wanted something, as opposed to **what** they wanted or needed" (Whitall et al. 2014: 176). In so doing, common interests emerged from intractable positions. Yet Burton (1990) and Maiese (2004) provided a cautionary note when using IBPS techniques: "…while interest-based bargaining is effective in interest-based disputes, it should not be applied to disputes involving deep differences in values."

Thus, this research (Elliott et al. 2003, Lengwiler 2008, McKinney and Harmon 2008, Whitall et al. 2014) suggests that in at least some environmental conflicts, frames can change through intentional actions and interventions. Reframing environmental issues within a wider socioeconomic context has the potential to bridge the gap between technical experts and laypersons. Finally, by reframing dialogue from positions (**what** people want) to interests (**why** people want it) it is possible to render interest-based disputes more tractable.

Public participation and the identification of stakeholders—

Reed et al. (2009) found that the role of stakeholders is becoming increasingly embedded in environmental policy. Yet, they argued, "…stakeholders are often identified and selected on an ad hoc basis. This has the potential to marginalize important groups, bias results and jeopardize long-term viability and support for the process" (Reed et al. 2009: 1933). Thus, they discussed growing interest in a collection of systematic methods that can be used to identify

individuals, groups, and organizations who are affected by a decision and then prioritize these individuals and groups for involvement in the decisionmaking process (Reed et al. 2009). Stakeholder analysis is one way of systematically identifying groups implicated by an environmental policy or decision (Grimble and Wellard 1997, Prell et al. 2009, Reed 2008, Reed et al. 2009).

Reed et al. (2009) identified three critical, sequential steps of stakeholder analysis: (1) identifying stakeholders and their interest in the problem or decision, (2) differentiating between and categorizing stakeholders, and (3) exploring relationships among stakeholders. For each step, a variety of methods exist depending on the knowledge, skills, and resources available. For example, in step one where individuals and groups with a stake in the plan revision or amendment process are widely known, the stakeholder analysis can be conducted without active participation of the stakeholders themselves. Yet, Reed (2008) cautioned that stakeholder participation may be necessary if the agency has incomplete knowledge on the population that may have an interest in the outcome. Identifying stakeholders is an iterative process, where stakeholders are added as the analysis continues using different methods such as expert opinion, focus groups, semistructured interviews, or snowball sampling (Prell et al. 2009, Reed 2008, Reed et al. 2009).

Various methods also exist for step two: categorization of stakeholders. Here, methods may be either top-down or bottom-up. In the top-down approach, stakeholders are classified based on their observations as applied through a predetermined conceptual framework or theoretical perspective (Grimble and Wellard 1997, Reed 2008). The bottom-up approach allows categories to be defined by the stakeholders themselves, allowing the analysis to better reflect their perceptions (Dryzek and Berejikan 1993, Hare and Pahl-Wostl 2002).

Finally in step three, two principal methods are used to investigate the relationships among and between stakeholders (both as individuals and groups): social network analysis, which provides insights into patterns of communication, trust, and influence between stakeholders in social networks (Lienert et al. 2013, Prell et al. 2009, Whitall 2007); and knowledge mapping analysis, which examines the flow of information between these stakeholders (Reed et al. 2009). When used in conjunction with social network analysis, Reed argued that knowledge mapping may extend the "who knows who" of social network analysis by providing a visual representation of "who knows what" (Reed et al. 2009: 1940). Social network analysis has been used in the NWFP area to evaluate the structure of fire protection and restoration institutions in the eastern Cascade Range of Oregon (Fischer and Jasny 2017, Fischer et al. 2016).

The increasing use of stakeholder analysis in natural resource management reflects a growing recognition that stakeholders influence environmental decisionmaking (Prell et al. 2009). The literature also shows that stakeholder analysis can be used to minimize conflict, reduce marginalization of certain groups, and provide fair representation of diverse interests (Prell et al. 2009, Provan et al. 2005, Reed 2008, Reed et al. 2009, Whitall 2007).

Participatory mapping and geospatial approaches— A growing number of scholars and government agencies are interested in the integration of technology and spatial information into public participation strategies (Brown et al. 2013). As an example, the 2012 planning rule encourages the U.S. Forest Service to be proactive and use contemporary tools such as the Internet to engage the public in forest planning (USDA FS 2012). As noted earlier, public participation GIS has featured prominently in forest plan revision efforts in the past decade (Brown and Donovan 2013, Brown and Reed 2009, Brown et al. 2013).

The term "public participation geographic information systems" was conceived in 1996, during the National Center for Geographic Information and Analysis meeting (Sieber 2006). Brown and Reed (2009: 166–167) described the process as "…using GIS technologies to produce local knowledge with the goal of including and empowering marginalized populations." In 2012, they conducted a public participation GIS case study on the Chugach National Forest as part of the forest plan revision process under the 2012 planning rule. Results of their study indicate the potential utility of public participation GIS to assist forest planners

in identifying areas suitable for various forest uses (Brown and Reed 2012). Essentially, Brown and Reed (2012) found that public participation GIS provides a systematic approach to identifying the social suitability of various forest uses to supplement traditional biophysical analyses and can assist the agency in determining whether particular activities or uses are consistent with desired conditions (box 4; fig. 9-7).

Effectiveness of public involvement approaches— Reed (2008: 2417) suggested, "The complex and dynamic nature of environmental problems requires flexible and transparent decisionmaking that embraces a diversity of knowledge and values." Studies suggest that public involvement can improve Forest Service analyses and provide information otherwise unavailable to the agency that may improve the quality of the decision (Creighton 2005, Hoover and Stern 2014). Scholars have identified additional benefits, including enhanced relationships, reduced conflict, public buy-in, and increasing compliance with agency regulations and removing barriers to project implementation (Koontz 1999, Stern 2008, Whitall 2007). Although these studies suggest that stakeholder participation can improve the quality of decisions, Reed (2008: 2421) asserted that they do so with one strong caveat: "…the quality of a decision is strongly dependent on the quality of the process that leads to it." What follows is current research concerning institutional constraints as well as public involvement best practices that can either enhance or hinder the quality of public involvement and hence the quality of associated decisions. Another critical consideration affecting the quality of decisionmaking is the perception and effect of public involvement activities on indigenous peoples and nations.

Von der Porten and De Loë (2014) conducted a systematic review of collaboration literature that focused on environmental concerns and referred to indigenous peoples. Through this review they found that many collaborative processes are grounded in assumptions about the roles of

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Figure 9-7—Participatory mapping for travel management planning, Washington.

different members of society in decisionmaking that are incompatible with how indigenous peoples view themselves. While indigenous peoples have been portrayed as "stakeholders," "minorities," "groups," "participants," or as "nations," only the recognition of indigenous peoples as nations aligns with indigenous governance literature (Von der Porten and De Loë 2014: 1041). Thus, they affirm, "…how indigenous peoples are characterized and treated in collaborative processes is a sensitive and important issue" (Von der Porten and De Loë 2014: 1041). Chapter 11 discusses tribal governance and efforts to share traditional ecological knowledge and tribal perspectives as part of tribal engagement in resource management.

Institutional constraints—

Scholarly research concerning institutional constraints to public participation and the quality of decisions addresses three different levels within the U.S. Forest Service: agency, unit, and employee (Davenport et al. 2007, Kaufman 2006, Margerum and Whitall 2004, Stankey et al. 2003). Agency-level constraints have been attributed to diminished resources, organizational commitment, centralized power structure, and the statutory and regulatory environment (Davenport et al. 2007, Stankey et al. 2003).

Through their research, Davenport et al. (2007) identified the centralized system of decisionmaking as inhibiting the unit's ability to be responsive to the public and address their concerns in a timely manner. Unit-level constraints include increased division of labor, use of technical jargon in planning documents, and reliance on traditional forms of public involvement (Davenport et al. 2007). Here, an increasing division of labor, or specialization, among unit employees was found to reduce the unit's overall responsiveness to communities (Davenport et al. 2007). Additionally, Davenport et al. (2007) found that meeting minimum legal requirements for public involvement was not enough to stimulate local participation.

Employee-level constraints included staff turnover and long-distance commuting (Davenport et al. 2007, Margerum and Whitall 2004, Wondolleck and Yaffee 2000). Studies also acknowledge the difficulty in maintaining long-term relationships with local communities, private entities, and nongovernmental organizations from frequent turnover of personnel (Davenport et al. 2007, Margerum and Whitall 2004, Wondolleck and Yaffee 2000). Paradoxically, advancement within the Forest Service hierarchy is frequently dependent on personnel moving to different locations within the agency (Wondolleck and Yaffee 2000). Kaufman's study of the U.S. Forest Service (2006) found that by routinely moving field officers to different agency locations and levels, they formed allegiances to one another, the organization, and specific policies and procedures, allowing a large, dispersed organization with multiple objectives to successfully create a coherent, unified decisionmaking regime. Kaufman (2006) further acknowledged that this unified approach has not been without challenges, especially during times of social change. The 2012 planning rule's emphasis on collaborative development of land management plans represents a change from previous planning rule public involvement requirements by emphasizing the importance of building and maintaining relationships. Specifically, the planning rule final directives state that "public participation…helps build and maintain working relationships, trust, capacity, and commitment to the plan" (USDA FS 2015b: 3). Building and maintaining relationships takes time and requires access. Margerum and Whitall (2004) found that staff turnover slowed the momentum of collaboration efforts in southwest Oregon because of the time required for new participants to become involved and the different operating approaches that new managers held. Davenport et al. (2007: 47) emphasized these findings, noting, "Staff turnover has reduced the time communities and agency personnel have to get to know and trust one another. Long-distance commuting by agency employees has meant they are not actively participating in the community…"

Assessing success of public involvement and applying best practices—

Current research on the effectiveness of public involvement approaches is divided into two categories: (1) those that evaluate the success of **processes** and (2) those that evaluate the success of **outcomes** of processes (Chess and Purcell 1999, Cundill and Rodela 2012, Muro and Jeffrey 2008, Newig and Fritsch 2009, Renn 2006). Chess and Purcell (1999: 2685) acknowledged that "evaluating the

outcome …is problematic because researchers cannot be sure if an effect is due to public participation efforts or to other variables." Yet they take a position in the middle of the process-outcome spectrum by arguing that "…neither "good" process nor "good" outcome is sufficient by itself." Cundill and Rodela (2012) agreed with this middle ground by suggesting that processes and outcomes work in tandem: improvements in processes such as sustained interaction, shared knowledge, and ongoing deliberation can lead to social outcomes of improved decisionmaking, better relationships, and improved problem-solving capacity. Muro and Jeffrey's (2008) research found additional social outcomes of participatory learning processes, including the generation of new knowledge, acquisition of technical and social skills, and increased trust. Finally, Newig and Fritsch (2009) supported Renn's (2006) argument that listening to the public and establishing a two-way communication stream is not alone sufficient: "Discursive processes need a structure that assures the integration of technical expertise, regulatory requirements, and public values" (Renn 2006: 9). In combining these processes effectively, Newig and Fritsch (2009) concluded that the ecological standard of decisions was positively influenced. Yet, Irvin and Stansbury (2004) argued for caution in deciding whether participatory processes achieve better outcomes on the ground. They found that certain situations precipitate "ideal" (low-cost/high benefit) conditions for public involvement, while other circumstances led to "ineffective and wasteful" (high-cost/low benefit) participatory processes (Irvin and Stansbury 2004: 62).

Finally, the literature shows broad consensus over key features of best practices in public involvement processes. Reed (2008) used qualitative methods and a systematic approach to derive key features from existing literature that includes the following:

- Stakeholder participation needs to be underpinned by a philosophy that emphasizes empowerment, equity, trust, and learning.
- Stakeholder participation should be considered as early as possible and throughout the process.
- Relevant stakeholders need to be analyzed and represented systematically.
- Clear objectives for the participatory process need to be agreed among stakeholders at the outset.
- Methods should be selected and tailored to the decisionmaking context, considering the objectives, type of participants, and appropriate level of engagement.
- Highly skilled facilitation is essential.
- Local and scientific knowledges should be integrated.
- Participation needs to be institutionalized, ensuring that decisionmakers are comfortable in committing to an unknown outcome of a participatory process, while understanding that ultimate decision authority resides with the agency.

Summary—
The quality of a resource management decision depends on the quality of the process that leads to it. A public involvement strategy that resonates with a dynamic and diverse range of interests helps to ensure sound resource decisionmaking. Best practices include a philosophy of empowerment, equity, and inclusiveness; systematic assessment of potentially relevant stakeholders and strategies to encourage participation; engaging stakeholders early in the process; iterative or frequent engagement throughout the process; clear objectives, timelines, and parameters; skilled facilitation; integration of local and scientific knowledge; and enduring agency commitment to the process. NEPA grants agencies broad discretion in the structure of public involvement; agencies engaged in resource planning are empowered to take advantage of the spectrum of public involvement approaches. Different planning phases may call for different levels of public involvement. Defining these various levels of engagement prior to initiation of plan revision promotes a robust participation process.

Agency-Citizen Collaboration

Contemporary natural resource management decisions present complex choices among interests and values, so that the choices are political, social, cultural, and economic, as much as they are scientific and technical (Dietz and Stern 2008). As a result, over the past several decades, communities, governments, private organizations, and individuals

have increasingly turned to collaboration as a supplement to traditional planning and decisionmaking processes. By focusing on shared concerns and promoting problem-solving, the intent is to better address complex resource management issues such as watershed management, endangered species management, planning for climate change, or habitat restoration.

Collaboration is defined here as "a process through which parties who see different aspects of a problem can constructively explore their differences and solutions that go beyond their own limited version of what is possible" (Gray 1989: 5). Collaborative approaches are often place based, cooperative, involve multiple parties, and strive to create or improve relationships between individuals and groups, or develop solutions to specific issues or problems. The approach involves interactions with representatives of a variety of stakeholder groups and organizations, often over a period of months or years, depending on the scope and complexity of the group's efforts. Collaboration requires diverse stakeholder participants (private landowners, American Indian tribes, government organizations, nongovernmental organizations, businesses, and others) to work together over a period of time to identify and address resource management issues. The efforts often rely on outside neutral facilitators to help them work toward their common goals.

Why collaboration?—

The rise of collaborative approaches reflects a shift toward increased civic participation in agency planning and decisionmaking. This shift has occurred because resource management issues are not easily solved, are characterized by incomplete or contradictory information, and are subject to increasing interdependencies between management agencies, nongovernmental organizations, and citizens (Head 2008). Natural resource management also has become extremely complex and networked, as responsibility for many issues has shifted from the federal government to state and local governments as a result of shrinking federal government resources and programs (Emerson and Nabatchi 2015). Frustration with gridlock, declining budgets, and overall lack of trust in government decisionmaking processes have fueled interest in collaboration, as have challenges with the multiple jurisdictions and landowners needed to effectively manage resource issues across landscapes (Dukes and Firehock 2001, Wondolleck and Yaffee 2000).

Societal expectations and policy-driven requirements for public involvement in resource decisionmaking have also increased the use of collaborative approaches. For example, in the Forest Service, "…laws such as NEPA, NFMA, and the Endangered Species Act (ESA) provided important leverage to conservation groups and gave them an empowered seat in collaborative processes" (Nie and Metcalf 2015: 6). Nie and Metcalf (2015) summarized the evolution of collaboration in the Forest Service, noting that "collaboration was increasingly invoked to facilitate a more inclusive dialogue as part of a new focus on ecosystem management in the 1990s," and the two were linked together by the Forest Service's Committee of Scientists (1999), which recommended more ecosystem and collaborative-based approaches to forest planning (Committee of Scientists 1999). Collaboration was also called for in the 2003 Healthy Forests Restoration Act, the 2009 Collaborative Forest Landscape Restoration Act, and the 2012 NFMA regulations, which focus extensively on public participation in forest planning, with collaboration encouraged by the agency, and public participation required during plan development, revision, and amendment (Nie and Metcalf 2015).

Collaboration is touted as an appropriate approach because many resource management issues are local, site specific, and often cannot be easily resolved within legislatures, agencies, or courts (O'Leary and Bingham 2003). Proponents of collaboration argue that it is a logical response to policy gridlock and litigation (Susskind et al. 1999) and an alternative to centralized planning and command and control regulation. Collaboration can produce more creative and adaptive solutions to natural resource management problems, encourage shared ownership of the problem, and facilitate implementation of potential solutions (Bacow and Wheeler 1984, Susskind et al. 1999). Such efforts also can garner sufficient resources or expertise to achieve what cannot be accomplished by one single party or a smaller coalition, and is often less costly than litigation

(Dukes and Firehock 2001, Susskind and Ozawa 1984). In many cases, collaboration has proven to be a powerful tool for resolving conflict, building trust, addressing uncertainty, fostering cooperation and coordination, and developing capacity for addressing future resource management issues (Wondolleck and Yaffee 2000). Collaboration is often viewed as part of the solution to increasing trust and social license for forest management.

General critiques and concerns about collaboration— Critiques of collaborative approaches argue that the process does not necessarily ensure "better" decisions, and that collaboration may reinforce existing power disparities rather than promote truly diverse stakeholder inclusion and meaningful dialogue (Burke 2013, Dukes and Firehock 2001). Not all stakeholders can or will participate; there may not be enough time to resolve the issues; the issues may not be "ripe" or ready for collaboration; and there are serious capacity concerns related to the time and other resources needed for participation (Amy 1987).

Other studies have raised concerns about the devolution of public lands management and suggested that collaboration could potentially weaken environmental protection (Hibbard and Madsen 2003, Kenney 2000). Questions have been raised about the nature and quality of the environmental outcomes from collaborative processes, which is an enduring question across all sectors. Layzer (2008: 5) suggests that "…the initiatives whose goals were set in collaboration with stakeholders have produced environmental policies and practices that are less likely to conserve and restore ecological health than those whose goals were set through conventional politics." More recently, efforts to understand links between collaboration and performance reveal that while there is a perceived positive link between the two, concerns remain about costs in terms of power, time, conflict, stress, process, suboptimal outcomes, and resources required (Mitchell et al. 2015).

Structures and functions of collaborative approaches— In practice, collaboration is designed and implemented in a wide variety of ways. Differences in structures and functions across several key factors illustrate multiple interactions, each of which affect the processes and outcomes of a particular effort. Collaborative efforts can vary in several ways including:

- Who sponsors (funds all or part)
- Who convenes (plans and leads)
- Facilitation
- Scope (local, state, regional, national, international)
- Jurisdictions, authorities, and laws
- Geographic scale (related to scope)
- Participants and who they represent (more inclusive or less inclusive)
- Purpose and goals (e.g., policy or issue oriented; or site specific and focused on a specific issue related to a particular place)
- Drivers of the effort, such as direct conflict over an issue, or a perceived opportunity
- Urgency of issues and timeframe for decision
- Formal and informal rules (decisionmaking approaches—ranging from consensus to voting to agency maintaining decision authority, managing interactions over time)

Types of federal forest land collaboration and trends in the Pacific Northwest— Research on federal forest land collaboration in the Pacific Northwest has covered collaboration at scales from local communities of place to larger landscapes and regions. It has tended to focus on collaboration for wildfire risk reduction and forest health restoration, and particularly on collaboration during planning (e.g., before and during NEPA analysis, or community wildfire protection planning). Although collaborative watershed management for fish habitat and other aquatic restoration goals has also become common practice, most of these efforts have focused on private landownerships and capacity to implement restoration projects on the ground, so science on this topic is not reviewed here.

Because there is no established baseline from which to begin, it is difficult to accurately and completely describe the status of collaborative forest management on national forests, and whether or how this has changed over time. Anecdotally, there are a plethora of types of collaboration

in the region, yet there are few if any studies that comprehensively document this (censuses, statewide assessments, etc.). Some documentation can be found in policy or program reports (Bixler and Kittler 2015, Swezy et al. 2016, White et al. 2015), or student theses (Hughes 2015, Spaeth 2014, Summers 2014), but there is no single standard for defining, identifying, or studying collaboration. Although much of the existing science on collaboration consists of case studies, the research has identified common themes, challenges, lessons learned, and best practices. Two overall trends emerge from the available science:

- Collaboration takes place at a variety of spatial and political scales but is increasingly occurring over larger landscapes as federal policies and programs have focused at larger scales over time.
- Collaboration is increasingly occurring through collaborative groups ("forest collaboratives") that meet regularly and focus on a specified landscape, rather than individual processes or projects. Organization and leadership of these groups differ greatly by location and context.

Changes in the scale of collaboration over time— Collaboration often is thought of as occurring at the local community scale, referring to communities of place. This is a very fine-scale approach. Following the NWFP and listing of species such as the northern spotted owl (*Strix occidentalis caurina*) and Chinook salmon (*Oncorhynchus tshawytscha*), community-based collaborative efforts arose in several affected communities in the Pacific Northwest states. These are documented in previous science syntheses covering the period prior to 2003 and are often described as community-based forestry, community forestry, community-based conservation, or grassroots ecosystem management (Baker and Kusel 2003, Weber 2003). Early efforts were often spurred by local community members, typically working on a range of projects including, but not limited to, federal lands management, e.g., local business development or community multiparty monitoring. The goal of these efforts was to improve ecological and socioeconomic conditions in a given place, and leadership was local.

From 2001 onward, there has been a trend toward collaboration driven in part by state and national policies and programs. A primary focus of more community-scale collaboration since 2003 has been community wildfire protection planning, spurred by the National Fire Plan (2001) and Healthy Forests Restoration Act (2003). However, the scale of these processes and plans differed, as some plans covered subdivisions or neighborhoods, while others were for entire counties (Jakes et al. 2007). Currently, there are community wildfire protection plans (CWPPs) in nearly every county and at smaller community scales in the NWFP area, indicating that this form of collaboration has become widespread (Oregon Department of Forestry, Washington Department of Natural Resources, California Fire Safe Council). However, the nature of collaboration around the plans also differed; some were largely developed by consultants and others through extensive community engagement and collective action (Williams et al. 2012). Over time, there has been an increase in community-scale groups collaborating beyond this planning process under the "cohesive strategy" process (USDA FS 2014). Twelve communities (two of which are in the Plan area) are collaborating through the tools provided by the Strategy to become "fire-adapted communities." They also are participating in a larger nationwide network (Fire-Adapted Communities Network).

No scientific research has comprehensively reviewed these CWPPs, but there has been some case study research. The largest study included 13 CWPP cases at diverse scales, (including two cases from the Plan area), and found that successful CWPP processes emphasized problem framing, choosing tractable scales, and ensuring a path toward implementation (Williams et al. 2012). Other studies found that trust was an essential ingredient in two cases in west-central Montana (Lachapelle and McCool 2012). However, one study of two cases in Oregon (one in the Plan area and one in eastern Oregon) concluded that CWPP processes were not necessarily successful for future wildfire risk reduction, in part because communities could not or did not establish effective decisionmaking processes or have sufficient influence to induce change (Fleeger and Becker 2010).

Collaboration in the Pacific Northwest has more recently shifted to a focus on watershed and landscape-scale restoration. The term "landscape" has multiple definitions and expressions. For the Forest Service, the Forest Landscape Restoration Act (2009) and resulting Collaborative Forest Landscape Restoration Program (CFLRP 2010) allocated funds to national forest units and their collaborative partners to work on landscapes of at least 50,000 ac (20 234 ha) with a 10-year plan of prioritized restoration treatments (Schultz et al. 2012). Within the Pacific Northwest states, there are currently nine CFLRP projects (USDA FS 2015a). These are largely outside the NWFP area, given the program's wildfire focus. Portions of the Okanagan-Wenatchee and Deschutes National Forests, where two CLFRPs are active, are within the Plan area. Insights about the program, however, may be applicable to future collaborative efforts within the Plan area.

An initial study of the CFLRP suggested that collaborating at the landscape scale and requiring monitoring could result in more efficient future forest management (Schultz et al. 2012); but further research indicates that barriers such as lack of stakeholder and agency capacity may be emerging (Schultz et al. 2014). Another monitoring report identified inconsistent implementation of socioeconomic monitoring among the CFLRs (Swezy et al. 2016). Other recent research has dug more deeply into collaborative processes and collaboration during the implementation stage (Butler et al. 2015). Collaboration during implementation expands possible roles for collaborative groups, which in the past have been confined to planning and monitoring activities. Collaboration during the implementation phase also may strengthen accountability and stakeholder diversity (Butler et al. 2015). Increasing collaboration during implementation may pose new legal tensions; meanwhile, given that ultimate decisionmaking authority remains with the land management agency. Another related study finds that the program's mandate to collaborate may lead to increased stakeholder engagement and attention to designing effective collaborative processes (Monroe and Butler 2016). Bixler and Kittler (2015) conducted a meta-analysis of CFLR research to identify research gaps. The biggest needs in research were related to leadership, trust, and accountability. Finally, Urgenson et al. (2017) examined six CFLRP collaborative groups, identifying common challenges (meeting multiple objectives; collaborative capacity and trust; and integrating ecological science and social values in decisionmaking) and strategies used to overcome these challenges.

From "collaboration" to "collaborative"—
There is little scientific documentation of how the organization and structure of federal forest land collaboration may be changing (Davis 2015a, 2015b, 2017) and general knowledge of forest collaborative groups in the NWFP gained from discussions with colleagues in regional and national conferences as well as preliminary (unpublished) research in Washington and Idaho. Numerous forest collaborative **groups** or "collaboratives" are now active on national forests in the NWFP area—working together and with the Forest Service beyond individual processes or projects (fig. 9-8). These groups typically have a recognized name, mission, and a regular process for meeting, reviewing federal land management activities, and providing collective input to the Forest Service. But, there is no single definition of "collaborative" currently found in federal or state policy, and likely a great degree of variability in what these collaboratives do and how they are organized between and among states.

The trend of organized collaboratives groups has been extensive in Oregon, where an estimated 25 forest collaboratives are currently identified as active in all national



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Figure 9-8—South Santiam All-Lands Collaborative, Oregon.

forests (Davis et al. 2015a, 2017). Other Western states (California, Colorado, Idaho, Montana, and Washington) also have growing numbers of identified collaborative groups. Although some of these efforts date to the 1990s, particularly in California and Oregon, a majority appear to have originated more recently (post-2009). No comprehensive assessment or empirical research on these collaboratives has been conducted. Existing research suggests that "collaboratives with formalized structures and workgroups" tend to be more successful at attracting and using resources than less formalized groups (Cheng and Sturtevant 2012). The capacity of these groups to organize and accomplish their goals has not been tested.

Elements of successful collaboration—
Notions of success depend on the particular goals of the participants in the collaborative process, and evaluation is challenging because collaborative efforts produce a variety of different products. The large variation in the structure, function, goals, context, and terminology of collaborative processes poses challenges for researchers, making it difficult to operationalize and measure collaboration and collaborative performance, and there is little agreement about what constitutes effective performance in collaborative arrangements (Emerson and Nabatchi 2015). Further, a majority of existing science on collaborative evaluation examines single or few case studies, and often, only a few factors of success. Therefore, the amount of generalizable or comprehensive information about what constitutes successful collaboration is limited. In particular, little to no research explicitly evaluates collaboration in the NWFP area.

Evaluations of collaboration that do exist have tended to focus on combinations of process, social, environmental, or economic criteria (Conley and Moote 2003). For example, collaborative efforts are often deemed successful based on process outcomes such as whether the effort established a shared vision among participants, had diverse and inclusive participation, used an open and transparent process, made links to groups beyond those participating, and made decisions by consensus. Social outcomes could include relationships built or strengthened, increased trust, whether participants gained knowledge or understanding, increased capacity for dispute resolution, or changes in existing or new institutions. Process and social outcomes can be particularly confusing to analyze, because they can also be factors in success as well as evidence of success. A study conducted of six projects in national forests in eastern Oregon suggests that four of the six projects that had input from collaborative groups appeared less likely to be appealed (Summers 2014); more research is needed to understand potential intervening variables and to identify a clear definition of "collaboration" among these cases (box 5).

The environmental outcomes of collaboration are also difficult to evaluate owing to monitoring challenges, relatively long time frames between implementation of collaborative outputs and detection of environmental responses, and demonstrating that implementation of collaborative involvement (rather than other factors) changed environmental conditions (Koontz and Thomas 2006). Further, scientific studies of economic impacts of collaboration are also limited, although some policies and programs are increasingly requiring monitoring of job creation and economic activity. Similar to the environmental outcomes challenge, linking specific collaborative activities to economic outcomes is quite difficult.

More recent efforts to understand links between collaboration and performance reveal that while there is a perceived positive link between collaboration and performance, concerns remain about costs in terms of power, time, conflict, stress, process, suboptimal outcomes, and resources required (Mitchell et al. 2015). Margerum (2011) presented an overview of the principal elements of successful collaboration (see box 5), which can focus on inputs (information for decisionmaking); process (such as the equitability, diversity of participation, and other aspects of the decisionmaking process); outputs (assessing products, such as plans or agreements); performance (measuring plan and policy performance); outcomes (monitor actual results); and program logic (linking outputs to outcomes).

The available research on successful collaboration in federal forest lands is quite limited, and focuses on selected factors of success. No research is available that addresses all possible factors of success. From the available research, the following can be important ingredients for success:

Box 5— Factors Identified With Successful Collaboration

Inputs:

- Clear goals
- Available information
- Appropriate scope
- No fundamental value differences
- Issues are "ripe" for collaboration
- Appropriate scale
- Appropriate authority

Process:

- Shared information
- Trust/good faith in participation
- Decision rules
- Shared vision/goals
- Diverse participation
- Satisfaction
- Membership
- Facilitation
- Legitimacy
- Support for agreement/process

Outputs:

- Plan, agreement or project
- Implementation plan
- Monitoring or enforcement
- Clear communication
- Shared, high-quality fact base
- Intervention strategy

Outcomes/performance:

- Difficult to evaluate because of time lag associated with implementation
- Difficult to link to collaborative effort unless well documented and monitored
- Research needed linking outcomes to specific actions of collaborative groups
- Collaborative capacity, or the ability to "organize, coordinate, and manage people, resources, and tasks to achieve desired outcomes" (Cheng and Sturtevant 2012: 2).
- A shared culture and set of behaviors (Cheng 2006).
- Inclusion of all interests (Hibbard and Madsen 2003)
- Undertaking monitoring, joint fact-finding, or other information gathering and learning activities, which has been found to lead to shared understanding, social learning, a sense of community, and trust; however, research also finds that monitoring data are often not being used or rarely results in adaptive management (Fernandez-Gimenez et al. 2008).
- Agency participation, which can demonstrate commitment and bring technical knowledge and support (Butler 2013, Wondolleck Yaffee 2003).
- Genuine non-agency, community leadership (Cheng 2006).

Summary—

Collaboration has been widely accepted as a useful model for engaging diverse stakeholders in the process of deliberation over critical forest issues, including fire, forest restoration, and wildlife protection. Collaboration requires time, resources, and enduring commitment. Managers choosing to participate in collaborative efforts may want to ensure they have adequate resources and provide support to staff to enable them to build these relationships over time. Successful agency participation in collaboration includes open communication, clear expectations, and realistic information about internal priorities, plans, schedules, and decision points. Collaborative groups may be part of the solution to increasing trust and social license for forest management to meet NWFP and other goals. Yet, not every stakeholder is eager to participate in a collaborative. The scope, scale, and end goals of a given collaborative effort may make it more relevant and accessible to some stakeholders than others. Currently, collaboratives in the NWFP area exist in a variety of forms and are engaged in a diversity of

activities, including stewardship contracting, environmental assessment for NEPA, and monitoring (Davis et al. 2015b). Federal land management agencies have committed resources to collaboration and have invested in its long-term success. Collaboration is often viewed as part of the solution to increasing trust and social license for forest management. Yet, we do not have consistent evidence that collaboratives are achieving the goals that proponents have espoused, including trust building, better results on the ground, a reduction in appeals or litigation, or improved forest health.

Research Needs, Uncertainties, Information Gaps, and Limitations

Socioecological systems science recognizes that human societies and ecological systems are interwoven and interdependent (Berkeset al. 2000). We understand that ecosystems are embedded in levels of social organization (Brondizio et al. 2009). Although contemporary resource management is built from a strong foundation of ecological information, knowledge of our social systems and how they integrate with ecological elements at the appropriate geographic scale is sorely lacking. The need is great for data that describe the socioeconomic, psychological, cultural, and political landscape in the NWFP. This chapter characterizes the current state of knowledge in the planning area and identifies the gaps.

In this section, we identify the most high-priority research needs and significant gaps in knowledge for each of the five key findings of this chapter. The dearth of social science research in the NWFP area creates a need for a wide variety of studies to understand more about changing values and relations with place, changing recreation patterns, and changing expectations for public involvement in resource management. The recent emergence of collaborative forms of governance is creating new opportunities for the public to engage in resource management, although the science has not yet captured the benefits and challenges of collaboration.

Public Values, Attitudes, and Beliefs

Values orientations of North Americans are said to be shifting from an emphasis on resource production to a balance of resource protection and production. However, little research has been conducted in the past 20 years to assess the current status of environmental values, either nationally or regionally. Longitudinal data is sorely lacking in the social sciences, as most research studies focus on a single case (Stidham et al. 2014). Longitudinal social values monitoring in the NWFP area would help to evaluate regional trends and identify any subregional variations or disparities among urban, amenity-migrant, and rural residents. Values research also would be useful to identify value sets held by sociocultural groups and stakeholders with a keen interest in management of the NWFP lands. A better understanding of stakeholder values will help land managers identify and predict attitudes toward resource management practices such as restoration.

Constraints to conducting this work are primarily budgetary and regulatory. First, the cost of random-sample survey work has escalated in recent years, and societal trends in favor of privacy have made it challenging to collect survey data with an adequate response rate from the study population. New ways to budget for this type of consistent social data might be considered as well as ties with existing agency monitoring programs. Second, any survey being conducted by federal government agencies or on behalf of federal agencies is required to undergo review by the OMB per the Paperwork Reduction Act of 1995. This OMB approval process must ensure that the public is not being unduly burdened or harmed by the study or that the project is not redundant. Interagency coordination of public values studies within the NWFP area may help to increase efficiencies associated with obtaining OMB approval.

If a process was established to monitor public values at reasonable iterations (every 10 years, for example), data collection and analysis could be standardized and institutionalized, with efficiencies gained. These data would benefit multiple resource agencies and provide the opportunity for

public values and environmental beliefs to be considered by federal, state, and municipal land managers. Without these data at the regional or local scale, land managers are left to make decisions based on information gathered in public meetings or in small studies that are not coordinated regionally and may not accurately reflect the definitive views of a diverse public.

Finally, new research about the social acceptability of forest management practices is warranted, with emphasis on public knowledge and perceptions of ecological forestry as well as traditional forms, reactions to a diversity of treatment types and setting conditions, and with a focus on understanding the role of trust and communication on shaping public responses.

Valuing Place

Extensive literature exists on the concept of place and its relationship to natural resource management. However, very little of this research has taken place in the Pacific Northwest or California. The need for applied research that helps managers and policymakers capture and integrate into planning the place meanings associated with forest socioecological systems is therefore great. Findings from such studies can be applied to the NWFP area.

One area for place research that has immediate practical utility for land managers is improving understanding of the physical and social characteristics associated with places that tend to trigger place-protective behaviors. This knowledge would be useful for land managers making decisions about what places to emphasize for protection through management, where to focus management, or where to allow certain activities to occur. Places mean different things to different people. A related research topic has to do with identifying how place attachment differs within forest user groups. For example, boaters residing near a lake may resist proposed closures of picnic areas on the lakeshore, whereas boaters who come from a distance may be indifferent to those closures. More broadly, place research can also help managers better understand where to allow certain activities by forest users and where to focus vegetation management and other activities.

A gap exists in our knowledge about which public engagement methods are most effective for capturing place meanings for different segments of the public. Studies suggest that Internet and mail surveys as well as standard mapping workshops tend to be biased toward forest users who are older, better educated white men with relatively high incomes. A workshop format proved successful at reaching Latino forest product harvesters on the Olympic Peninsula (Biedenweg et al. 2014), forest users who were not reached through a broader mapping workshop process. However, only the tip of the iceberg has been seen so far, and more work needs to be done to determine which methods work for which segments of the population. Additionally, there is a mismatch between the techniques likely to be effective at reaching nontraditional forest users and the capacity of the land management agencies to conduct such outreach. A grassroots-driven mapping project on the Mount Baker–Snoqualmie National Forest offers a promising avenue for how land management agencies can work with partners to augment their capacity for developing place meaning inventories (McLain et al. 2017a).

Finally, a regional or forestwide sense of place assessment might usefully inform forest management decisions and public engagement processes. Key questions might be: What places matter to people? To whom do they matter, why, or for what? How much do they matter? And, under what social, economic, political, and ecological circumstances do they matter? Because the answers to these questions are likely to differ depending on the socioecological context, a clear need exists for research that moves beyond isolated case studies toward a coordinated set of regionwide applied research projects. There is a need for applied research on place meanings and related concepts, such as place attachment, place identity, and place dependence. By applied research, we mean the systematic collection and analysis of data that are deliberately structured so as to inform land management and policy.

Cultural Ecosystem Services

A 2015 presidential memorandum directs all federal land managers and regulatory agencies to use an ecosystem services framework for planning, policymaking, and decisionmaking (OMB 2015), and consideration of ecosystem services is also required by the 2012 forest planning

rule (USDA FS 2012). New research on cultural ecosystem services has drawn attention to the less tangible benefits associated with forest ecosystems. However, there have been few empirical studies that explore how people perceive cultural services, how cultural services may be operationalized, measured, and monitored, and how to integrate cultural services into the planning process. Case studies in ecosystem services management with inclusion of cultural services are needed to build a foundation of knowledge. In addition, tools and applications are needed that reinforce concepts in cultural ecosystem services. Early studies and cases in the NWFP area offer new insights and promising prototypes. In particular, it would be helpful to learn more about how cultural services have been bundled in various ways and whether it makes sense to unbundle them.

Outdoor Recreation

Much of recent scientific literature on U.S. outdoor recreation is at the national level or from studies in other U.S. regions. Just because those studies were not completed in the NWFP area does not mean their findings are not transferable to the NWFP area. However, it would be useful to increase the amount of recreation research in the NWFP area to learn whether there are unique patterns locally. Much of the traditional scientific literature on national forest recreation focuses on what the authors thought were traditional national forest recreation activities, such as backpacking, primitive camping, and hunting. Contemporary recreation use is much more focused on short visits, often to developed recreation sites, and focused on generalist activities. New research is needed to understand how the Forest Service fits into current and future demands for the full suite of leisure patterns by Americans, and specific desired outcomes from national forest recreation. The recreation research literature lacks comprehensive studies of multiple, combined factors of sustainable recreation; most of the current literature has focused on one or two factors (e.g., economic impacts, social impacts) individually, and does not look at the whole array of factors in an integrated fashion. Comprehensive studies that consider integrated factors of sustainable recreation will inform managers as they respond to policy direction to manage for sustainable recreation.

Trust

Research on trust has identified and defined multiple types of trust in the context of natural resource governance. Stern and Coleman (2014) identified four types of trust: dispositional (one's natural inclination to trust); rational (stemming from predictable behavior, past performance, and reasoned logic); affinitive (based on personal relationships that develop through repeated encounters); and procedural (based on having processes that are viewed as fair, just, and open). A follow up study found that at least three types of trust needed to be present for broader institutional trust to be acknowledged (Stern and Baird 2015). Although this study was conducted in the context of natural resource collaborative groups, the trust typology is applicable to other forms of forest governance. More research is needed to understand the various types of trust and how they interact. For example, how does affinitive (interpersonal) trust relate to broader agency trust? What happens when rational trust declines, while procedural trust grows? What types of processes and protocols help to enhance procedural trust?

There are opportunities to explore how broad-based trust for a public agency affects project-level trust, and vice versa. In other words, what happens when the public distrusts the agency at the national policy level but has greater trust in the ability of local officials to manage a project? And, what happens when there is high broad-based trust in an agency's purpose, but lack of trust at the project level? In addition, more information is needed about the ways that public trust can influence social acceptability of forest management practices, such as active management and forest restoration as well as prescribed burns. Finally, trust can be enhanced through participation in various types of public engagement opportunities and in collaborative or comanagement groups. Yet, it is not clear what types of trust may be generated by these different types of processes.

Public Involvement

Peer-reviewed research on public involvement is limited in the NWFP area. Broad-scale questions exist concerning the disconnect between participatory requirements and Forest Service structures and cultural norms. Practical policy implications of public involvement in decisionmaking lead

to questions of accountability, such as: To what degree does the agency give up some control and still maintain or improve social, economic, and ecological outcomes? Perhaps more fundamental is the question: What results are important to achieving socially sustainable outcomes? The application of stakeholder and social network analysis within the government sector remains largely untapped, and could provide a wealth of knowledge about building effective networks in support of the public good. Specific questions also exist concerning public involvement methods employed by the "early adopter" national forests engaged in planning under the 2012 planning rule.

Forest Service social scientists can play a much greater role in assisting the agency develop innovative public involvement strategies. Although the field of social science is diverse, expertise exists in the methods and practice of understanding values, attitudes, and beliefs; stakeholder and social network analysis; and place identity and attachment through tools like public participation GIS. Integration of these foundational methods and practices into programmatic forest planning can increase the likelihood that land management decisions better reflect the diverse range of public and tribal interests.

Agency Collaboration

Very little research has been conducted on forest collaboration in the NWFP area, and our synthesis only examines research on Forest Service-related collaborative efforts. Therefore, many gaps and research needs exist. First, large-scale, comprehensive studies of collaborative forest management and how it has changed are needed, including basic information about how many collaboratives exist and how they are defined and function. It is not possible to say whether communities are more engaged with the agency than before, or how, as there is no commonly accepted definition of "engagement" or what would indicate "more engagement." Research on collaboratives tends to occur via case studies, and single case studies are not generalizable to broader scales. Further, because much collaboration has occurred around wildfire in dry forests, few studies have focused on the NWFP area, which means there is even less clarity about the drivers, activities, outputs and outcomes of collaboration. Many NWFP forests differ from their east-side counterparts in terms of higher annual precipitation, longer historical fire-frequency intervals, diverse moist/wet forest types, presence of endangered species, different forest health challenges, increased population density, and proximity to urban areas; southern Oregon and northern California forests have more frequent fire and a mixture of east- and west-side characteristics.

Second, no scientific evaluations have been conducted on whether, or how, collaboratives are achieving resource management goals or social or economic objectives. No studies measure these goals or outcomes, or identify what can be attributed specifically to collaboratives as opposed to other variables such as economic change, agency or other organizational change, efforts from programs and activities occurring outside the collaboratives, etc. One study monitored changes in several indicators such as timber harvest, acres restored, and jobs created as a result of the state's Federal Forest Health Program in Oregon, but it did not clearly link these outcomes to specific activities of collaboratives (White et al. 2015). One master's thesis examined the question of whether collaboratives in eastern Oregon are decreasing appeals—a topic of great interest to managers and policymakers—but the evidence was largely inconclusive (Summers 2014).

Beyond these broad questions, additional questions about collaboratives remain unanswered and present rich opportunities for future research. Some of these relate to process: How do collaboratives build, codify, and use social agreement? Does the agency use the agreements that collaboratives make, and if so, how? Other questions relate to the roles of various stakeholder types (e.g., industry, conservation, American Indian tribes) and whether and how they participate. How collaboration relates to other processes such as consultation with tribes or the established public process used during environmental planning is not well understood. Moreover, the potential tradeoffs of forming an enduring collaborative group versus a collaborative process for specific issues or decisions have not been assessed. For example, do the investments in capacity and organizational development of collaborative groups pay off in outcomes? Do collaborative groups offer input

that accurately reflects the spectrum of public values? In general, the need for collaborative groups or processes may differ and collaboration may not provide solutions for all issues in all places. Additional questions concern collaboratives and knowledge production, as many collaboratives focus on "science-based restoration." How compatible are scientific and collaborative processes? What role do collaboratives and agencies have in bringing science to bear on management? Finally, few if any studies have examined the ability of collaboratives to endure and adapt in the face of shocks and stressors, such as large wildfires, climate change, or community social discord.

Conclusions and Management Considerations

Conservation goals are most often met when ecological and social elements are integrated (Charnley 2006). Socioecological system (SES) science recognizes that changes to society, including demographic shifts, changes in human settlement patterns, new governance structures or regulations, can affect interactions with the natural environment and likewise, large-scale landscape and climate variations can affect human institutions, such as markets and communities. Greater awareness of how social and ecological systems intersect will help resource managers improve the quality of their decisionmaking. This includes greater understanding of human values and management preferences, place-relations, resource uses, and visitation patterns. New participatory strategies have attempted to democratize and deepen citizen engagement in environmental decisionmaking. The proliferation of collaborative institutions has the potential to influence future management of ecological systems. As agencies expand their conceptualizations of forest resources from "sustained yield" to "ecosystem management" to "ecosystem services" in the NWFP area, there are no doubt implications for what this means on the ground. A greater recognition of diverse stakeholder values and place attachments, of shifting visitation patterns across the forest landscape, and of the opportunities for public expression of these values will enhance efforts to understand the NWFP area as a dynamic and integrated system. This chapter notes several highlights of interest to resource managers.

Systematic and steady research and monitoring of public values will enhance our understanding of what is important to people living in and around the NWFP area, or who have a stake in the future of these lands. A greater understanding of environmental values associated with public lands can improve the ability of land managers to weigh public needs alongside the best available science to make management decisions. Information about public values, attitudes, and beliefs also allows managers to anticipate conflicts in values and develop strategies for communicating with stakeholders. As societal values shift, public responses to resource policies and decisions will also likely evolve. And, as population changes occur, new migrants can influence the existing composition of values and value orientations within a particular subregion. Land managers who have access to up-to-date information about the values, beliefs, and preferences of both the general public and a variety of stakeholders and socioeconomic groups at the appropriate geographic scale will be better equipped to understand characteristics of their social system and anticipate the need for change. Moreover, social system data gathered at the appropriate scale can be integrated with biophysical data about ecological conditions to expand understanding of the complex socioecological system and identify possible barriers and opportunities in implementing management plans.

Residents of the NWFP area embody a range of views related to the social acceptability of various land uses, including timber harvest and these views are based on their environmental values, connections to place, knowledge of harvest practices, awareness of goals and outcomes, and degrees of trust. Existing research suggests that stakeholders and citizens in the NWFP generally do not support clearcutting as a desirable silviculture strategy. There does appear to be potential public support for alternative harvest strategies, such as disturbance-based management and other practices that mimic natural processes, particularly when old-growth forests can be avoided.

Recognition of the symbolic meanings and emotional ties that people have with places is important for engaging people in stewardship efforts, encouraging collaboration, and engaging the public in resource management.

The scientific evidence about the importance of place is unequivocal. Places and the meanings that are bound up in them have real implications for forest ecosystem management. Managers can take advantage of the positive power of place as the bonds that people have with places can also motivate them to engage in forest stewardship projects. By recognizing and appealing to these bonds, managers may be able to attract volunteers with substantial knowledge of local conditions to accomplish objectives.

The variability that exists in place meanings, together with the strong feelings that are bound up in people-place relationships, suggests that broad-based public engagement processes are critical at an early stage of the planning process. There are great benefits in considering the dynamics of place in a systematic way. For example, a conflict over forest management that threatens the social identity of stakeholders may call for a very different outreach and involvement approach than another type of conflict where place is important, but not critical to social identity. Because place meanings are dynamic and constantly being renegotiated, a public engagement process that emphasizes multiple ways of collecting data about place meanings and that is deliberately designed to reach out to a broad spectrum of the public, is far more likely to capture the range of meanings than processes that rely on only one type of information gathering approach.

Cultural ecosystem services provides a framework for land managers in the NWFP area to consider the diversity of spiritual, aesthetic, recreation, heritage, discovery and learning, and therapeutic benefits associated with forest settings. Recreation is one example of a quantifiable and measurable benefit that currently is monitored by federal agencies, along with scenic resources and heritage sites. Other aspects of cultural ecosystem services, like spirituality, solitude, wilderness therapy and education, are managed, but not actively tallied, which is a missed opportunity. A growing emphasis on cultural ecosystem services will allow resource managers to recognize the variety of benefits associated with a forest and stakeholder attachment to sets of benefits. The ecosystem services framework may prove useful in identifying and measuring a full range of benefits and values assigned to forests and landscapes.

Recreation visits are expected to grow in day-use settings and developed facilities. At the national level, current scientific literature indicates that the numbers of people participating in outdoor recreation will increase in the coming decades with continued population growth, although participation rates will be relatively flat. From general public surveys and NFS visitor monitoring, we know that the vast majority of outdoor recreation use is for general recreation activities, like hiking, viewing nature, visiting nature centers, viewing wildlife. Further, NFS recreation monitoring indicates that the vast majority of recreation visits to national forests are relatively brief, lasting less than one-half day, and the majority are focused on recreation at developed sites (e.g., day-use areas, campgrounds, visitor centers). Recognition of that pattern of use is helpful when considering the amount of resources committed to managing general, common recreation activities versus more specialized, but perhaps higher profile, activities in which fewer people are engaged. The greatest barriers to participating in outdoor recreation identified in the literature are items over which Forest Service managers have limited control: lack of time and distance to national forests. For items the Forest Service can control, expanding personal safety at recreation sites, improving signage, and providing information, all have been found to have positive effects on user perceptions of site conditions.

Developing decisionmaking processes and protocols that are consistent, reliable, fair, and transparent can help to improve institutional trust. The degree of trust established between public agencies, stakeholders, and communities is an important factor in public support for resource management decisions. Trust is not fixed, but rather is dynamic and iterative—modified by each encounter and shared experience. Public trust of natural resource agencies may vary between the local (or project) level and the national (broad-based) level. Trust exists in multiple forms: dispositional (based on inclination), rational (based on predictability), affinitive (based on relationships), and procedural (based on process), and although trust levels between entities can vary among those four types, enduring trust cannot exist without at least three of these present. Having clearly stated objectives, consistent communication, transparent

processes, reasonable timelines, honored commitments, and opportunities for candid deliberation can enhance trust. Enduring personal relationships also are important.

The quality of a resource management decision is strongly dependent on the quality of the process that leads to it. The necessity of designing public involvement strategies that resonate with a dynamic and diverse range of interests is imperative to ensuring sound decisionmaking affecting Forest Service lands. Best practices provide critical components of an effective public participation strategy, and offer useful guidance for incorporation into decision processes (Reed 2008), including: a philosophy of empowerment, equity, and inclusiveness; systematic assessment of potentially relevant stakeholders and strategies to encourage participation; engaging stakeholders early in the process; iterative or frequent engagement throughout the process; clear objectives, timelines, and parameters; skilled facilitation; integration of local and scientific knowledge; and enduring agency commitment to the process. The NEPA grants the Forest Service broad discretion in the public involvement process, and therefore this process should take full advantage of the spectrum of opportunities available.

Inconsistent use of "collaboration" as a catch-all term for public involvement has often led to conflicting expectations on the part of agency employees, stakeholders, and tribal entities. These different expectations can result in reduced trust, and more importantly, less willingness to participate in long-term planning. The IAP2 Public Participation Spectrum can assist in selecting the level(s) of participation that define(s) the public's role throughout a forest plan revision effort. Different phases of plan revision or any management decision process may call for different levels of public engagement. The key is defining these various levels of public participation prior to initiation of plan revision, ensuring the public a meaningful and robust participation process (Arnstein 1969).

Collaboration takes time, resources, and long-term commitment from all parties. Managers seeking to initiate or participate in a collaborative process or group may want to consider that collaboration, particularly through an organized group, is typically time consuming, requiring tremendous commitment and effort to build and maintain relationships. Managers choosing to participate in collaborative efforts may want to ensure they have adequate resources and provide support to staff who collaborate, so they can build these relationships over time.

Successful agency participation in collaboration includes open communication, clear expectations, and realistic information about internal priorities, plans, and timelines. If plans or timelines change, it helps to provide timely and transparent information. Managers can also aid collaborative efforts by notifying participants of future decision points, and how they may use any collaborative input that they receive. Collaborative groups may be part of the solution to increasing trust and social license for forest management to meet NWFP and other goals.

Collaboration is not the answer for every situation. Not every stakeholder for a management unit will be eager to participate in an organized collaborative group or process. If the alternatives to collaboration are expected to be better than participation, some stakeholders may opt out. In some cases, the outcome from an agency appeal or court decision process may be preferred over collaboration. Moreover, the scope, scale, and end goals of a given collaborative effort may make it more relevant and accessible to some stakeholders than others. Research about the effectiveness of collaborative groups for achieving social and ecological goals is still underway. Until we have definitive results, we do not really know yet whether collaboration is the ultimate answer.

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Inner City Youth Institute, High School Natural Resources Camp, Multnomah Falls, Oregon.
Photo by USDA Forest Service.

Chapter 10—Environmental Justice, Low-Income and Minority Populations, and Forest Management in the Northwest Forest Plan Area

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Introduction

This chapter synthesizes literature about the relation between federal forest management and low-income and minority populations, as defined by Executive Order (E.O.) 12898 (February 16, 1994)—"Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" (Clinton 1994). The order requires federal land managers to identify and address any disproportionately high and adverse human health and environmental effects of agency programs, policies, and actions on minority and low-income populations. In this chapter, we use the term "environmental justice populations" to refer to populations protected by E.O. 12898 in matters of environmental justice (defined below). The U.S. Department of Agriculture (USDA) Forest Service and U.S. Department of the Interior Bureau of Land Management (BLM) primarily address environmental justice in their land and resource management planning processes. For example, the Forest Service 2012 planning rule[2] requires responsible officials to "encourage participation by youth, low-income, and minority populations" (p. 21167) throughout all stages of the planning process, and, under the National Environmental Policy Act (NEPA) process, preparation of an environmental impact statement that includes impacts on low-income and minority populations.

Northwest Forest Plan (NWFP, or Plan) socioeconomic monitoring has not explicitly monitored low-income or minority populations other than American Indian tribes. Moreover, since 2006, NWFP socioeconomic monitoring has focused on status and trends in socioeconomic well-being in the Plan area, and has not examined how these trends might be linked to the NWFP. Thus, we are unable to specify how the NWFP has affected low-income and minority populations. However, federal land managers in the Plan area submitted several priority management questions pertaining to environmental justice and forest management for consideration in this science synthesis report. These serve as the guiding questions for this chapter. Chapter 8 discusses the economic impacts of the plan in Plan-area communities. American Indian tribes are the subject of chapter 11; this chapter focuses on other minority populations.

In the absence of monitoring data, we rely mainly on existing scholarly research studies. Existing environmental justice-related forestry research focuses mainly on urban issues; for example, the distribution of urban tree cover in relation to the social and economic characteristics of people living in different city neighborhoods (e.g., Schwarz et al. 2015). Nevertheless, some studies address how environmental justice populations use and value federal forests. Although none has directly investigated how the NWFP has affected minority populations, some include information about how federal forest management may affect them more broadly. A tendency to think about environmental justice as an urban issue challenges federal forest managers to consider how their actions may affect environmental justice populations in rural settings.

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[2] U.S. Department of Agriculture, Forest Service, 36 CFR Part 219, National Forest System Land Management Planning, Section 219.5. Federal Register 77(68): 21162–21276. April 9, 2012, Rules and Regulations.

Defining Environmental Justice

Most of the following section on defining environmental justice—including the references to other documents—is excerpted from Grinspoon et al. (2014: 3–8), a guidance document for Forest Service staff to help them comply with E.O. 12898 during the NEPA process. NEPA requires the agency to consider the potential social and economic effects of its proposed actions. There is no one universally agreed-upon definition of environmental justice in the scholarly literature; the Forest Service defines environmental justice in accordance with USDA departmental regulations (USDA 1997). Environmental justice includes the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies (USEPA 2013). An environmental justice population is a group of people that meets the criteria for low-income or minority status under E.O. 12898. An environmental justice population may be low income and/or minority.

Defining Minority Population

During the 1980s and 1990s, the U.S. Census Bureau (USDC CB 1999) enumerated population in four racial categories (White, Black, American Indian or Alaska Native, Asian or Pacific Islander), and two categories of ethnicity (Hispanic and non-Hispanic). Adopting the Census Bureau's categories, USDA regulations define a minority as "a person who is a member of the following population groups: American Indian or Alaska Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic" (USDA 1997: 2). Following guidelines for federal data regarding race and ethnic categories issued by the Office of Management and Budget in 1997, the Census Bureau revised its racial categories for the 2000 and 2010 censuses (White; Black or African American; American Indian and Alaska Native; Asian; Native Hawaiian and other Pacific Islander; some other race; and two or more races). It also revised its ethnicity categories for the 2000 and 2010 censuses from Hispanic and non-Hispanic, to Hispanic or Latino and Not Hispanic or Latino. USDA regulations have not been updated to reflect these more recent Census Bureau categories; however, environmental justice guidance documents continue to treat all populations other than non-Hispanic or non-Latino Whites as minorities. Note that there are some White people who are non-Hispanic or non-Latino who may be considered to be minorities based on other national origins (e.g., people of Middle Eastern origin) who are excluded by this USDA definition. For purposes of this chapter, we adopt the terminology for minority populations used by the Census Bureau at the time of the study or data cited; or by the terminology used by the study we cite if it is different from the Census Bureau categories (to accurately represent research findings).

In its direction on environmental justice in NEPA, the Council on Environmental Quality (CEQ) defines a minority population as:

1. A readily identifiable group of people living in geographic proximity with a population that is 50 percent minority or greater. The population may be made up of one minority or a number of different minority groups; together the sum is 50 percent or more; or,
2. A minority population may be an identifiable group that has a meaningfully greater minority population than the adjacent geographic areas, or may also be a geographically dispersed/transient set of individuals such as migrant workers or Native Americans (CEQ 1997).

Defining Low-Income Population

According to the CEQ, a low-income population is a community or a group of individuals living in geographic proximity to one another, or a set of individuals such as migrant workers or American Indians, who meet the standards for low income and experience common conditions of environmental exposure or effect (CEQ 1997). USDA departmental regulations (USDA 1997: 2) state that low-income populations in an affected area should be identified by the annual statistical poverty thresholds from the Census Bureau's annual current population reports (Series P-60) on income

and poverty. The official poverty measure was developed in the 1960s. The Census Bureau (USDC CB 2013) defines low-income populations by the percentage of people living below poverty in a given area, which is consistent with CEQ's environmental justice guidance. Low-income status is determined by comparing annual income to a set of dollar values called poverty thresholds that differ by family size, number of children, and age of householder. If a family's before-tax monetary income is less than the dollar value of their threshold, then that family and every individual in it are considered to be living in poverty. For people not living in families, poverty status is determined by comparing the individual's income to his or her poverty threshold.

For tables showing Department of Health and Human Services guidelines for poverty, see the Federal Register notice (USDHHS 2013).[3] For more information, see also "How poverty is calculated in the ACS [American Community Survey]" (USDC CB 2013). In 2013, the poverty guideline for the 48 contiguous states and the District of Columbia was $11,490 for a one-person household and $23,550 for a four-person household. The Census Bureau updates the poverty thresholds annually using the Consumer Price Index.

Guiding Questions

Regional federal land managers wished to know whether environmental justice populations in the NWFP area have been growing, and to understand the implications of trends in the size of these populations for federal forest management. Thus, this chapter addresses the following questions pertaining to environmental justice, low income and minority populations, and federal forest management:

1. What are the trends in the size of low-income and minority populations in the NWFP area since the Plan was adopted, and what is their current distribution?
2. How do low-income and minority populations interact with federal forests in the NWFP area?

We address the implications of these trends and interactions for forest management in the "Conclusions and Management Considerations" section of this chapter.

Key Findings

Trends in Low-Income and Minority Population Sizes and Current Distribution

The size and percentage of environmental justice populations in the Plan area have increased since the NWFP was adopted, consistently with national trends. This increase has occurred both in the size of low-income populations (measured here by number of people living below the poverty line), and the number of people belonging to minority groups specified by E.O. 12898. These trends are detailed below. We use 1990 as our baseline because of the availability of decennial U.S. Census data from 1990. For current status, we use U.S. Census data from 2012, consistent with the 20-year NWFP socioeconomic monitoring report (Grinspoon et al. 2016). The census data provide the best available information on low-income and minority populations across the Plan area. Although some low-income and minority populations may be missed by census takers, such as transient workers or undocumented immigrants, no other datasets are currently available that capture these populations for the Plan area as a whole in a statistically significant manner.

There are 72 counties—32 metropolitan, and 40 nonmetropolitan—in the Plan area (appendix). The population size data presented below are for the Plan area as a whole, and for metropolitan versus nonmetropolitan counties (in aggregate). There is no evidence to suggest that trends in the size and percentage of environmental justice populations since the NWFP was adopted are in any way linked to the Plan.

Low-income populations—

The poverty rate in the NWFP area as a whole increased from 11.2 to 14.7 percent of the region's population between 1990 and 2012 (table 10-1). Nevertheless, the poverty rate was lower overall than the national poverty rate during the three periods reported here. Although poverty rates fell in many subregions of the Plan area between 1990 and 2000, those improvements were more than offset by increases in poverty across the Plan area between 2000 and 2012. Poverty rates were uniformly higher in nonmetropolitan counties than in metropolitan counties during the analysis period, and they were also higher than the national average (which includes both metropolitan and nonmetropolitan

Table 10-1—County-level poverty rates in the Northwest Forest Plan (NWFP) area, 1990, 2000, and 2012

	1990 poverty rate	2000 poverty rate	2012 poverty rate
	Percent		
United States	13.5	11.3	15.0
All NWFP-area counties	11.2	10.0	14.7
All metropolitan counties	10.3	9.1	13.9
All nonmetropolitan counties	15.3	14.2	19.0
All California NWFP-area counties	11.4	11.1	15.4
All California metropolitan counties	9.6	9.0	13.1
All California nonmetropolitan counties	15.6	16.4	21.7
All Oregon NWFP-area counties	12.2	10.4	16.9
All Oregon metropolitan counties	11.4	9.7	16.4
All Oregon nonmetropolitan counties	15.2	13.2	19.2
All Washington NWFP-area counties	10.5	9.4	13.2
All Washington metropolitan counties	9.9	8.8	12.8
All Washington nonmetropolitan counties	15.1	13.3	16.7

Source: U.S. Census Bureau small-area income and poverty estimates.

counties) (table 10-1). Overall, poverty rates were highest in Oregon and lowest in Washington in both 1990 and 2012. However, in California, nonmetropolitan counties had the highest poverty rates within the Plan area during the period. These counties also experienced the biggest increase in poverty—rising from 15.6 percent in 1990 to 21.7 percent in 2012, with no dip in 2000, unlike the other subregions (table 10-1). Figure 10-1 shows poverty rates in the NWFP area by county in 2012. The highest poverty rates were concentrated in northern California and southern Oregon. Counties with the lowest poverty rates are concentrated around the greater San Francisco, Portland, and Seattle metropolitan areas.

Minority populations—

The percentage of the population identifying as a racial or ethnic minority grew in both metropolitan and nonmetropolitan counties within the Plan area between 1990 and 2012 (table 10-2). Most notably, the percentage of the population identifying as Hispanic or Latino doubled in nonmetropolitan counties, and nearly tripled in metropolitan counties in the Plan area. The percentage of the White population declined more in metropolitan counties than in nonmetropolitan counties. Plan-area counties with high concentrations of minority residents were clustered near California's Central Valley and east of the Cascade Range crest in Washington (fig. 10-2). This finding may be explained by evidence that about half of farm laborers and their supervisors in the United States are Hispanic or Latino (USDA ERS 2012), and these are areas of high agricultural activity.

American Indian and Alaska Native populations were higher in the NWFP area than in the nation as a whole (table 10-3). They were more prevalent in nonmetropolitan counties than in metropolitan counties of the Plan area throughout the period (table 10-2). In 2012, they accounted for a higher percentage of the population in nonmetropolitan counties in California (in aggregate) than in other subregions (tables 10-4 to 10-6; fig. 10-3). In Oregon and Washington, counties with high percentages of American Indian and Alaska Native populations reflect the presence of tribal reservation lands (e.g., the Warm Springs Indian Reservation in Oregon and the Colville Indian Reservation in Washington). In contrast, Black or African American, and Asian, Native Hawaiian, and other Pacific Islander populations formed a higher percentage of the population in metropolitan than in nonmetropolitan counties (table 10-2), and the highest percentage population for both was in metropolitan counties in Washington (tables 10-4 to 10-6). At the individual county level, Black or African American, and Asian, Native Hawaiian, and other Pacific Islander populations are concentrated around Seattle, Portland, and

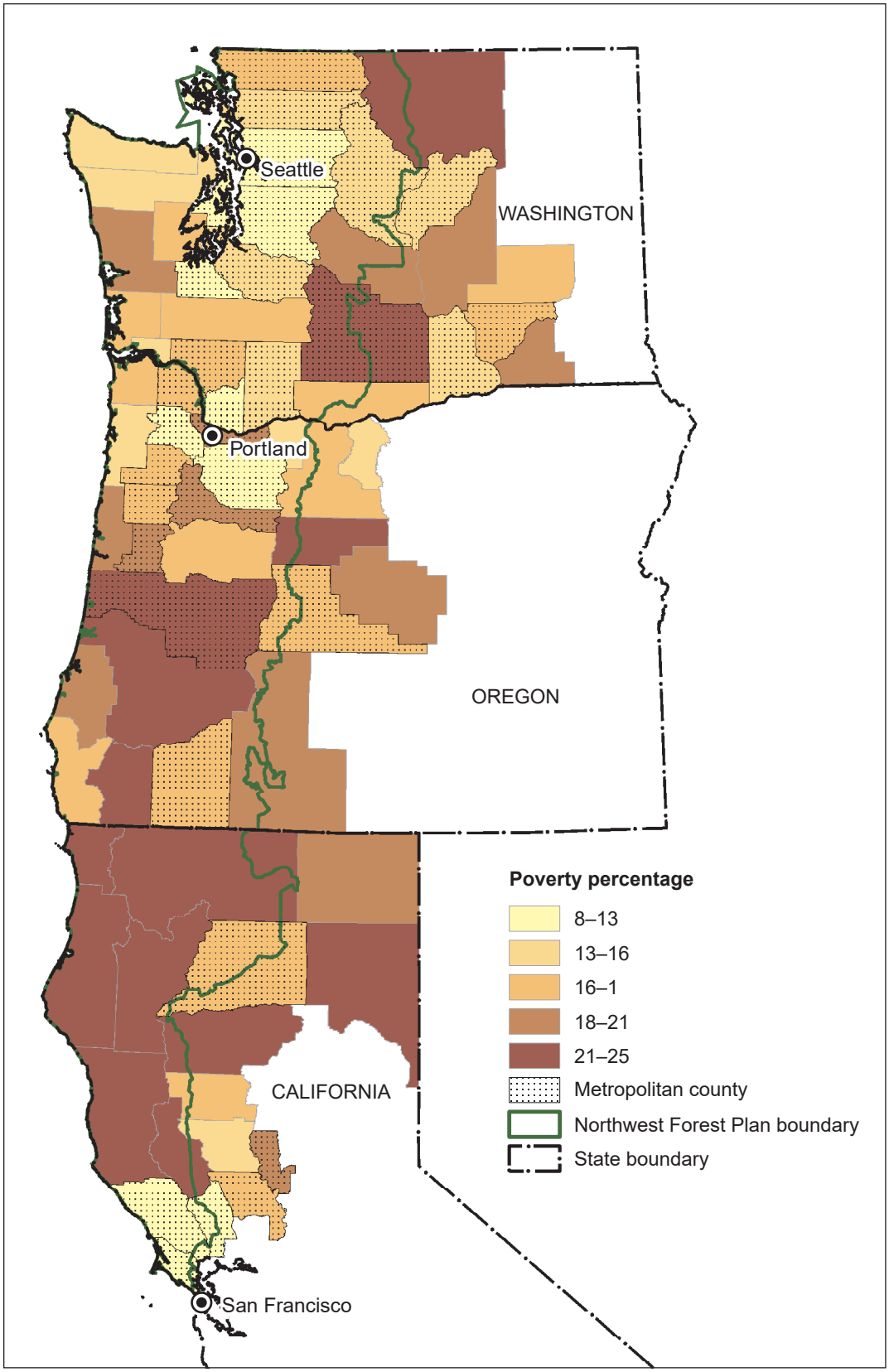


Figure 10-1—Percentage of people living in poverty in Northwest Forest Plan-area counties, 2012.

Table 10-2—Minority populations in the Northwest Forest Plan area, 1990, 2000, and 2012

	1990			2000			2012		
	Plan area	Nonmetro-politan	Metropol-itan	Plan area	Nonmetro-politan	Metropol-itan	Plan area	Nonmetro-politan	Metropol-itan
	Percent								
American Indian and Alaska Native	2	3	1	2	3	1	2	3	2
Asian, Native Hawaiian, other Pacific Islander[a]	4	1	4	5	1	6	7	2	9
Black or African American	3	1	3	3	1	3	3	1	4
White	92	95	92	88	93	86	84	90	82
Hispanic or Latino[b]	5	6	5	9	7	8	14	12	14
≥ two races[c]				3	2	3	4	4	4

Source: U.S. Census Bureau population estimates.
[a] The 1990 Census grouped Asians and Pacific Islanders into one category. In 2000, this category was divided into two: Asian, and Native Hawaiian and other Pacific Islander. For consistency across years, we have grouped these two back into one category.
[b] Hispanic or Latino is a category of ethnicity. Individuals may identify as Hispanic or Latino and any of the racial categories (e.g., Hispanic or Latino and White, Hispanic or Latino and Black). Therefore, table totals will not sum to 100 percent.
[c] This category was not available on the 1990 census form.

Table 10-3—Minority populations in the United States, 1990, 2000, and 2012

	1990	2000	2012
	Percent		
American Indian and Alaska Native	1	1	1
Asian, Native Hawaiian, other Pacific Islander[a]	3	4	5
Black or African American	12	13	13
White	84	81	78
Hispanic or Latino[b]	9	13	17
≥ two races[c]		1	2

Source: U.S. Census Bureau population estimates.
[a] The 1990 Census grouped Asians and Pacific Islanders into one category. In 2000, this category was divided into two: Asian, and Native Hawaiian and other Pacific Islander. For consistency across years, we have grouped these two back into one category.
[b] Hispanic or Latino is a category of ethnicity. Individuals may identify as Hispanic or Latino and any of the racial categories (e.g., Hispanic or Latino and White, Hispanic or Latino and Black). Therefore, table totals will not sum to 100 percent.
[c] This category was not available on the 1990 census form.

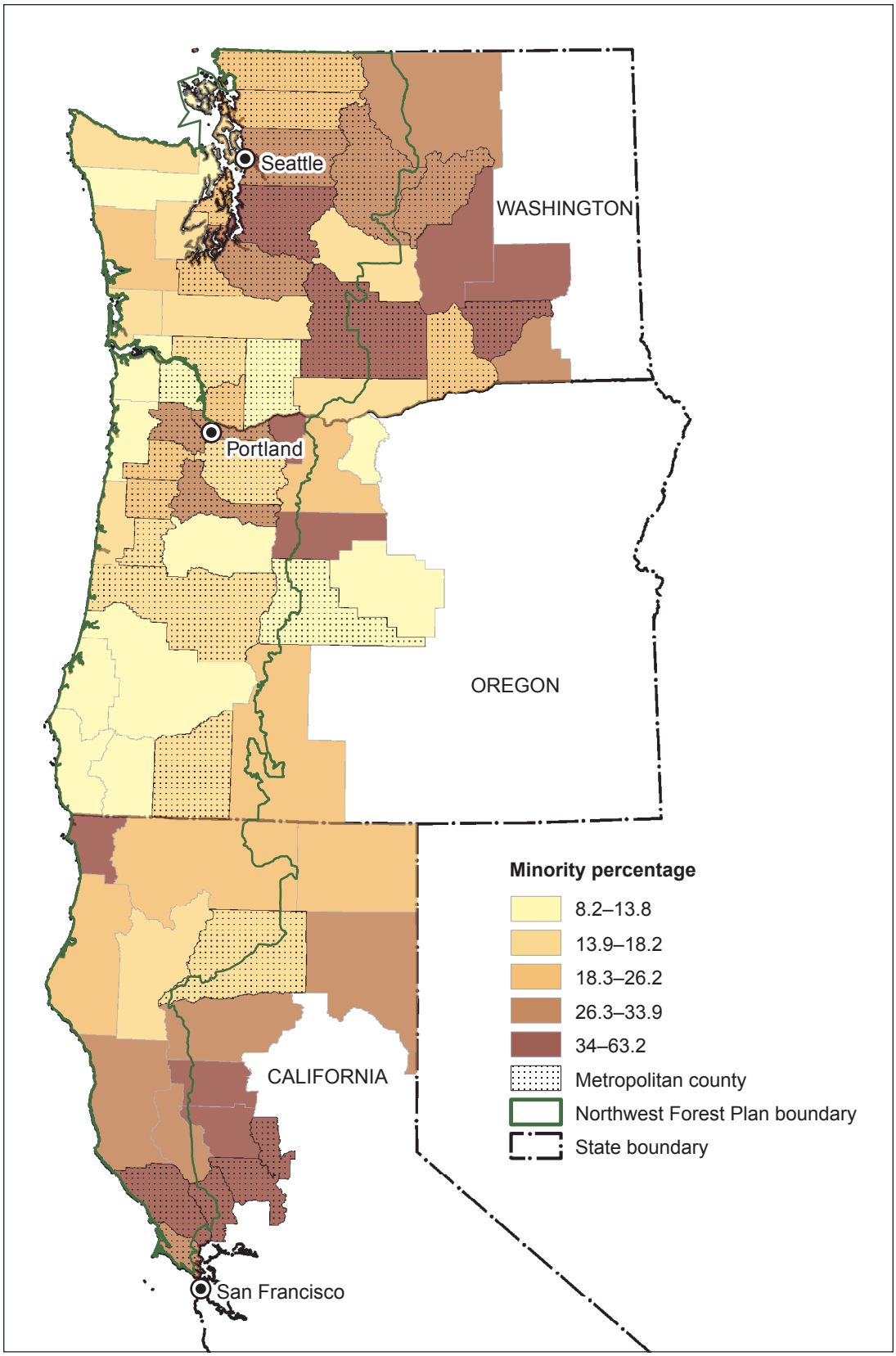


Figure 10-2—Minority percentage of populations (combined) in Northwest Forest Plan-area counties, 2012.

Table 10-4—Minority populations in California's Northwest Forest Plan area, 1990, 2000, and 2012

	1990		2000		2012	
California	Non-metropolitan	Metropolitan	Non-metropolitan	Metropolitan	Non-metropolitan	Metropolitan
	Percent					
American Indian and Alaska Native	4	1	4	1	5	2
Asian, Native Hawaiian, other Pacific Islander[a]	1	4	1	5	2	7
Black or African American	1	2	2	2	2	2
White	94	93	90	89	87	85
Hispanic or Latino[b]	9	11	14	17	19	23
≥ 2 races[c]			3	2	4	4

Source: U.S. Census Bureau population estimates.
[a]The 1990 Census grouped Asians and Pacific Islanders into one category. In 2000, this category was divided into two: Asian, and Native Hawaiian and other Pacific Islander. For consistency across years, we have grouped these two back into one category.
[b] Hispanic or Latino is a category of ethnicity. Individuals may identify as Hispanic or Latino and any of the racial categories (e.g., Hispanic or Latino and White, Hispanic or Latino and Black). Therefore, table totals will not sum to 100 percent.
[c]This category was not available on the 1990 census form.

Table 10-5—Minority populations in Oregon's Northwest Forest Plan area, 1990, 2000, and 2012

	1990		2000		2012	
Oregon	Non-metropolitan	Metropolitan	Non-metropolitan	Metropolitan	Non-metropolitan	Metropolitan
	Percent					
American Indian and Alaska Native	2	1	2	1	2	1
Asian, Native Hawaiian, other Pacific Islander[a]	1	3	1	1	2	6
Black or African American	<0.5	2	1	3	1	3
White	97	94	94	90	92	86
Hispanic or Latino[b]	3	4	6	9	9	15
≥ 2 races[c]			2	2	3	4

Source: U.S. Census Bureau population estimates.
[a] The 1990 Census grouped Asians and Pacific Islanders into one category. In 2000, this category was divided into two: Asian, and Native Hawaiian and other Pacific Islander. For consistency across years, we have grouped these two back into one category.
[b] Hispanic or Latino is a category of ethnicity. Individuals may identify as Hispanic or Latino and any of the racial categories (e.g., Hispanic or Latino and White, Hispanic or Latino and Black). Therefore, table totals will not sum to 100 percent.
[c] This category was not available on the 1990 census form.

Table 10-6—Minority populations in Washington's Northwest Forest Plan area, 1990, 2000, and 2012

	1990		2000		2012	
Washington	Non-metropolitan	Metropolitan	Non-metropolitan	Metropolitan	Non-metropolitan	Metropolitan
	Percent					
American Indian and Alaska Native	3	2	3	1	3	2
Asian, Native Hawaiian, other Pacific Islander[a]	2	5	2	8	2	10
Black or African American	1	4	1	4	1	5
White	94	89	92	84	90	79
Hispanic or Latino[b]	6	5	7	7	11	12
≥ 2 races[c]			2	3	3	5

Source: U.S. Census Bureau population estimates.

[a] The 1990 Census grouped Asians and Pacific Islanders into one category. In 2000, this category was divided into two: Asian, and Native Hawaiian and other Pacific Islander. For consistency across years, we have grouped these two back into one category.

[b] Hispanic or Latino is a category of ethnicity. Individuals may identify as Hispanic or Latino and any of the racial categories (e.g., Hispanic or Latino and White, Hispanic or Latino and Black). Therefore, table totals will not sum to 100 percent.

[c] This category was not available on the 1990 census form.

the San Francisco Bay area (figs. 10-4 and 10-5). The high percentage of the population that was Black or African American in northeastern California is attributable to the demographic composition of the prison population that resides in Lassen County. The percentage of the population identifying as Hispanic or Latino was high relative to other minority groups in the Plan area as a whole, and was similar between metropolitan and nonmetropolitan counties (table 10-2). The percentage of the population that was Hispanic or Latino was highest in California counties (in aggregate) (tables 10-4 to 10-6). Hispanic or Latino populations were highest in NWFP counties of eastern Washington and California's Central Valley, where farming is an important economic sector.

The percentage of American Indian and Alaska Native, and Black or African American populations did not increase between 1990 and 2012, while the percentage of Asian, Native Hawaiian, and Pacific Islander populations grew, and the percentage of Hispanic or Latino populations grew substantially (table 10-2). The NWFP area had a higher percentage of the total population that was American Indian or Alaska Native, and Asian, Native Hawaiian, or other Pacific Islander compared with the nation as a whole in 2012, but a substantially lower percentage of the total population that was Black or African American, or Hispanic or Latino, compared with the nation as a whole (tables 10-2 and 10-3).

Many poor counties in the Plan area also have large shares of minority residents (fig. 10-7). However, poverty is not limited to those areas having high concentrations of minorities. For example, Josephine, Douglas, and Lane counties in Oregon and Trinity County in California have some of the highest rates of poverty in the Plan area (all exceed 20 percent), yet their residents are predominantly White who are not of Hispanic/Latino origin. Similarly, low-poverty counties in the greater San Francisco, Portland, and Seattle metropolitan areas have relatively high concentrations of minorities. The coarseness of county-level data used for NWFP socioeconomic monitoring over the past decade, and the data presented here, prevent finer scale comparisons (e.g., community-level) of minority status, poverty, and the relationship between them. Examining how trends in minority group populations and poverty rates may be linked is beyond the scope of this chapter. Nevertheless, at the national level, Black/African American, American Indian, and Hispanic or Latino populations in the United States experience significantly higher rates of poverty than White and Asian populations (Macartney et al. 2013).

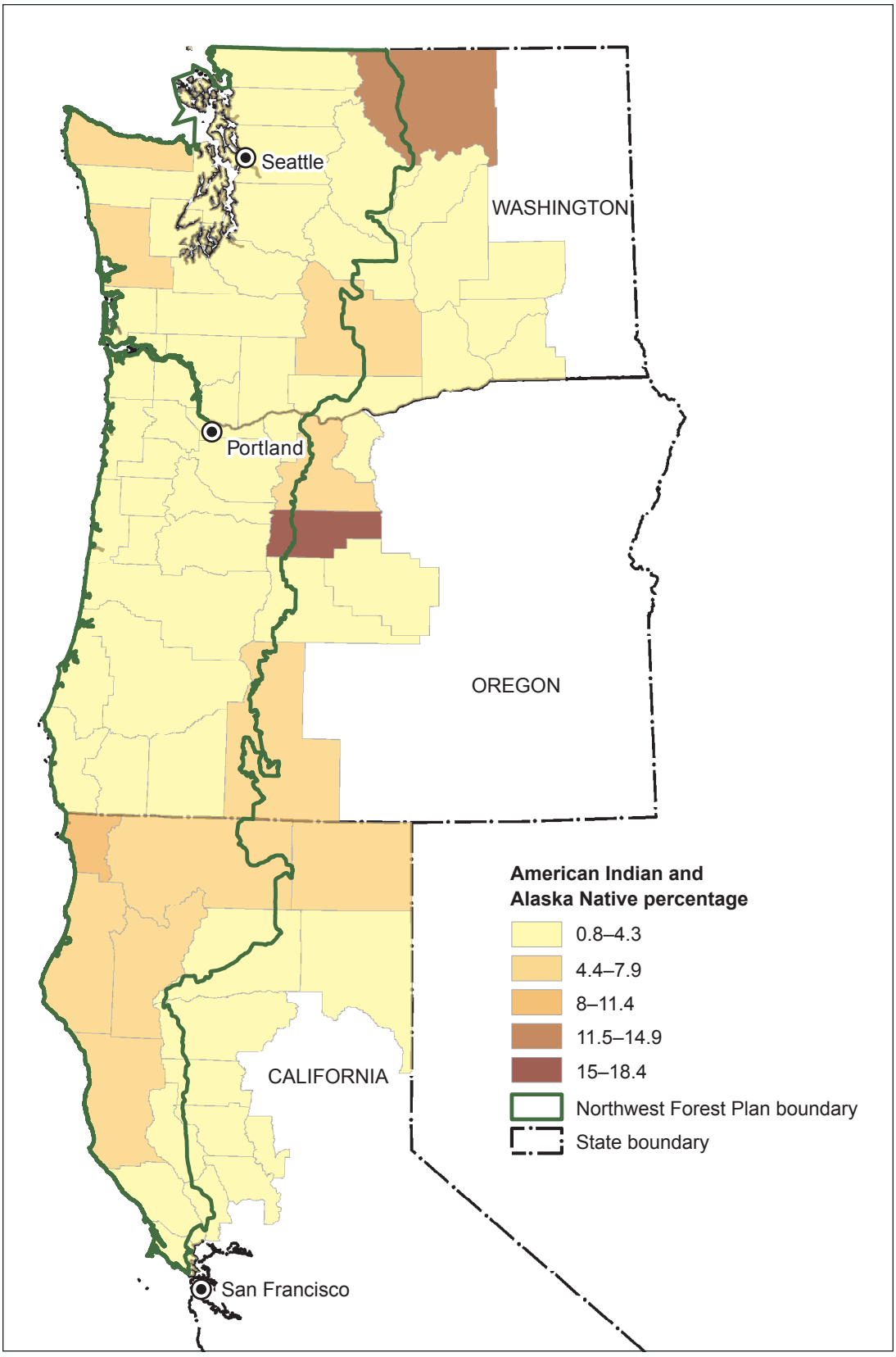


Figure 10-3—American Indian and Alaska Native percentage of populations in Northwest Forest Plan-area counties, 2012.

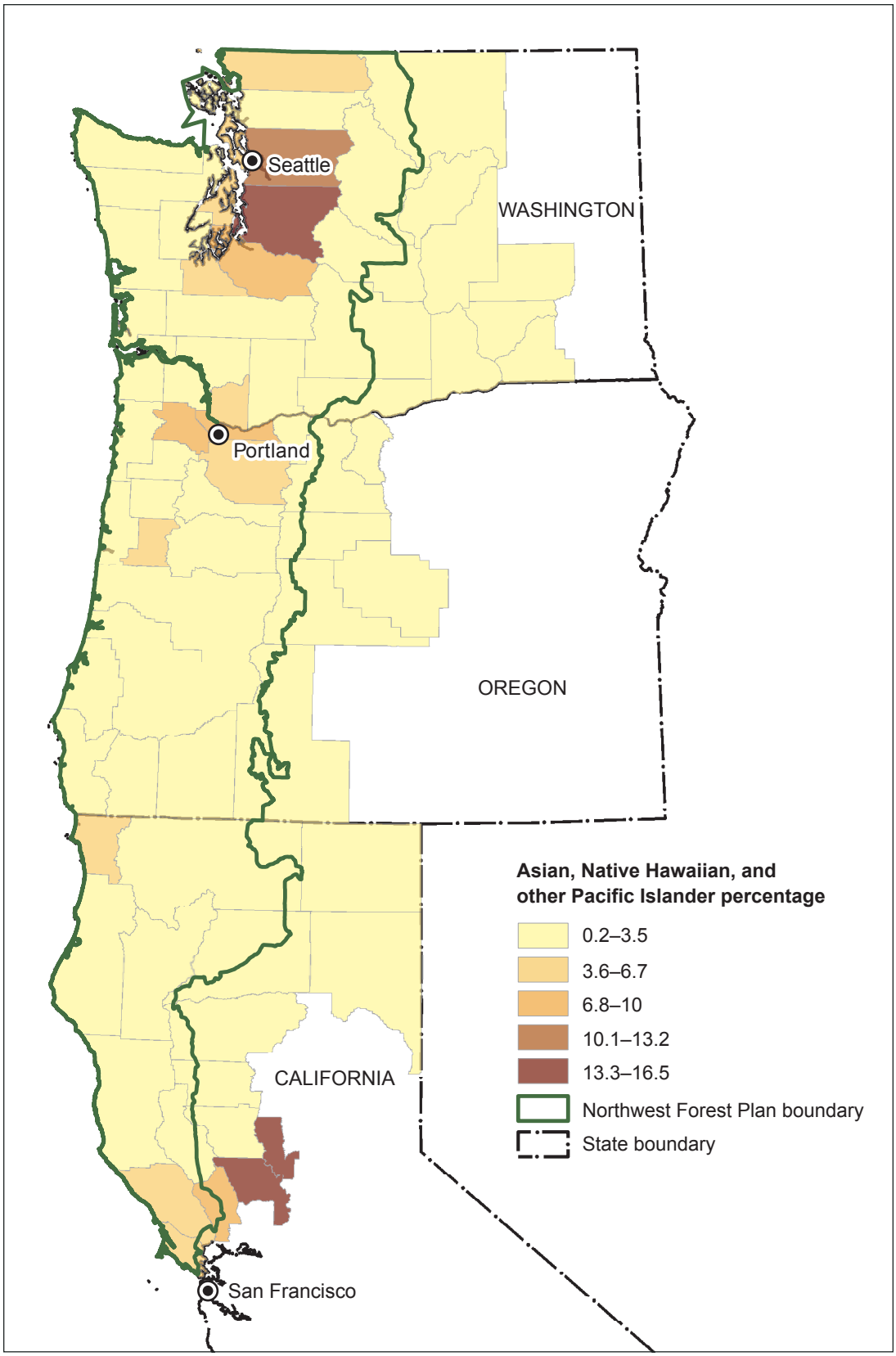


Figure 10-4—Asian, Native Hawaiian, and other Pacific Islander percentage of populations in Northwest Forest Plan-area counties, 2012.

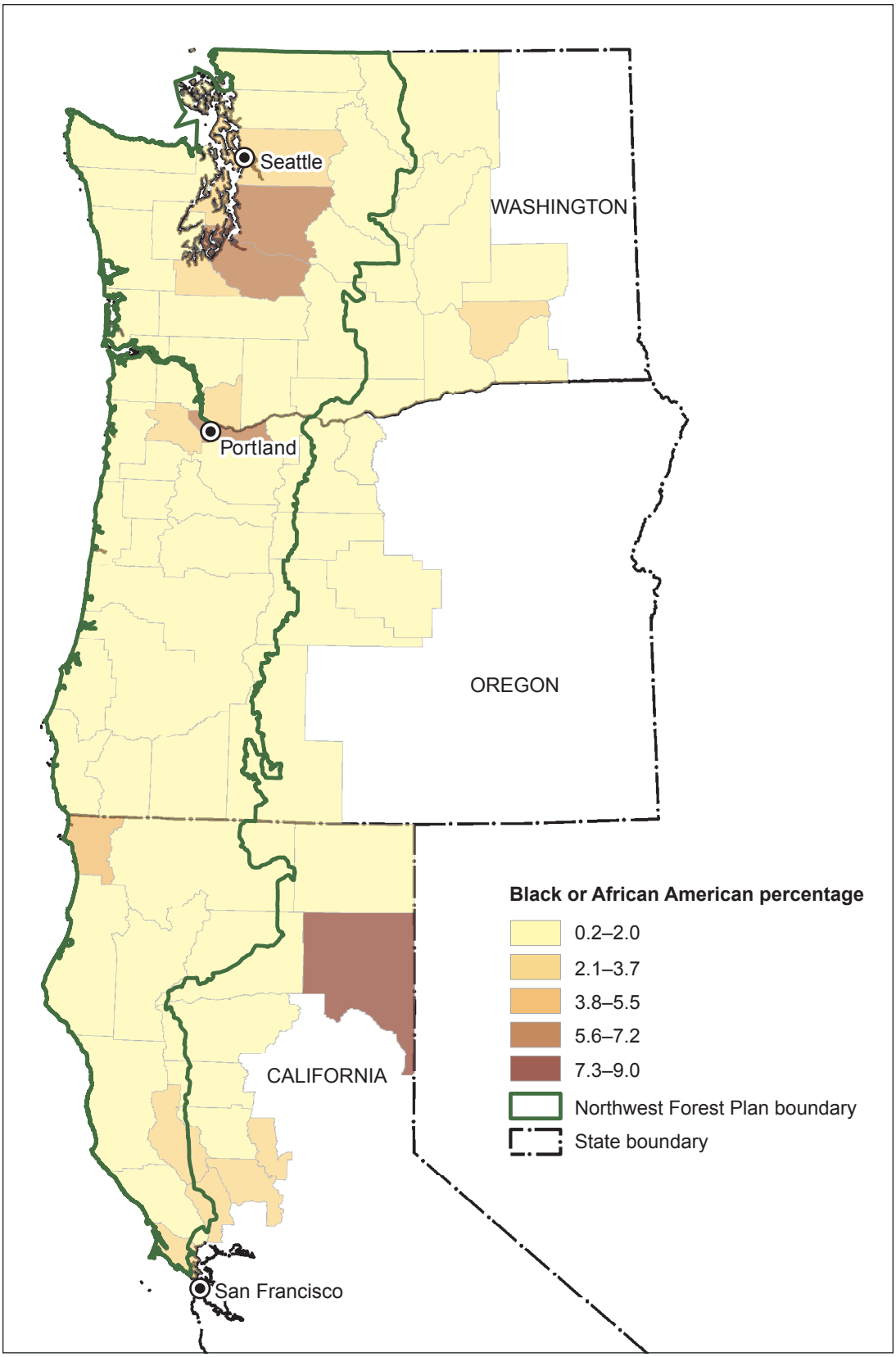


Figure 10-5—Black or African American percentage of populations in Northwest Forest Plan-area counties, 2012.

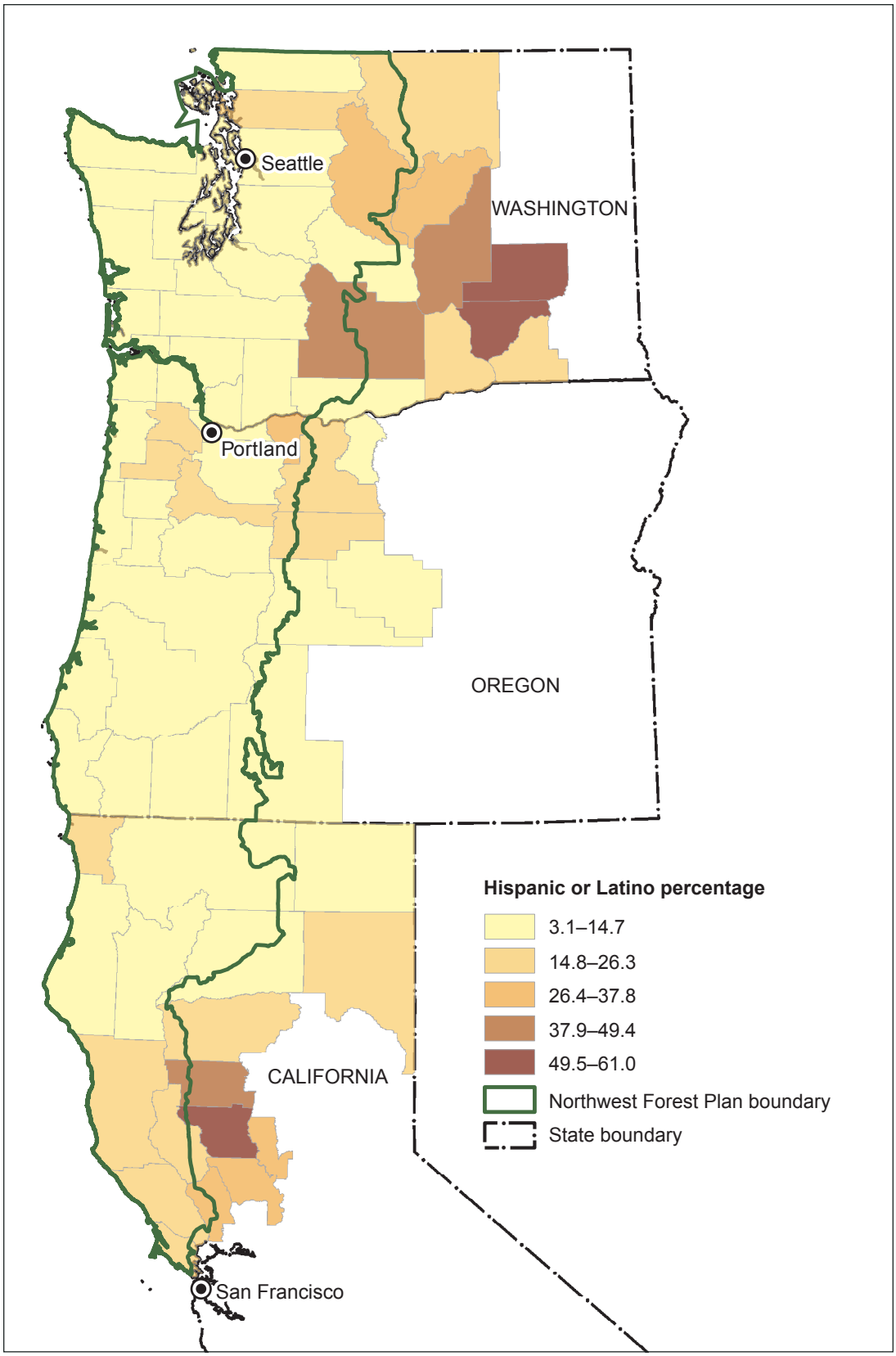


Figure 10-6—Hispanic or Latino Percentage of populations in Northwest Forest Plan-area counties, 2012.

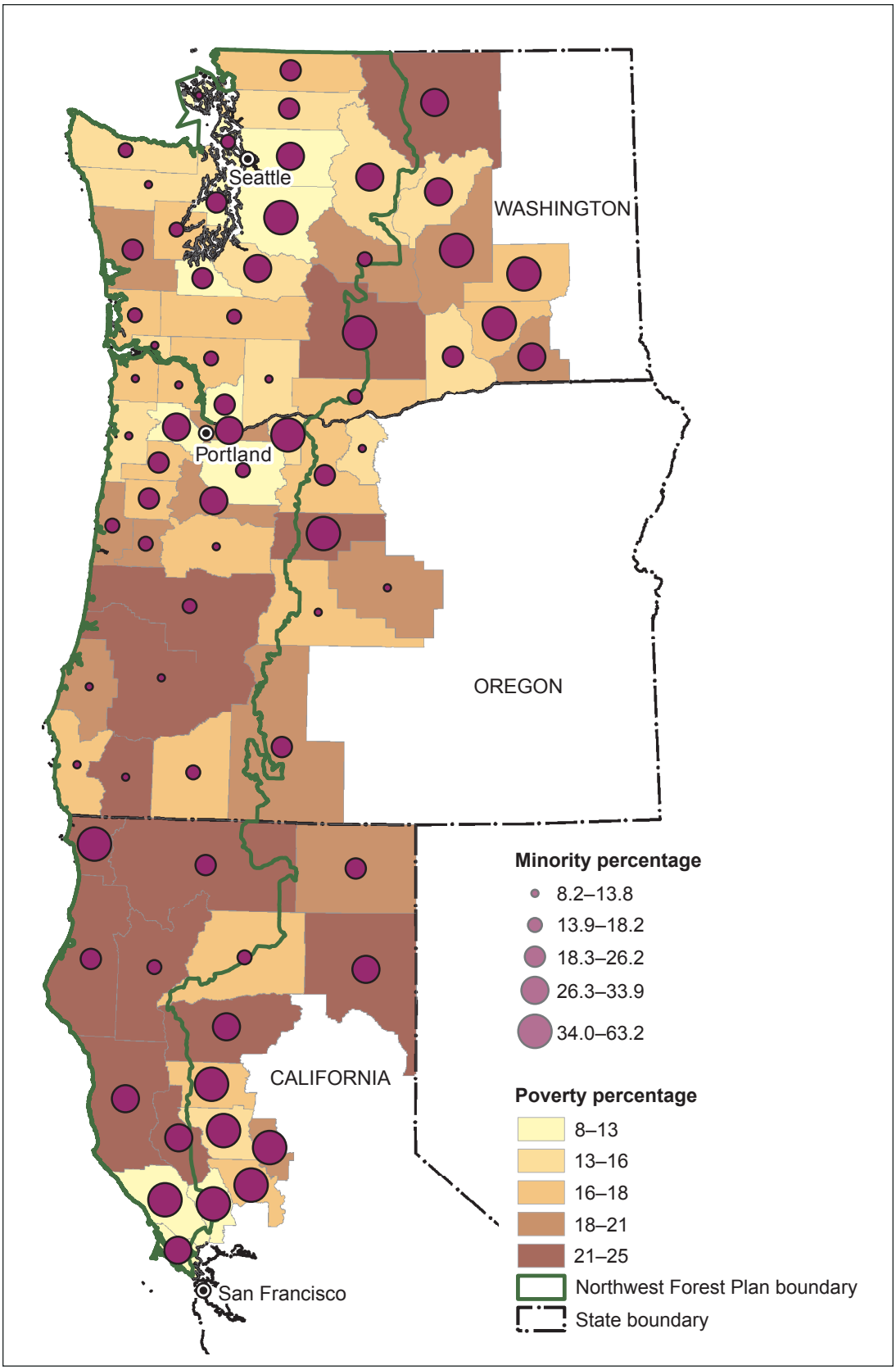


Figure 10-7—Minority populations by Northwest Forest Plan-area county poverty rates, 2012.

How Low-Income and Minority Populations Interact With Federal Forests in the Plan Area

The demographic composition of the NWFP area is changing: the percentage of the total population comprised of minority groups, especially Hispanic or Latino, is increasing, as are poverty rates. Research indicates that to some degree, different populations maintain different relations to federal forests, have different use preferences, and face different constraints that influence their use of federal forests, though variation within groups exists (as it does among all demographic groups). They may also have different views of the environment and resource management, and different environmental behaviors and values (see chapter 9). To comply with E.O. 12898 and to encourage use of federal forests by environmental justice populations, it is important to understand these differences and ways of overcoming constraints. The scientific literature from the Pacific Northwest is limited in this arena, and focuses mainly on participation by low-income and minority populations in the environmental work force, the gathering of nontimber forest products, and recreation. We address these topics below, and also note some emergent issues: the presence of temporary residents—including homeless populations—on national forests, many of whom are likely low income; and connections between wildfire management and environmental justice.

The environmental workforce—

Forest workers are employed by contracting businesses to conduct forest restoration and related work, often on federal lands. Forest workers in the Pacific Northwest perform a variety of labor-intensive tasks, such as planting and thinning trees, piling and burning brush, manual herbicide application, and digging firelines to fight wildland fires (Moseley 2006) (fig. 10-8). These tasks, which typically



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Figure 10-8—Forest workers cut and pile brush on the Six Rivers National Forest in California.

require shoveling, planting, hand cutting, and similar manual labor, are more labor-intensive than other work performed by forest workers that entails less manual labor, such as operating heavy machinery and timber cruising. In 2014, there were an estimated 6,400 forest workers in Oregon alone during peak season (Wilmsen et al. 2015). This section focuses on the working conditions of workers hired by forestry and fire contracting businesses. To date there have been few systematic studies conducted on forest workers (Wilmsen et al. 2015). Most of the studies we draw on took place in western Oregon; information is much more limited for the California and Washington parts of the Plan area.

Since the late 1970s, forest workers in the Pacific Northwest have been predominantly Hispanic or Latino, marking a shift away from what was previously a White, not Hispanic or Latino, workforce toward one that is now primarily composed of low-income Hispanic or Latino immigrants and undocumented workers (Casanova and McDaniel 2005; Moseley et al. 2014; Sarathy 2006, 2012). Although the available scientific literature does not provide current statistics on the proportions of Hispanic or Latino workers now in the Northwest's forestry workforce, research by Sarathy (2008) found that, in the mid-2000s, Mexican immigrants constituted the largest proportion of immigrant forest workers on federal lands in the Pacific Northwest. Moseley (2006) found that at a time when the U.S. Census put Oregon's Hispanic or Latino population at 8 percent of the state total, a random sample of contractors interviewed from two national forests in Oregon during the high season were 45 to 60 percent Hispanic or Latino. A 2006 estimate found that between 2.2 and 3.1 million of the unauthorized immigrants residing in the United States were active in the labor force, particularly the lower skilled labor force (e.g., agri-food, crop production, forestry, and food services) (Sarathy and Casanova 2008).

What has been termed the "Latinization" of forestry work originated in a confluence of public policy (e.g., Small Business Administration set-asides for minority-owned businesses) and social networks (i.e., recent immigrants enter the sector because of relationships with earlier immigrants who work in forestry services) (Sarathy 2006). In contrast, minorities are underrepresented in the white-collar environmental workforce that offers higher job quality (e.g., less manual labor, more consistent oversight of safety); one possible explanation is their low participation in university environmental programs (Weintraub et al. 2011). In Oregon, the majority of ecological restoration businesses are small, family-owned seasonal businesses that fit the Small Business Administration's definition of a small business (Nielsen-Pincus and Moseley 2013). Research about the proportion of forestry and fire contracting businesses that are minority owned is lacking.

With this change in workforce composition came a series of working condition concerns that disproportionately affected immigrant forest workers, especially those without legal immigration status (Sarathy 2008). These forest workers are often Hispanic or Latino, and have been referred to as "pineros" by the U.S. media (a Spanish word meaning "man of the pines" or "someone who works in the woods") to describe the ethnicity of the workers and the type of work that they do (see Knudson and Amezuca 2005, Sarathy 2012). Job quality among forest workers is typically low, measured by lack of employment stability, low wages, no benefits, and distance from home. Although all such workers face low job quality, Hispanic or Latino workers are more likely to work far from home and seasonally, and less likely to receive health insurance through their employers (Moseley 2006). For example, Moseley (2006) found a statistically significant correlation between the ethnic composition of a company's workforce and the type of work performed. During high season, Hispanics or Latinos comprised 43 percent of the total workforce and 66 percent of the labor-intensive workforce. By contrast, those who were not Hispanics or Latinos accounted for 53 percent of the total workforce but 73 percent of the equipment-intensive workers. Labor-intensive workers often work seasonally and travel long distances (Moseley and Reyes 2008). Although there is limited research on equipment-intensive contractors, available data suggest that these contractors do not typically travel as far for work, and are less exposed to exploitative working conditions, compared to labor-intensive workers (Moseley and Reyes 2008). These findings suggest that there are job quality differences between Hispanics or Latinos, and non-Hispanics or Latinos.

Research on forest workers from Oregon also shows that Hispanics or Latinos often face poorer working conditions than their counterparts who are not Hispanic or Latino, including disrespectful treatment, uncompensated injuries, little opportunity for advancement, and retribution if they complain (Sarathy 2012). High injury and fatality rates; low, unpaid, or stolen wages; lack of training; decline of union protection; and dangerous work environments also characterize this sector (Campe et al. 2011, Moseley et al. 2014, Sarathy 2012, Wilmsen et al. 2015). Similar poor working conditions exist for immigrants who are agricultural workers. For example, low-wage immigrant workers in labor-intensive agricultural occupations often experience wage theft, unsafe working conditions, inadequate safety training, and fear of retaliation for reporting injuries or unfair working conditions (Wilmsen et al. 2015). Hispanic or Latino immigrants often face a particular disadvantage owing to language barriers and limited access to legal resources; fear of deportation makes it less likely that forest workers will report labor exploitation or dangerous working conditions (Campe et al. 2011; Sarathy 2008, 2012; Sarathy and Casanova 2008). Many of these concerns have been hidden from elected officials, the general public, and decisionmaking bodies, with scholarship, media, and public policy focusing disproportionately on the concerns of White, native-born loggers (Sarathy 2008).

Poor working conditions for forest workers have persisted over the past two decades. This problem is particularly prominent in the Pacific Northwest; for example, forest workers in Oregon were found to have rates of occupational injury, illness, and fatality three times higher than the workforce at large (Hayford 2013, Wilmsen et al. 2015). Moreover, documented rates are thought to be low estimates owing to historical underreporting of such problems by workers and employers alike (Azaroff et al. 2002, Ruser 2008, Sarathy 2012, Wilmsen et al. 2015). Two deaths of forestry services workers in on-the-job accidents in southern Oregon in 2011 were a reminder to the public and others of the dangers found in this sector (Wilmsen et al. 2015). Increased media attention on working conditions for forest workers has led to more Congressional oversight and labor law enforcement, but this political attention has been inconsistent as other issues arise (Moseley et al. 2014). Some groups representing forest workers such as the Northwest Worker Justice Project and the Northwest Forest Worker Center (formerly the Alliance of Forest Workers and Harvesters) advocate for better federal labor and contracting law enforcement to improve working conditions. But as Moseley et al. (2014) explained, the persistence of poor working conditions despite decades of political attention and advocacy suggests that changing labor laws alone will be insufficient for improving job quality. The vulnerability of immigrant workers, federal land management policy, and federal contracting regulations can also affect working conditions, and deserve attention (Moseley and Reyes 2008).

The debate regarding how to address poor working conditions, punctuated by political controversy and advocacy, is as of yet unresolved. Recent research from southern Oregon (Wilmsen et al. 2015)—a region having a high proportion of forest workers who are mainly Spanish-speaking Hispanic or Latino immigrants—still reported workplace practices that are inconsistent with labor laws. Workers' vulnerable economic status, lack of legal status, and fear of retaliation remain some of the largest drivers of marginalization for the increasing immigrant labor force in the Pacific Northwest (Campe et al. 2011, Moseley et al. 2014, Sarathy 2008, Wilmsen et al. 2015). This situation can cause the most marginal and vulnerable groups to shoulder a disproportionate level of risk and find ways to navigate the system invisibly (Moseley et al. 2014, Wilmsen et al. 2015).

Although there have been some job quality improvements for Hispanics or Latinos in recent years, these have mainly occurred in the arena of fire suppression work, including compensation for travel and training (Moseley et al. 2014). There is limited research on the impacts of federal contracting on businesses that engage in wildfire suppression and their employees, many of whom are forest workers (Caldwell et al. 2005, Lyon et al. 2017). Nevertheless, fire suppression work is historically more profitable and less price competitive than federal forestry work, in which contractors are pressured to cut costs to get contracts (Moseley et al. 2014). Additionally, firefighter safety and preparedness have become a high priority for federal land management agencies, and a culture of firefighter safety

has been integrated into the incident command structure in which contractors operate (Moseley et al. 2014). Contract firefighters also work closely with federal, state, and local government employees on fire incidents, making it difficult to hide workplace safety issues. In contrast, working conditions for other forest workers have received inconsistent attention; labor and safety law enforcement is dispersed across a variety of state and federal labor and land management agencies, and workplace safety issues are less visible (Moseley et al. 2014).

Traditionally, most workplace health and safety strategies have focused on improving the physical safety of the workplace, which is particularly relevant for improving the safety of working in the woods (e.g., hard hats, correct equipment and gear). However, the broader well-being of workers is also important. Research suggests that, once basic physical safety conditions for forest workers are addressed, there should be more explicit consideration of employee well-being to improve retention, morale, and staff stability (Mylek and Schirmer 2015).

Research is lacking regarding the proportion of minority women who are forest workers. However, there has been increasing attention on issues of gender in the environmental workforce. To date, this attention has been more prevalent in the popular press than in the scientific literature, but the topic warrants attention in considering workforce conditions. A recent Washington Post article recounted women firefighters' experiences with harassment, discrimination, and sexual violence (Fears 2016), which was followed by Congressional oversight hearings. Although the hearings focused on federal employees, similar problems are experienced by those contracted by the federal government (Moseley et al. 2014, Sifuentez 2016). A 2016 Association for Fire Ecology survey found that 32 percent of firefighters have witnessed sexual harassment, and 54 percent have witnessed gender discrimination in the workplace (Association for Fire Ecology 2016). Similar to Hispanic or Latino environmental workers, women may be especially vulnerable to workplace safety and culture issues, an area that warrants future research attention.

In summary, forest workers in the NWFP area are predominantly Hispanic or Latino. They work as contractors who perform a variety of labor- and equipment-intensive forestry work on federal forests in addition to participating in fire suppression crews. Much of the published literature about forest workers draws attention to the low job quality and poor working conditions they have experienced over the past few decades. Low job quality includes low wages, lack of stable employment, no benefits, and long travel distances to work sites. Poor working conditions experienced by forest workers include disrespectful treatment, little opportunity to advance, unsafe working environments and high rates of injury and fatality, lack of training opportunities, and fear of retaliation or deportation if they complain. Although there have been some improvements in recent years, especially in the area of fire suppression work, debates over how to address these poor working conditions remain unresolved. To date, federal agencies have not notably changed their oversight of service contract crews or enforcement of labor law provisions (Moseley et al. 2014, Sarathy 2012, Wilmsen et al. 2015).

Nontimber forest products gathering—
The gathering of nontimber forest products (NTFPs) in the Pacific Northwest for subsistence, commercial, recreational, and cultural purposes is important and widespread, both in urban and rural areas (Alexander et al. 2001; Alexander and Fight 2003; Charnley et al. 2007; Jones and Lynch 2007; Love et al. 1998; Lynch and McLain 2003; McLain et al. 2012; Poe et al. 2013, 2014). National forests and BLM land are important sites for commercial NTFP harvesting (Charnley et al. 2008). Most commercial NTFP harvesting in the Pacific Northwest occurs in temperate forests from the Cascade Range crest west to the Pacific coast, owing to high concentrations of economically important species, more people, and infrastructure that makes access easier (Charnley et al. 2008). Chapter 8 provides an overview of NTFP gathering in the Plan area, including common species harvested. Our focus here is on commercial gathering owing to the scarcity of studies specific to environmental justice populations' participation in recreational gathering and subsistence gathering (apart from American Indians, see chapter 11) in the Plan area. One of the few studies that includes a substantive discussion of recreational harvesters found that the majority (83 percent) of the recreational

chanterelle mushroom (*Cantharellus* spp.) harvesters interviewed on the Olympic Peninsula were Euro-Americans, with the next most common ethnic group represented being Japanese Americans (6 percent) (Love et al. 1998). In that study, none of the Latinos or Southeast Asians categorized their harvesting activities as recreational. As elaborated in chapter 8, the distinction between work and leisure is blurred for many commercial NTFP harvesters.

Low-income and minority populations are often active in harvesting NTFPs for commercial purposes, although subsistence and cultural uses are also important. For instance, on Washington's Olympic Peninsula—a focal point for the Northwest's floral greens industry—the harvester workforce was originally Euro-American, but shifted in the late 1970s and early 1980s to being dominated by refugees from Southeast Asia,, then shifted again in the late 1980s to become dominated by immigrants from Mexico and Central America (McLain and Lynch 2010). Asians are also active participants in commercial wild mushroom harvesting, particularly matsutake (*Tricholoma magnivelare*) (Tsing 2015). Commercial NTFP harvesting for some people may be their primary source of income, but for most it fills gaps or provides supplemental income between other seasonal jobs such as agricultural or forestry services work, or jobs in cities (Love et al. 1998; McLain 2000, 2008; Tsing 2015).

A survey from the early 1990s—which provides the only regional-level data available—found that roughly half of the commercial mushroom harvesters in the Northwest were White, followed by 37 percent Asians and Pacific Islanders, and 9 percent American Indians (Schlosser and Blatner 1995). An ethnographic study of the Olympic Peninsula chanterelle harvest (Love et al. 1998) documented the presence of four major groups of pickers—Cambodian (and other Southeast Asian), White, Latino, and Native American—during 1994 and 1995, but did not provide percentages for each category. An analysis of wild mushroom permit data for 1996–1998 from the Sisters Ranger District on the Deschutes National Forest, which falls within the eastern margins of the NWFP area and is a popular morel (*Morchella esculenta*) and bolete (*Boletus edulis*) harvesting site during the spring, estimated that 62 percent of permit holders were White, 28 percent Southeast Asian, and 10 percent Latino (McLain 2000). The only study identified that examined the intersectionality between gender and ethnicity for NTFP harvesters found that, among commercial chanterelle harvesters on the Olympic Peninsula, women comprised roughly 30 percent of Euro-American pickers but few Latino and Southeast Asian pickers were women (Love et al. 1998). There are no more recent studies providing statistics on NTFP harvester sociodemographic characteristics, whether at the local or regional scale.

Beargrass (*Xerophyllum tenax*) is one example of an NTFP harvested from federal forests located within the Plan area. Commercial harvesting of beargrass for its flowers and leaves gained importance in the Pacific Northwest in the 1980s (Higgins et al. 2004, Lynch and McLain 2003), and it has since become one of the leading commercial NTFP species harvested in the region, and a multimillion dollar industry (Charnley and Hummel 2011). Most commercial beargrass harvesters in the Pacific Northwest are Southeast Asian and Latino immigrants (Hansis 1998). Despite the physical hardships, these groups may be drawn to gathering beargrass and other NTFPs because it is work that does not require English language skills; jobs in the forest may be more appealing than low-paying jobs in cities; the job can be performed by and with families; payment is in cash; and it may provide cultural continuity to gathering traditions from immigrants' home countries (Charnley and Hummel 2011, Hansis 1998).

Wild mushrooms are another example; matsutake, the most economically valuable mushroom in the world (Tsing 2015), is a case in point. Four distinct populations harvest matsutake in the Pacific Northwest. Japanese-Americans have been harvesting the mushroom in the region for a century and pick them as part of their cultural heritage; Oregon's Mount Hood area is a favorite spot (Tsing 2013a). These are largely recreational pickers who distribute mushrooms among their relatives and across the Japanese-American community, which reinforces social relations and their heritage. Matsutake gained commercial value for the export trade to Japan in the 1980s. At that time, a second group started picking it, White men, such

as workers who had lost jobs in the timber industry and other rural residents. These pickers have since been largely displaced by a wave of Southeast Asian refugees to the United States who entered the woods in the thousands beginning in the late 1980s: the Khmer from Cambodia, and the Lao, Hmong, and Mien from Laos (Richards and Creasy 1996; Tsing 2013a, 2013b). Many of these pickers migrate to the Pacific Northwest seasonally from cities in California to harvest mushrooms between other seasonal or temporary jobs (Tsing 2015). Despite associated dangers such as the presence of hunters or the possibility of getting lost, mushroom harvesting offers these pickers, who often are poor, a sense of freedom and the ability to earn money as long as they have a permit, transport, and camping equipment (Tsing 2013b). Latino pickers, originating primarily from Mexico and Guatemala, also participate in the commercial matsutake harvest in central Oregon. Many are undocumented and thus are in a more precarious legal position than Southeast Asian refugees, most of whom either have permanent residency or U.S. citizenship (Tsing 2013c). Many Latino pickers use the matsutake harvest as a way to fill in gaps in the demand for work in the agricultural and horticultural sectors (Tsing 2013c). Tsing (2015) described the matsutake industry and the pickers who are part of it in detail (fig. 10-9).

Salal (*Gaultheria shallon*), a major commercial product in the floral greens industry, is a third example of an NTFP harvested from federal forests in the Plan area. Most salal harvesters are undocumented migrant workers from Mexico and elsewhere in Latin America, and Southeast Asian immigrants (Ballard and Huntsinger 2006, McLain and Lynch 2010). Research about these harvesters finds that many have detailed local ecological knowledge related to stand conditions, canopy cover, soil conditions, and disturbances that affect salal (Ballard and Huntsinger 2006).

Other researchers have also found that NTFP harvesters may possess substantial local ecological knowledge about the species they harvest, though this varies with experience (Charnley et al. 2007, Love et al. 1998, McLain 2000, Tsing 2013a). These findings indicate the potential capacity of NTFP harvesters to contribute to sustainable forest management. However, environmental justice populations who engage in NTFP harvesting, and NTFP harvesters more broadly—regardless of ethnic or racial identity—have been underrepresented in the process of developing management guidelines and regulations for NTFPs (Charnley et al. 2007, Jones and Lynch 2007, McLain 2000, McLain 2002, McLain and Jones 2001, McLain and Lynch 2010). A variety of factors likely contributes toward NTFP harvester underrepresentation, including limited knowledge of English on the part of some harvesters, commercial harvesters' unfamiliarity with land management agency public input processes, and ineffective outreach on the part of federal and state land management agencies (Ballard and Sarathy 2008, McLain 2002, McLain and Lynch 2010).

Land tenure, and the formal and informal rules governing harvester access to commercially viable harvesting sites, further condition environmental justice populations' interactions with forests in the NWFP area (Charnley et al. 2007, Love et al. 1998, McLain 2000, McLain and Lynch 2010, Tsing 2015). Harvesters are highly dependent on public or large tracts of private lands for gathering, making them subject to access and use regulations imposed by landowners who typically grant access through the issuance of short-term permits or longer term leases (Ballard and Huntsinger 2006, McLain and Lynch 2010, Tsing 2015). Research on wild mushroom policies in central Oregon suggests that failure to incorporate or consider



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Figure 10-9—Southeast Asians play a prominent role in the matsutake industry.

harvester input has sometimes resulted in the development of regulations, such as prohibitions on harvesting very small-sized matsutake (known as "babies") and fixed harvesting season starting and ending dates, that fit poorly with ecological conditions (McLain 2002, Tsing 2015). Moreover, other land uses (e.g., timber harvest, grazing) and management actions (e.g., fire suppression) have an impact on the productivity and diversity of NTFP species. Thus, NTFP harvesters have a strong interest and stake in federal forest management.

Little research has focused specifically on assessing the impacts of restrictions emanating from the Plan on NTFP harvesters, whether members of environmental justice populations or not. An exception is McLain's (2000, 2002, 2008) research on central Oregon's wild mushroom harvest, which documented how restrictions on the commercial harvest of NTFPs in late-successional reserves and the closure of thousands of miles of forest roads significantly reduced areas open to commercial wild mushroom harvest on national forests in that area. As discussed in chapter 8, the extent to which NTFP harvesters rely on late-successional forest ecosystems for products will vary, depending on the requirements of the species gathered. No studies about NTFP harvesting on lands administered by the BLM were identified in our literature search.

As commercial harvesting of NTFPs increases in response to market demand, tensions between commercial gatherers and gatherers primarily interested in recreational, subsistence, and cultural uses have emerged in some areas where there is competition over harvesting the same species (Charnley and Hummel 2011, Dobkins et al. 2016, Jones and Lynch 2007, Tsing 2015). For example, beargrass is highly valued for the floral greens industry, but it is also a culturally important plant to American Indian tribes in the NWFP area, especially for basketry (Charnley and Hummel 2011) (see chapter 11). Leaf properties desirable for commercial versus cultural purposes differ, as does forest stand management to promote the desired properties (detailed in Charnley and Hummel 2011). These competing interests and management requirements can cause conflict among users; some tribal members have expressed concern over the impact of commercial beargrass harvesting on the plant (Charnley and Hummel 2011). Tension also exists among participants within specific NTFP sectors, such as within the floral greens industry. For example, on the Olympic Peninsula, tensions have arisen among floral green harvesters when some participants follow harvest regulations and others do not (McLain and Lynch 2010). Moreover, some environmental groups do not support any gathering activities that they perceive as threatening forest health, even if only for subsistence use (Salazar 2009). A generalized lack of inventory and monitoring data collected in ways that would enable the impacts of harvesting on NTFP species to be evaluated makes it difficult to develop effective management guidelines (Jones and Lynch 2007).

For their part, harvesters have expressed a number of concerns related to NTFP gathering and management. For example, Latino harvesters from the Olympic Peninsula who participated in a natural resource values mapping exercise that included national forest lands stated that their main concerns were: the presence of hunters and target shooters who they perceived as acting irresponsibly in places where they harvest, making them feel unsafe; challenges associated with harvesters who do not comply with harvest regulations; and encounters with immigration and law enforcement officers looking for undocumented workers (Biedenweg et al. 2014). Racial profiling by Forest Service law enforcement officers is another concern expressed by floral greens harvesters on the Olympic Peninsula (Biedenweg et al. 2014) and the Gifford Pinchot National Forest (Northwest Forest Worker Center 2015), and by matsutake harvesters in central Oregon (Tsing 2015). Additional studies are needed to determine whether these concerns apply more generally across the Plan region, to harvesters of other NTFPs, or to groups other than Latino harvesters.

Other concerns revolve around the intersection between labor relations and land tenure. In the wild mushroom sector throughout the Plan area, most pickers, regardless of ethnicity, operate as independent or family-based entrepreneurs and gain access to harvesting sites through relatively affordable permits (McLain and Lynch 2010, Tsing 2015). They thus have some measure

of independence from the firms to which they sell their mushrooms. Conditions for many pickers in the floral greens industry on the Olympic Peninsula are much less favorable. In that setting, most floral greens harvesters, most of whom are Latino, gain access to harvest sites through people who operate buying sheds. Buying sheds are the buildings where the greens are purchased from harvesters, sorted, quantified, and boxed for shipping to wholesale distributors and exporters. Shed owners on the Olympic Peninsula often obtain leases to large tracts of public or private forest where harvesting occurs, then give permission for harvesters to pick on those lands, often specifying informally (and illegally) that the harvesters must sell their product to them (Lynch and McLain 2003, McLain and Lynch 2010). One consequence of the pickers' economic position under such circumstances is that they are unable to take advantage of higher prices paid by competing sheds (McLain and Lynch 2010). Harvesters and small-scale buyers have expressed opposition to leases, which large-scale buyers have historically monopolized and which appear to facilitate the exploitation of harvesters by limiting their resource access options (McLain and Lynch 2010, Northwest Worker Center 2015).

Harvesters have also identified theft of floral greens from leased lands as a problem (McLain and Lynch 2010, Northwest Forest Worker Center 2015). In response to complaints during the early 2000s by shed operators who did not have leases, the Washington Department of Labor and Industries sought, unsuccessfully, to have floral greens harvesters who gained access to harvesting sites through sub-leasing arrangements categorized as employees rather than independent contractors. The debate over whether harvesters acquiring access to floral greens through sub-leases should be considered shed employees, rather than independent entrepreneurs, has implications for their rights as workers, their working conditions, and whether they receive fair prices for their products (McLain and Lynch 2010).

To summarize, environmental justice populations in the NWFP area—particularly Southeast Asians, Latinos, and low-income Whites—play an active role in the commercial NTFP industry, with Latinos especially prominent in the floral greens industry and Asians and Whites prominent in the wild mushroom industry. National forests and BLM lands are important harvesting sites, but there has been virtually no published research documenting the impact of the NWFP on environmental justice populations who harvest NTFPs there. Although these populations are affected by agency regulations associated with NTFP harvesting and management practices influencing the distribution and productivity of the species they target, they have been underrepresented in developing regulations and management guidelines for NTFPs on federal forests in the Plan area. Important issues for managers to be aware of include potential social tension between commercial gatherers and those primarily interested in recreational, subsistence, and cultural gathering; tenure arrangements governing access to NTPFs; physical safety of harvesters when they are out in the forest; fear of encounters between undocumented workers and immigration and law enforcement officers; challenges associated with illegal harvest activities (e.g., theft); and the rights to safe working conditions and fair employment practices for harvesters.

Recreation—

Research about recreational uses of federal forests in the NWFP area by environmental justice populations comes from national surveys and scholarly research. The NWFP socioeconomic monitoring reports (Charnley 2006, Grinspoon et al. 2016) contain data on recreation visitation in the NWFP area by national forest and BLM district, but these reports do not display recreation visitation data by income, racial, or ethnic group. In this section, we present recreation participation data for Plan-area national forests in aggregate by income, and minority group from the Forest Service National Visitor Use Monitoring Program. Comparable data are unavailable for BLM districts. We also briefly synthesize key areas of knowledge from the literature about outdoor recreation participation by environmental justice populations in the region and nationwide, and constraints to participation. Some of this literature is specific to Forest Service lands, but none is specific to BLM lands. See chapter 9 for a broader discussion of recreation in the NWFP area.

Low-income populations—

More than half of recreation visits to NWFP-area national forests are made by people whose household incomes are less than $75,000 per year (table 10-7). Households with incomes under $25,000 per year account for about 12 percent of all recreation visits in the NWFP area, slightly higher than what is found nationally. The only income group with a lower participation rate is households having incomes of more than $150,000 per year (table 10-7).

Research from the Pacific Northwest about recreational use of public lands among low-income populations focuses on income levels and cost as determinants of participation. Using a random sample of 2,005 adult Washington and Oregon residents, Burns and Graefe (2006) found lower interest and participation in outdoor recreation among those with the lowest personal incomes. One-quarter of those surveyed whose personal incomes were less than $10,000/year reported that they were "not at all" interested in outdoor recreation; and 13 percent of those with personal incomes between $10,000 and $30,000 reported the same low interest level. In contrast, only about 5 percent of respondents with incomes greater than $30,000 reported no interest in outdoor recreation. The vast majority (between 86 and 92 percent) of those making more than $30,000 per year had participated in an outdoor recreation activity during the preceding year, while about 56 percent of those making less than $10,000 had participated (Burns and Graefe 2006). On average, those earning less than $10,000 per year visited national forests about 2.6 times per year compared to about 8.5 times per year for other income groups (Burns and Graefe 2006). This pattern of visit frequency may be due, at least in part, to the ability of people with higher incomes to afford the cost of recreation trips to national forests (Ostergren et al. 2005).

Regardless of urban or rural residency, the cost of recreation on federal forests includes equipment and gear expenses, transportation costs to reach the recreation site, and in some places, recreation fees. Of these expenses, federal land managers have influence only over recreation fees. The Forest Service's Recreation Fee Demonstration program, initiated in the late 1990s, established recreation fees at many dispersed areas on national forests that previously had no site fees. Brown et al. (2008) examined permit data from 1991 through 2005 and found that recreation fees to park and access a wilderness area on Oregon's Willamette National Forest had a greater negative effect on recreation visitation than did high-severity fire within the wilderness area. In their previously referenced survey from Washington and Oregon, Burns and Graefe (2006) found that the lowest income respondents in their study (earning less than $10,000 per year) were the most likely to indicate that they could not afford to pay a hypothetical recreation-use fee on national forest lands (although more than half of the respondents in this income category indicated they could pay a hypothetical recreation use fee).

Table 10-7— Visits to national forests in the Northwest Forest Plan area and nationally of people age 16 and older by household income

Annual household income	Plan area 2006–2010	Plan area 2011–2015	National 2011–2015
		Percent	
Less than $25,000	10	12	10
$25,000–$49,000	24	18	18
$50,000–$74,999	25	23	22
$75,000–$99,999	18	20	18
$100,000–$149,999	15	17	16
$150,000 and up	8	11	16

Source: USDA FS 2016.

Minority populations—
Nearly all recreational visits to NWFP-area national forests are by White visitors (table 10-8). People of Hispanic or Latino ethnicity account for more recreation visits to NWFP-area national forests (4 percent) than people belonging to other minority groups. Across all national forests, the vast majority of visits are also from White visitors, and about 6 percent of visits nationally are from those of Hispanic or Latino ethnicity, again exceeding visits by other minority groups (table 10-8).

Data from the 2008 National Survey on Recreation and the Environment (NSRE) (Cordell 2012) indicate that, nationwide, American Indians have activity participation patterns that are similar to Whites, although American Indians have higher rates of participation in backcountry activities (like primitive camping, backpacking, visiting wilderness), and lower rates of nonmotorized winter recreation participation than Whites (table 10-9). Asian, Native Hawaiian, and other Pacific Islanders, like most other groups, have high rates of participation in activities at developed sites. A much higher percentage participate in viewing and photographing nature than in backcountry activities, hunting and fishing, motorized recreation (e.g., off-highway vehicles, motorized trail bikes, use of motorized play areas), and nonmotorized activities. Hispanic or Latino populations surveyed participate more in some activities than other minority groups, and less in others, but the relative popularity of different activities is generally similar between Hispanics or Latinos and other groups.

Table 10-8—Visits to national forests in the Northwest Forest Plan area and nationally of people age 16 and older by racial and ethnic group

	Plan area 2006–2010	Plan area 2011–2015	National (2011–2015)
	Percent		
American Indian and Alaska Native	3	3	2
Asian	2	3	2
Black or African American	1	1	1
White	96	95	95
Native Hawaiian and other Pacific Islander	1	1	1
Hispanic or Latino	4	4	6

Source: USDA FS 2017.

Table 10-9—Nationwide percentage of participation in outdoor recreation activities of people age 16 and older by racial and ethnic group

Activity	American Indian	Asian, Native Hawaiian, Pacific Islander	Black or African American	White	Hispanic or Latino
			Percent		
Visiting developed sites	84	82	69	80	75
Viewing and photographing nature	79	73	59	78	71
Backcountry activities	60	34	21	46	43
Motorized activities	42	24	15	41	35
Hunting and fishing	38	19	21	38	32
Nonmotorized winter activities	7	11	4	13	12
Nonmotorized water activities	21	21	7	24	19

Source: Adapted from White et al. (2014) and Cordell (2012).

Visiting developed sites, and viewing and photographing nature, were the most common activities. Adult Hispanic or Latino day visitors interviewed at urban national forests in southern California reported that they most often participated in picnicking and water recreation when visiting day-use sites (Chavez and Olson 2009). Blacks or African Americans have the lowest levels of participation in outdoor recreation relative to the other groups surveyed. However, more than half of respondents had visited developed sites and participated in viewing and photographing nature (table 10-9).

Floyd et al. (2008) provide a comprehensive review of research related to race/ethnicity and leisure, including the many factors that affect recreation participation by minority groups. One national-level study using the 2004 NSRE data found that, relative to other groups, ethnic minorities, older people, women, and those living in rural places perceived higher constraints to participating in outdoor recreation (Ghimire et al. 2014). The primary perceived barriers were lack of time or money, concerns about personal safety, lack of transportation, and lack of multilingual signage. Facility condition, perceived crowding, and environmental quality were infrequently seen as barriers to outdoor recreation by these groups. Distance and cost to access recreation opportunities on federal lands are key factors influencing outdoor recreation use (Cho et al. 2014, Stevens et al. 2014) (fig. 10-10). For example, Bowker et al. (2006), in a national



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Figure 10-10—Distance to primitive settings and the cost of recreation, including equipment expenses, are constraints to outdoor recreation participation by low-income and minority populations.

study using NSRE data, found evidence that a central factor in lower participation by minority group members age 16 and older is distance to primitive settings. Johnson et al. (2007), also using NSRE data, found that minority groups were less likely than other groups to support a fee for using a recreation site.

Chavez (2008) pointed out the importance of understanding the distinct preferences, expectations, and barriers to participation in outdoor recreation among Hispanic or Latino populations in the United States. As table 10-2 shows, the share of the Hispanic or Latino population is large and growing in metropolitan counties of the NWFP area (see also Johnson and Stewart 2007), making consideration of Hispanic or Latino preferences and barriers to access especially important for the management of urban national forests (e.g., the Mount Baker–Snoqualmie National Forest in Washington and the Mount Hood National Forest in Oregon). Some studies have found that Hispanics or Latinos tend to participate in outdoor recreation activities with extended family members in natural areas located close to urban centers (Burns et al. 2008, Chavez 2008). Constraints to participation include distance to recreation areas, lack of transportation, and lack of information (in Spanish and English) about where to recreate and who to contact to learn about recreation opportunities (Burns et al. 2008).

Burns et al. (2008) conducted four focus groups (small groups of select people who discuss questions pertaining to specific research topics) with adults belonging to different minority groups in several Oregon cities. Potential participants were identified through recreation managers (mostly from the Oregon Parks and Recreation Department) who worked in the communities where the focus groups were held. They found that Asian Americans in their study liked to recreate with their children and extended family, and preferred developed facilities having amenities over camping. Safety concerns loomed large, however, especially the safety of children. African Americans in the study disliked recreating in remote locations, preferring parks close to urban areas having well-managed, clean facilities, aesthetically pleasing views, and amenities such as picnic tables, places to barbeque, and areas to play sports. Both groups identified lack of information about opportunities to recreate in parks and on public lands, information in multiple languages as an additional constraint (fig. 10-11). Metcalf et al. (2013) surveyed 234 racial and ethnic minority groups visiting the Mount Baker–Snoqualmie National Forest about their perceived constraints to outdoor recreation participation, and strategies they use to overcome these constraints. The chief factors constraining recreation on national forests among these users were preferences for other recreation activities, limited time and other obligations, and weather conditions. Very few survey respondents reported that discrimination from other recreation users or Forest Service employees limited their outdoor recreation participation.

In sum, recreation visitation by environmental justice populations to national forests in the NWFP area is relatively low. Nationwide, different racial and ethnic groups exhibit different preferences for types of outdoor recreation activity, although visiting developed sites and viewing and photographing nature are the most popular activities among all groups, including Whites. A main barrier to recreating on national forests for low-income populations is cost of the trip. Among minorities, distance, cost, lack of transportation, safety concerns, lack of awareness about recreation opportunities, and lack of available information in languages other than English are barriers. Ways of overcoming these barriers are discussed under Management Considerations.

Nonrecreational camping and homelessness— Camping is a common recreational use of Forest Service and BLM lands in the NWFP area. But many people camp on public lands for nonrecreational purposes, with these lands serving as a temporary residence. Some nonrecreational or long-term campers temporarily reside on public lands as a lifestyle choice or in response to local economic conditions. Others are homeless (with no permanent address).

Accurate estimates of homeless individuals in the United States are difficult to achieve. One study by Abt Associates for the U.S. Department of Housing and Urban Development estimated 549,928 homeless persons in a one-day count in 2016 (Henry et al. 2016). Yet, the National Law Center on Homelessness & Poverty suggests that these figures are grossly underestimated, and places the figure



USDA Forest Service

Figure 10-11—Information in multiple languages may encourage recreation use of national forests by minority populations whose primary language is not English.

between 2.5 to 3.5 million (NLCHP 2015). Some people who are chronically or episodically homeless choose to live on public lands. These represent vulnerable populations, both in terms of economic vulnerability and social vulnerability. Poverty is the primary risk factor for homelessness (Ji 2006). Other economic risk factors include high unemployment, lack of affordable housing, and a female-only head of household. Personal setbacks, such as an accident, divorce, natural disasters, unpaid medical bills, sudden job loss, or loss of a loved one can exacerbate these problems and increase a person's vulnerability (Elliott and Krivo 1991). Social vulnerabilities include lack of access to adequate health care, unmet mental health needs, domestic violence, and divorce (Elliot and Krivo 1991, Wasserman and Clair 2010). Untreated mental health issues such as depression, addiction, post-traumatic stress disorder, and others, can negatively affect personal resiliency and are associated with homelessness.

Federal land management agencies do not have accurate counts of how many people live on federal lands. A recent survey of 290 national forest law enforcement officers revealed that encounters with nonrecreational campers occur in every region of the United States, and that nonrecreational campers were most common in national forests near urban areas (Cerveny and Baur n.d.). For national forests and grasslands in California (Region 5)

and Oregon and Washington (Region 6), 41 percent of law enforcement officers surveyed reported weekly encounters with nonrecreational campers, and 85 percent reported encounters at least monthly. These encounter rates were higher than for the nation as a whole (39 percent weekly and 75 percent monthly). In addition, 47 percent of officers in Region 5, and 49 percent in Region 6 reported that encounters with long-term nonrecreational campers had increased in the years since they had begun their current assignment (mirroring the national average of 47 percent).

Cerveny and Baur (n.d.) also identified 10 types of nonrecreational campers who were using the national forest as a residence. The most common type in Regions 5 and 6 were "separatists," who were alone and seeking solitude; "transient retirees" living in RVs and moving from place to place; and "families." The survey asked officers what they perceived as most often contributing to people living in national forests on a long-term basis. The most commonly mentioned factors associated with homelessness and long-term camping were substance abuse, mental health issues, lack of employment, and lack of available housing (Cerveny and Baur n.d.).

An unpublished master's project conducted in Oregon's Willamette National Forest by students from the University of Oregon explored the incidence of homelessness and long-term camping there (Bottorff et. al. 2012). The authors conducted interviews with staff from the national forest, local service agencies, law enforcement, and homeless individuals to gain a better understanding of homelessness. They learned that the homeless people on the Willamette were mostly seasonal, and that lack of services in nearby towns often drives the homeless to nearby forests. In addition, many homeless people were unwilling to stay in available shelters, which prohibited either children or pets. They also observed that homeless people living in the forest often struggled with addiction and mental health problems.

These results echo the risk factors mentioned above and suggest economic and social vulnerabilities. National forests and grasslands are serving as a temporary home for people who are suffering from health challenges or economic hardship. These results confirm a finding from the Deschutes National Forest (Asah et al. 2012) that one ecosystem service not commonly identified is the ability of national forests to serve as a temporary shelter for people who are marginalized by dominant economic, social, and health care systems. The magnitude of temporary residence as a phenomenon and management issue on federal forests, and the degree to which it represents a problem for federal forest managers in the NWFP area, are unknown; research on these topics is only beginning to emerge.

Wildfire management and environmental justice— Wildfire management is one of the many areas in which federal land management actions may affect adjacent and nearby residents and landowners, some of whom may be low income or minorities. Research about the relation between wildfire management and low-income and minority populations living in fire-prone forest ecosystems of the United States is limited; research on this topic from the Pacific Northwest is even more limited. Key findings from the studies that have been conducted include the following:

1. The rural poor living in fire-prone areas in the wildland-urban-interface (WUI) in Arizona's White Mountains, and low-income residents in a community in the Sierra-Cascades foothills of northern California, were found to have fewer resources for creating defensible space around their homes, investing in fire-resistant building materials, purchasing insurance, or adopting other wildfire mitigation strategies than middle- and high-income rural residents (though other variables also influence people's choices to mitigate fire on their properties) (Collins 2005, 2008).
2. In the southeastern United States, communities having high wildfire risk and high social vulnerability (e.g., below poverty line, non-White, low education) are less engaged in wildfire mitigation programs than communities having high wildfire risk and low social vulnerability (Johnson Gaither et al. 2011, Poudyal et al. 2012). Similarly, research from Arizona found that participation in wildfire mitigation programs is lower among socially vulnerable communities located in areas of high wildfire risk, than among communities with low social vulnerability located in high wildfire risk areas (Ojerio et al. 2011).

3. In Washington state, a higher percentage of poor households than non-poor households live in areas having few to no wildfire response resources that provide wildfire protection (Lynn and Gerlitz 2006). In Florida, Mercer and Prestemon (2005) found that the more poverty in a county, the lower the rate of wildfire ignitions but the larger the wildfire (acres burned) when an ignition occurs. They attribute the lower rate of ignitions to the fact that poorer counties have more rural WUI, and federal and state lands dominated by pine forests that are intensively managed for timber production, where prescribed fire is commonly applied. These management actions lower wildfire hazard. However, wildfires burn more acres when an ignition occurs because poorer counties have fewer firefighting resources available for initial attack.
4. Research from Utah (Roberts 2013) and Florida (Mercer and Prestemon 2005) found that people living in higher income WUI locations prefer dense forest stands for aesthetic reasons, increasing wildland fire risk; however, they are less vulnerable to wildfire because they can afford insurance policies and have better access to fire mitigation and suppression resources.
5. In the Northwest and elsewhere in the Western United States, poor households usually outnumber wealthier households near federal lands, but tend to be located in areas having low housing density that do not meet the threshold for WUI delineation (Lynn and Gerlitz 2006, Radeloff et al. 2005). Thus, they receive fewer benefits from fire hazard mitigation activities and suffer longer wildfire response times (Lynn and Gerlitz 2006).
6. Research from the Southern United States (Johnson Gaither et al. 2015) found that smoke plumes from wildfires and prescribed fires did not disproportionately adversely affect socially vulnerable populations (defined using an index of indicators including poverty, minority status, renters, and age- and education-related variables). These populations experienced no more smoke exposure than populations who are not socially vulnerable. Comparable research about the impacts of smoke on environmental justice populations from the Pacific Northwest is lacking.
7. Research about the location of hazardous fuels reduction treatments on national forests in relation to the distribution of nearby environmental justice populations in the Pacific Northwest is currently underway. Initial results from two national forests in central Oregon found no systematic evidence of disproportionate benefit or lack of benefit to environmental justice populations from fuels reduction treatments (Adams and Charnley 2018). However, localized areas of potential concern were identified where further inquiry is warranted.
8. Finally, decades of disaster research by social scientists reveal that the effects of natural hazards, such as wildfire, are not experienced equally within a community. The most socially vulnerable people have the most difficulty coping and recovering from the hazard event and adapting afterward (e.g., Oliver-Smith 1996).

These research findings indicate that wildfire management actions can have differential impacts on people living adjacent to or near federal forests because of differences in social vulnerability to wildfire that may be associated with low-income and minority status. Wildfire management is but one example of how the environmental effects of agency management actions such as timber harvesting and watershed management, and associated changes in ecosystem services, have environmental justice implications.

Research Needs, Uncertainties, Information Gaps, and Limitations

The vast majority of scholarly research on environmental justice has focused on unequal exposure to environmental toxins, largely in urban areas. There is only a small subset of research that focuses on environmental justice in the context of unequal access to environmental benefits, and that work mostly concerns parks, outdoor recreation opportunities, and street trees in urban areas (e.g., Landry

and Chakraborty 2009, Montgomery et al. 2015). Furthermore, there is virtually no research or monitoring data that concern the specific impacts of the NWFP on low-income or minority populations apart from American Indians (see chapter 11). If federal forest managers wish to fill this information gap, perhaps environmental justice inquiry could be integrated into NWFP socioeconomic monitoring. However, this would require revising the current monitoring approach to explore links between federal forest management and socioeconomic well-being. This chapter provides information about general trends in environmental justice populations in the NWFP area between 1990 and 2012 using readily available county-level data. More recent, detailed, or geographically specific trends in low-income and minority populations could be identified using U.S. Census data as part of the socioeconomic assessment to support forest plan revisions for NWFP-area national forests.

Most of the research reported here about how environmental justice populations relate to federal forests comes from Washington and Oregon; this literature is more limited for the California portion of the NWFP area, except for American Indian tribes. Literature for BLM lands is also scarce. There is a reasonably substantive literature about how minority populations relate to national forests around work (e.g., forestry services work, commercial NTFP harvesting) and recreation. However, neither the complexity of forestry work impacts on forest worker vulnerability, nor the relationship between changing agency and contracting business employment structures and forest worker vulnerability, are well studied or understood. Also missing in the literature are explorations of how and which environmental justice populations have input into provisions in the NWFP, and associated regulations and management approaches regarding NTFPs. Most of the literature on NTFP harvesting is from the 1990s or early 2000s, and may not reflect current conditions. Little information is available about uses (recreational, subsistence, and cultural) of NTFPs by environmental justice populations apart from American Indians.

More broadly, apart from recreation, little information is available about noneconomic relations between environmental justice populations and federal forests, including cultural and spiritual connections, except for American Indians. This gap could potentially be filled through additional research, including using methods such as focus groups with populations of interest that include participatory values mapping exercises to document how different populations use and value federal forests (e.g., Biedenweg et al. 2014).

Regarding the impacts of forest management activities on environmental justice populations, research is beginning to fill the gap in knowledge about the environmental justice implications of Forest Service hazardous fuels reduction activities. However, there is a lack of information about how fire—managed, prescribed, or wild—and associated smoke affect low-income and minority populations in the Plan area. There is also a research void regarding how other federal forest management activities such as timber harvesting, travel management, and watershed management affect environmental justice populations. Finally, there is a void in the literature about the role of environmental justice populations in forest governance, particularly collaborative decisionmaking processes associated with federal forest management and planning.

It is uncertain whether the research findings presented here are relevant locally, and reflect the nature of interactions between environmental justice populations and federal forests on specific national forest and BLM units. Research pursued at finer scales would help address this uncertainty, as would research to better understand the variation within minority groups regarding their interactions with federal forests in particular places. Another large gap in the literature on environmental justice and forests from the NWFP area and nationwide is how low-income or minority status intersect with subgroup characteristics (i.e., gender, age, religion) to influence forest values, uses, and management impacts. The only related research we are aware of in this area is a handful of recreation studies conducted in urban and rural parks (e.g., Casper et al. 2013, Cronan et al. 2008, Larson et al. 2014, Perry et al. 2011). Growth in environmental justice populations throughout the NWFP area calls for reassessing earlier findings, and ongoing research into how these populations relate to federal forests and are affected by their management in order to address the information gaps and limitations of existing research identified in this chapter.

Conclusions and Management Considerations

Environmental justice populations in the NWFP area are growing. Census data reflect the changing demographics of the region, and research from within and outside the Plan area provides insight into how some members of low-income and minority populations interact with federal forests. When thinking about these relationships, it is important to avoid overgeneralizing and creating stereotypes about the values, uses, preferences, and behaviors of specific groups. Inevitably, there will be variation within groups, some of it influenced by gender, age, length of time in the United States, and other factors. The research synthesized here can be used to increase awareness and flag potentially relevant topics for agency staff to examine more closely at the local level. It also raises a number of issues that are relevant to federal forest management.

Management Considerations

The environmental workforce—

As the demographic composition of the NWFP area continues to change, and the forestry workforce is increasingly represented by Hispanics or Latinos and other environmental justice populations, it is important that federal forest managers address the issue of working conditions for forest workers. Doing so means considering contracting markets and contract oversight, which include bidding on, awarding, and monitoring compliance for projects. Based on the literature synthesized in this chapter, the following actions might help improve working conditions for forest workers.

1. The Forest Service and BLM already stipulate in service contracts that contractors must comply with all relevant labor laws. These agencies have the authority to enforce the provisions of their own contracts, which includes the labor law provisions, and could do so more rigorously.
2. Agencies could examine how the beneficial features of fire-suppression contracting could be incorporated into other, non-fire contracts (e.g., specific contract requirements and more oversight).
3. Agencies could strengthen policies to make labor law compliance inspection more consistent, combining these inspections with technical specification inspections, and increasing agency inspector training (Wilmsen et al. 2015).
4. The competitive low-cost bid process could be changed to reduce contractor incentives for cutting costs and explicitly incorporate the costs of safety trainings and daily safety briefings into contract awards (Moseley et al. 2014, Wilmsen et al. 2015).

Other considerations that emerge from the literature pertain to increasing the ability of forest communities to capture contracting opportunities on nearby federal forests, which would contribute to local economies. For example, agencies might structure contracts in ways that allow local communities to benefit by facilitating local training opportunities, or changing contracting guidelines. They might also consider using local restoration contracting service providers for fire suppression to support local forest contracting capacity, and the ability of local contractors to capture contracts during wildfires. Agencies could also identify how to address potential obstacles, such as wildfire contracting policies, that inhibit local contractors' participation. Having a trained local workforce with the capacity to respond to wildfire rapidly and perform forest restoration work could help increase community preparedness for wildfire.

NTFP harvesting—

Despite the long history and continued prevalence of NTFP gathering in the Pacific Northwest, federal forest managers have been slow to meaningfully consider NTFPs in management (Jones and Lynch 2007). Ballard and Huntsinger (2006), Biedenweg et al. (2014), Charnley et al. (2007), Jones and Lynch (2007), McLain (2008), McLain and Jones (2001), and McLain and Lynch (2010) offered numerous insights into how to address issues associated with NTFP gathering and management on public forest lands in the Pacific Northwest, and how to better engage harvesters in management and decisionmaking associated with NTFPs in the region. Many of these are relevant to all harvesters, regardless of race, ethnicity, or class (see chapter 8). Those pertaining specifically to issues raised by environmental justice populations, include addressing harvesters' safety concerns associated with NTFP gathering (for example,

encouraging harvesters to wear blaze-orange vests during hunting season), and examining how policies, including tenure arrangements for NTFP harvesting on federal forests, affect the working conditions and earnings of harvesters. Consideration of how federal forest management activities affect the abundance, distribution, diversity, and quality of economically and culturally important NTFP species also warrants more attention in the planning process.

Recreation—
The growing ethnic and racial diversity of the American population, reflected in NWFP area statistics reported in tables 10-4 through 10-6, has important implications for recreational uses of federal forests because recreation patterns are shaped by cultural norms and preferences (Sheffield 2012). Minority and low-income populations are currently underrepresented among national forest visitors nationwide (Roberts et al. 2009). To ensure that all populations can enjoy federal forests, and to broaden the base of support for public lands, finding ways to increase recreation use by environmental justice populations is important. However, it is also important to recognize the diversity in values within individual ethnic and racial minority groups and to not view these groups as homogenous (Li et al. 2007). The management considerations discussed here focus on how to foster more recreation participation by environmental justice populations on federal forests in the Plan area.

Constraints to recreation participation by these populations that are important to address include a lack of information about available recreation opportunities; improving transportation options to urban national forests; and a shortage of recreation opportunities that match these users' preferences (Metcalf et al. 2013). For example, Spanish-language materials, developed recreation sites that accommodate large groups, and outreach to Hispanic or Latino communities related to volunteer and employment opportunities could strengthen the relationship between federal forests and Hispanic or Latino populations (Chavez 2008). Burns et al. (2008) make a number of suggestions for improving outreach to Latinos, Asian Americans, and African Americans to increase their recreation participation on national forests. Key among these are increasing information about available opportunities in multiple languages, and working with media outlets that target these populations in doing so. Improving facilities so that they accommodate user preferences is also important. For groups concerned about safety, safety concerns could be addressed by increasing the visibility of law enforcement officers and access to agency and emergency personnel (Ghimire et al. 2014). However, increasing the presence of law enforcement may create an environment in which some racial and ethnic minority groups feel threatened. Increasing the presence of Forest Service or BLM employees in uniform on federal forests could also be helpful.

Several strategies to help alleviate cost barriers to recreation participation on national forests by low-income visitors have been suggested: (1) offer people who cannot afford to pay visitor use fees the opportunity to do volunteer work on a national forest in exchange for a fee waiver; (2) set aside areas where visitor use fees are not required; (3) establish days or times when site fees are waived; and (4) provide financial assistance to low-income visitors, for example, by giving them free annual recreation passes (Burns and Graefe 2006, Scott 2013). Some of these practices are already in place in the Pacific Northwest (Burns and Graefe 2006).

Roberts et al. (2009) provided a resource guide to help land management agencies better serve culturally diverse populations in California by improving communication and outreach, providing appropriate facilities and services, developing partnerships and relationships with organizations that promote outdoor experiences for low-income and minority groups, and taking advantage of other available resources. For example, some specific suggestions include: (1) use international symbols for facilities that are easily understood across cultures; (2) hire multilingual field personnel with strong cultural competency; (3) cultivate a partner to sponsor a van or minibus to transport local diverse populations to recreation sites; and (4) engage with community centers in hard-to-reach communities (Roberts et al. 2009). The suggestions contained in the guide are relevant to the NWFP area as a whole.

Nonrecreational camping and homelessness—
U.S. Forest Service law enforcement officers surveyed by Cerveny and Baur (n.d.) reported that the frequency of

homelessness and long-term camping on national forests is increasing and that the greater share of responsibility for addressing the issue seems to fall on patrol officers. The officers typically respond on a case-by-case basis by issuing citations for "stay violations," "illegal residence" violations, or other violations (e.g., sanitation, litter, or drug possession). However, the same individuals repeatedly return to the forest, often to the same sites, or they may shift between national forest land and other nearby public lands. Recognition by agency management of the resource impacts and social effects associated with long-term camping would spotlight the concerns raised by law enforcement. Treating homelessness as a chronic and systemic phenomenon in which the agency plays a critical role would potentially lead to greater acceptance of responsibility and action. For example, law enforcement officers surveyed described creative solutions that involved partnerships with public health agencies, social services, municipal police, and citizen groups to identify safe housing options in local communities.

Wildfire management—
Whether reducing hazardous fuels or engaging in other forest management activities, managers are required to consider how their actions may adversely affect environmental justice populations disproportionately. It is also important to consider whether certain populations disproportionately benefit from wildfire risk mitigation and wildfire suppression activities and resources so that these benefits may be more equitably distributed. Poverty and minority status are among the social variables that researchers use as indicators of social vulnerability. Research indicates that socially vulnerable populations living in fire-prone forest ecosystems in which the fire hazard is high tend to be more vulnerable to wildfire than less socially vulnerable populations because they often have fewer resources to invest in wildfire mitigation actions, have lower participation rates in wildfire mitigation assistance programs, and have less access to wildfire response resources when a fire ignites. These findings suggest that not only is it important for fuels reduction treatments to be proportionately distributed to places where low-income and minority populations border or live near fire-prone federal forests characterized by high wildfire hazard; but treatments might target these locales because of higher social vulnerability to wildfire. Furthermore, given research that indicates that low-income and minority populations may have less access to assistance programs that support wildfire mitigation strategies, directing outreach as well as financial and technical assistance to these populations may help them increase fire-safe practices around their homes for greater protection from high-severity fire.

Conclusions

This chapter responds to federal forest managers' request for information about trends in the size of environmental justice populations in the NWFP area, and the implications of these trends for federal forest management. We found that poverty rates grew in the Washington, Oregon, and California portions of the Plan area between 1990 and 2012, and were most pronounced in northern California and southern Oregon. Poverty rates were uniformly higher in nonmetropolitan counties than in metropolitan counties in the Plan area during the analysis period, and were also higher than the national average. Minority populations also increased in size and percentage of the regional total, and this increase was greatest among the Hispanic or Latino population. The percentage of the population identifying as Hispanic or Latino doubled in nonmetropolitan counties, and nearly tripled in metropolitan counties in the NWFP area.

The published literature about environmental justice populations and their relations with federal forests in the Plan area focuses primarily on the environmental workforce, commercial NTFP gathering, and recreation. Low-income and minority populations are prominent in the environmental workforce and in commercial NTFP gathering on federal forest lands. However, as forest workers, they often experience low job quality, and they are underrepresented when it comes to developing regulations and management guidelines for NTFP harvesting, suggesting a need for more oversight and outreach by forest managers. In contrast, low-income and minority populations have low participation rates in recreation on national forests in the Plan area. The literature addresses constraints to their participation and provides suggestions for how forest managers can overcome some of these constraints. Two emergent

topics that are less well documented but where research is ongoing are nonrecreational camping on federal forests, particularly homelessness, and the impacts of wildfire management activities on environmental justice populations.

Important information gaps remain, however. There is virtually no information about how the NWFP or forest management activities more broadly have affected low-income or minority populations apart from American Indians. Aside from recreation, research gaps exist regarding noneconomic relations between environmental justice populations and federal forests. More research is needed to increase understanding about variation within minority groups regarding their interactions with federal forests in particular places, including how low-income or minority status intersects with subgroup characteristics (i.e., gender, age, religion) to influence forest values, uses, and management impacts. The growth in environmental justice populations throughout the NWFP area calls for ongoing investigation into how these populations relate to federal forests and are affected by their management.

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Appendix: Counties in the Northwest Forest Plan area (2012 designation)

State, county, designation	State, county, designation
California, Colusa County (nonmetropolitan)	Oregon, Polk County (metropolitan)
California, Del Norte County (nonmetropolitan)	Oregon, Sherman County (nonmetropolitan)
California, Glenn County (nonmetropolitan)	Oregon, Tillamook County (nonmetropolitan)
California, Humboldt County (nonmetropolitan)	Oregon, Wasco County (nonmetropolitan)
California, Lake County (nonmetropolitan)	Oregon, Washington County (metropolitan)
California, Lassen County (nonmetropolitan)	Oregon, Yamhill County (metropolitan)
California, Marin County (metropolitan)	Washington, Adams County (nonmetropolitan)
California, Mendocino County (nonmetropolitan)	Washington, Benton County (metropolitan)
California, Modoc County (nonmetropolitan)	Washington, Chelan County (metropolitan)
California, Napa County (metropolitan)	Washington, Clallam County (nonmetropolitan)
California, Shasta County (metropolitan)	Washington, Clark County (metropolitan)
California, Siskiyou County (nonmetropolitan)	Washington, Cowlitz County (metropolitan)
California, Sonoma County (metropolitan)	Washington, Douglas County (metropolitan)
California, Sutter County (metropolitan)	Washington, Franklin County (metropolitan)
California, Tehama County (nonmetropolitan)	Washington, Grant County (nonmetropolitan)
California, Trinity County (nonmetropolitan)	Washington, Grays Harbor County (nonmetropolitan)
California, Yolo County (metropolitan)	Washington, Island County (nonmetropolitan)
Oregon, Benton County (metropolitan)	Washington, Jefferson County (nonmetropolitan)
Oregon, Clackamas County (metropolitan)	Washington, King County (metropolitan)
Oregon, Clatsop County (nonmetropolitan)	Washington, Kitsap County (metropolitan)
Oregon, Columbia County (metropolitan)	Washington, Kittitas County (nonmetropolitan)
Oregon, Coos County (nonmetropolitan)	Washington, Klickitat County (nonmetropolitan)
Oregon, Crook County (nonmetropolitan)	Washington, Lewis County (nonmetropolitan)
Oregon, Curry County (nonmetropolitan)	Washington, Mason County (nonmetropolitan)
Oregon, Deschutes County (metropolitan)	Washington, Okanogan County (nonmetropolitan)
Oregon, Douglas County (nonmetropolitan)	Washington, Pacific County (nonmetropolitan)
Oregon, Hood River County (nonmetropolitan)	Washington, Pierce County (metropolitan)
Oregon, Jackson County (metropolitan)	Washington, San Juan County (nonmetropolitan)
Oregon, Jefferson County (nonmetropolitan)	Washington, Skagit County (metropolitan)
Oregon, Josephine County (nonmetropolitan)	Washington, Skamania County (metropolitan)
Oregon, Klamath County (nonmetropolitan)	Washington, Snohomish County (metropolitan)
Oregon, Lane County (metropolitan)	Washington, Thurston County (metropolitan)
Oregon, Lincoln County (nonmetropolitan)	Washington, Wahkiakum County (nonmetropolitan)
Oregon, Linn County (nonmetropolitan)	Washington, Walla Walla County (nonmetropolitan)
Oregon, Marion County (metropolitan)	Washington, Whatcom County (metropolitan)
Oregon, Multnomah County (metropolitan)	Washington, Yakima County (metropolitan)



Roasting salmon over an open fire.
Photo by Jon Ivy, Coquille Indian Tribe.

Chapter 11: Tribal Ecocultural Resources and Engagement

Jonathan Long, Frank K. Lake, Kathy Lynn, and Carson Viles[1]

Introduction

In this chapter, we review scientific information regarding the conservation and restoration of forest ecosystems on public lands within the Northwest Forest Plan (NWFP, or Plan) area that harbor special value for American Indian tribes and individuals. We highlight advances in understanding how changes in climate, fire, hydrology, vegetation, and resource management regimes have affected tribal ecocultural resources and how land management can promote ecocultural resources in the future. In particular, we examine how distinctive strategies for engaging tribes in restoring ecocultural resources can uphold both tribal rights and federal responsibilities, while supporting other federal land management goals.

An Integrative Perspective on the Term "Ecocultural Resources"

A key theme in this chapter is the interconnections among tribal communities and their environment within a larger socioecological system. When considering socioecological systems that have developed with indigenous people over millennia, dividing biophysical entities into "ecological" and "cultural" categories would be particularly problematic (Burger et al. 2008). Tribal worldviews in the Pacific Northwest emphasize that humans are an integral part of the natural world and their well-being depends upon maintaining reciprocal relationships with its inhabitants (Anderson 2005, Heyd and Brooks 2009). Based upon work by others who have addressed that issue, we adopt the more integrative term "ecocultural" in this chapter. Rogers-Martinez (1992) was an early advocate for recognizing the need for ecological and cultural integration in restoration in a tribal context: "In other words, what we aim to restore is not only the land, but our relationship with it" (p. 69). Similarly, Harris and Harper (2000) used the term "eco-cultural dependency webs" in characterizing interactions between tribal people and their environment. The term "ecocultural" has been featured by Tomblin (2009) and the Karuk Tribe (Lake et al. 2010) and many others to characterize goals of tribal restoration in recent years.

The term "resource" can help to describe physical assets for which the U.S. government has a particular responsibility to tribes to protect (see "The Federal-Tribal Relationship"), but it also suggests an emphasis on material uses. Tribes regard many places, waterbodies, animals, plants, and fungi for material uses as foods (figs. 11-1 through 11-3), medicines, and crafts, but also for nonmaterial values, including sense of place, sacredness, and other dimensions of cultural significance (Burger et al. 2008). In a similar vein, we use the term "ecosystem services" (see chapters 1, 9, and 12), but we emphasize the importance of "cultural ecosystem services" that encompass both subsistence values and nonmaterial values important to native peoples (Burger et al. 2008, Schröter et al. 2014).

Background on Tribes in the Northwest Forest Plan Area

Over 70 federally recognized American Indian tribes, and many more tribes that are not currently recognized, have tribal lands or ancestral territory within the NWFP boundary (Vinyeta and Lynn 2015). Between 1954 and 1964, Congress "terminated," or ended federal acknowledgment, for scores of tribes particularly in California and Oregon. This chapter uses the term "tribes" when describing the collectives recognized as sovereign governments by the U.S. government, as well as many tribes that have petitioned for such recognition (Koenig and Stein 2008).

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Frank K. Lake



Figure 11-1—A traditional meal of lamprey and Chinook salmon (*Oncorhynchus tshawytscha*) is prepared on coast redwood and western redcedar sticks over a madrone wood fire along the Salmon River, California, April 2016.

Frank K. Lake



Figure 11-2—Tanoak acorns, lion's mane (*Hericium erinaceus*) mushrooms, and evergreen huckleberries collected on the Six Rivers National Forest near Orleans, California, October 2005.



Frank K. Lake

Figure 11-3—Preparing a fall dinner plate of mushrooms (lion's mane, chanterelles, and oyster) with a leg of black-tailed deer, served in Orleans, California, October 2005.

Much of the ancestral territory of tribes was transferred to the U.S. Forest Service, Bureau of Land Management (BLM), and National Park Service by the early 20th century; however, that process of land transfer continued even into the 1960s, when the U.S. government terminated its relationship with the Klamath Tribes and transferred their reservation to form much of the current Fremont-Winema National Forest in Oregon (Catton 2016). Many tribes that were re-recognized starting in the last quarter of the 20th century did not regain control over their former lands (Slagle 1989). However, the U.S. government has transferred some public lands back to tribal control in recent decades (Catton 2016). Several returns were made to correct for survey errors, including transferring part of the Gifford Pinchot National Forest to the Yakima Indian Reservation, parts of the Mount Hood and Willamette National Forests to the Warm Springs Reservation, and parts of the Olympic National Forest to the Quinault Tribe. Congress also transferred public lands to the Coquille Tribe in 1996 after it was re-recognized (see "Coquille Indian Tribe" on p. 882).

Each tribe has a unique history and relationship with the U.S. government, as well as unique environmental, economic, and cultural ties that influence how they are affected by public land management in the NWFP area. Federal land management and policy affects tribal ancestral lands and resources that remain critical to the well-being of tribal communities. The U.S. government has a legal responsibility to consult with federally recognized tribes regarding their interests in public lands and potential impacts to tribal trust resources and rights (see "The Federal-Tribal Relationship" on p. 854), as articulated in the Presidential Memorandum on Government-to-Government Relations with Native American Tribal Governments (Clinton 1994). The Record of Decision for the NWFP restates that responsibility and calls for resolving conflicts collaboratively with affected tribes because of the potential to affect tribal activities in areas subject to tribal treaty off-reservation rights (USDA and USDI 1994).

The chapter also uses the term "American Indians" to refer to individuals of Native American ancestry and especially in a historical context before the United States assumed control over the lands of the NWFP. In addition to laws and policies that deal with tribes as sovereign nations, the U.S. government has policies that deal with American Indians as individuals (Catton 2016). For example, the new 2012 forest planning rule accords both tribes and American Indians special consideration (USDA FS 2012). The rule highlights environmental justice, for which Executive Order 12898 directs agencies to evaluate whether federal activities have disproportionately high and adverse human health or environmental effects on minority and low-income populations, which includes American Indians (see chapter 10).

Guiding Questions

Managers from the Forest Service requested that the synthesis report address the two-part question of "What is the capacity of the Northwest Plan area to provide for Native American first foods (e.g., salmon, elk, huckleberry, camas, etc.), and is active management called for?" "First foods" is a term that some tribes have applied to traditional foods that have been and remain very significant in their diet and culture (Lynn et al. 2013). This chapter addresses that question as part of a larger examination of opportunities to promote tribal ecocultural resources and engagement in management of federal forest lands. In particular, we consider the effects of historical changes in the relationships between tribes and forests in the NWFP area, and how restoring tribal cultural practices would affect sustainability of those socioecosystems. After first considering the general context for land management and restoration to support values important to tribes, we delve into recent science to address several questions in more detail:

1. What resources within the NWFP area have special value to tribes, and what factors are influencing the quality and availability of those resources, as well as the ecosystems that produce them? In particular, how has the reduction in tribal influences since Euro-American colonization affected those resources and ecosystems?

The Federal-Tribal Relationship

A brief overview of the distinctive relationship between the U.S. government and 567 federally recognized American Indian and Alaska Native tribes is important to understanding the issues considered in this chapter. All federal agencies have a trust responsibility to protect tribal rights, lands, assets, and resources, which collectively constitute tribal trust rights and resources (Clinton 1994, Wood 1995). Federal recognition acknowledges tribes as political sovereigns with inherent rights to self-governance. When the U.S. government entered into treaties with American Indian tribes, it made commitments to provide tribes with goods and services and to protect their ability to harvest natural resources. For example, the Superintendents of Indian Affairs in Washington and Oregon, Isaac Stevens and Joel Palmer, respectively, negotiated 10 treaties involving tribes in the Pacific Northwest between 1853 and 1856. These treaties included provisions to protect specific activities on lands beyond the reservations such as harvesting fish (fig. 11-4) and shellfish, hunting, gathering plants such as roots and berries and erecting temporary buildings to cure them, and pasturing horses and cattle (Bernholz and Weiner 2008, Woods 2005). Court decisions have recognized that tribes reserved rights to harvest resources in ways that encompass trapping, camping, and other activities on public lands that are not necessarily referenced in a given treaty (Catton 2016, Goodman 2000, Wilkinson 1997). Figure 11-5A shows the locations of present-day reservations and the much larger cessions of lands from tribes to the U.S. government under those treaties. The U.S. government had negotiated 18 treaties with many tribes in California from 1851 to 1852, totaling one seventh of its land area, but the Senate refused to ratify them (Wood 2008). Instead, through executive orders and Congressional authorizations over subsequent decades, the U.S. government established a number of small reservations across the Pacific Northwest, and even smaller "Rancherias" for many tribes in California (fig. 11-5B) (Wood 2008).

Tribes have other claims that influence off-reservation land management even in the absence of ratified treaties of cession. For example, tribes have fishing and water rights for their reservations; legal defenses of those rights have prompted restrictions on upstream water withdrawals, notably in the Klamath River basin (Gosnell and Kelly 2010). Some tribes, such as the Klamath Tribes, have retained rights in former reservation lands that were acquired by the United States following termination (Goodman 2000). The Forest Service has established agreements with many tribes that do not have formal treaty rights that allow traditional harvesting within their ancestral lands (Catton 2016). Therefore, the cessions mapped in figures 11-5A and 11-5B present a very incomplete picture of tribes' ancestral connections to lands in the NWFP area, but they nevertheless illustrate particular connections between tribes and public lands that are enshrined in federal law. Given that federal public lands agencies control so much tribal ancestral land, and many tribes have only small land areas under their direct control, federal land management actions profoundly affect tribal access to resources (Dobkins et al. 2016).

The unique status of federally recognized tribes requires that U.S. government entities consult directly with these tribal governments when addressing issues that may affect trust resources and the welfare of their tribal members. Consultation is a cornerstone of the

government-to-government relationship and clearly distinguishes the tribes from other entities (Nie 2008). Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, sets requirements for the consultation process to ensure meaningful and timely input by tribal officials when federal action may affect tribal lands and resources. In addition, consultation obligations are found in numerous statutes (Galanda 2011). For example, the Native American Graves and Repatriation Act (P.L. 101-601) of 1990 imposed requirements for consultation with tribal officials or lineal descendants when officials anticipate or discover that activities on federal lands will affect American Indian burials.



U.S. Army Corps of Engineers

Figure 11-4—Tribal members fishing with dipnets at Celilo Falls, which was submerged by the construction of The Dalles Dam in the 1950s. Several tribes have rights to fish associated with this historic location on the Columbia River on the border of Washington and Oregon.



Figure 11-5A—Present-day tribal reservations, and ancestral lands mapped as cessions to the U.S. government in Library of Congress records, within the Northwest Forest Plan area in Washington and Oregon. The asterisk denotes the Colville Reservation, which lies outside the boundary but belongs to tribes that have ancestral lands and reserved treaty rights within the boundary.



Figure 11-5B— Present-day tribal reservations, and ancestral lands mapped as cessions to the U.S. government in Library of Congress records, within the Northwest Forest Plan area in California. Asterisks denote tribal lands outside the boundary belonging to tribes that have ancestral lands within the boundary.

2. What land management strategies can promote tribal ecocultural resources, and how do those strategies relate to management, research, and monitoring for economic, social, cultural, terrestrial and aquatic systems more broadly?
3. What strategies for engaging tribes in forest planning and management have been effective in addressing tribal concerns over how federal land management affects tribal ecocultural resources and rights?

This chapter focuses on issues for which federal land management entities such as the U.S. Forest Service and BLM have primary influence, such as managing vegetation, fire, roads, and trails. Because of that focus, this chapter mentions but does not examine in depth many other issues that have important effects on tribal ecocultural resources, including reintroduction of extirpated species, human population growth, urban development, and management of nonfederal lands. The intent of the science synthesis is to inform land management planning but not to make policy recommendations (see chapter 1). However, the periodic monitoring reports under the NWFP (Harris 2011, Stuart and Martine 2005, Vinyeta and Lynn 2015) were guided by a Tribal Monitoring Advisory Group to complete tribal surveys and case studies that informed recommendations for strengthening federal-tribal relationships under the NWFP.

Source Materials

The current land management planning rule requires decisionmakers to use best available science and also to request information about tribal traditional ecological knowledge (referred to as "native knowledge," see Glossary), land ethics, cultural issues, and sacred and culturally significant sites (USDA FS 2012). This chapter, as do others in this science synthesis, draws primarily from peer-reviewed scientific publications, focusing on those published since the NWFP was adopted. This chapter also draws upon findings from related chapters in this report to highlight how broader strategies being considered in forest management and planning may affect tribal ecocultural resources. Because considerable information regarding particular tribal resources and federal-tribal relationships has been documented in other kinds of publications, including theses, dissertations, and agency and tribal reports, this chapter refers to some of these publications to help fill gaps in peer-reviewed literature. However, tribal knowledge is often passed down orally in native languages rather than specialized, technical terminology (Ellis 2005). Therefore, relying on published information excludes traditional tribal knowledge that has not been referenced in such publications. Such exclusion risks perpetuating long-standing power imbalances (Gavin et al. 2015) as well as reinforcing barriers to integrating traditional knowledge into land management. Managers may discount traditional knowledge that does not seem to fit with their framing or understandings of particular issues (Bussey et al. 2016). Furthermore, tribal knowledge may be distorted or diminished as it is "scientized," or translated into Western scientific syntheses written in nonnative English (Agrawal 2002). Publication and institutionalization of traditional knowledge risks transforming it into "non-living knowledge for which no one has specific responsibility to pass on" (Gamborg et al. 2012: 542). The section on "Integrating traditional ecological knowledge in collaborations" (p. 900) identifies safeguards that have been recommended to avoid such outcomes.

Despite these concerns, it is important to recognize that many tribes have become forerunners in producing scientific knowledge in the Western tradition (Breslow 2014), and the participatory approaches used with tribes to prepare many of the articles, theses, dissertations, and scientific reports considered in this synthesis afford some protections against misuse. Nevertheless, readers of this synthesis are advised to consider the implications of relying exclusively on scientific publications. For example, published science may not well reflect tribal concerns over practices that are widely used in nontribal institutions, such as permitting, herbicide use, and burning outside of customary seasons (Halpern 2016, LeCompte-Mastenbrook 2016). Consistent with the planning rule, planners can elicit such information through a variety of pathways in addition to formal consultation, including collaborative partnerships as discussed within this chapter.

Key Findings

Our synthesis starts by considering important concepts that help to frame the context for forest management to promote tribal well-being.

What Is the Context for Promoting Tribal Well-Being Through Forest Management?

The forest planning rule requires that land management plans promote ecological sustainability and contribute to social and economic sustainability, in particular by managing areas of tribal importance (USDA FS 2012). Scientific research has recognized the deeply interwoven relationships between American Indians and the nonhuman elements of ecological systems in the Pacific Northwest region. These relationships remain critical to sustaining tribal food and health security; economic prosperity; recreation and tourism; spiritual and ceremonial practices and observances; heritage and cultural identity; and traditional knowledge systems, beliefs, and intergenerational exchange (Burger et al. 2008, De Groot et al. 2002, Fisher et al. 2008, Tengberg et al. 2012). For example, tribal material well-being continues to depend on material from forests for food, water, medicines, fuel, crafts, arts, and other creations. Tribal well-being also depends upon forest environments for sense of place and the ability to practice and pass on cultural traditions (Satterfield et al. 2013), including ceremonies for world renewal, coming of age, and first foods (Willette et al. 2015). Various species represent "cultural keystones" because of their prominent roles in maintaining tribal economies, identity, and cultural traditions (Garibaldi and Turner 2004). For example, first food ceremonies held by many tribes feature huckleberries (*Vaccinium* spp.), salmon (*Oncorhynchus* spp.), venison, and edible roots (Mack and McClure 2002), while salmon and tanoak (*Notholithocarpus densiflorus)* may have provided half of the traditional diet among members of the Karuk Tribe in California (Norgaard 2014a). The inability of many tribal members to harvest such foods has been linked to a host of social ills (LeCompte-Mastenbrook 2016, Norgaard et al. 2017). Many tribes are working to increase their access to traditional foods (figs. 11-1, 11-2, and 11-3) as part of a food "security" or "sovereignty" movement, which is part of broader efforts to sustain and enhance the well-being of tribal communities (Daniel et al. 2012, Hernández-Morcillo et al. 2013, LeCompte-Mastenbrook 2016). Researchers have extended the cultural keystone concept to "cultural keystone places," where cultural keystone species often occur, and which also have particularly great cultural, historical, social, ecological, and economic values (Cuerrier et al. 2015). Tribal cultural revitalization efforts depend heavily on having influence over management of public lands (MacKendrick 2009, Turner and Turner 2008).

The new land management planning rule focuses on ecosystem services (see chapter 9), encompassing "provisioning services" that support tribal harvesting of wild plants, animals, and materials, as well as less tangible "cultural ecosystem services" that are distinctively important to tribes and often underaccounted in conventional analyses (Asah et al. 2014). However, Raymond et al. (2013) and others have criticized the implicit emphasis of ecosystem services on economic production and associated markets. In contrast, they suggest that other metaphors such as "ecocultural community" invoke values that are important to indigenous peoples, such as reciprocity and relationships with past and future human generations and nonhuman entities. Upholding such values traditionally limited resource harvest in ways that promote sustainability, as highlighted in studies of harvesting plants and wildlife (Deur 2009, Jordan 2015). Such traditional principles are important in modulating societal demand for ecosystem services, which is a key challenge in applying the concept to public lands management (Patterson 2014).

Vulnerability and risk assessments for tribal communities need to be specialized to properly consider risks to tribes and their members who have traditionally relied more heavily upon wild fish, game, and wild plant foods, medicines, and other natural materials that are processed, stored, and used in homes (Burger 2008; Donatuto et al. 2014, 2011; Kerns and Ager 2007). For example, in a study of members of the Confederated Tribes of the Umatilla Reservation (within the Columbia River watershed east of the NWFP area), Harris and Harper (1997) reported that exposures to various contaminants for an average American Indian engaged in a traditional subsistence lifestyle may be 2 to 100

times greater than for an average suburban resident owing to greater ingestion of fish and other products that could bear contaminants. These findings are likely relevant to American Indians throughout the NWFP area who engage in lifestyles that similarly involve high consumption and handling of resources from wildlands. These factors increase the need for both protective standards and management that account for the distinctive characteristics of tribal communities.

Cross-boundary and broad-scale perspectives— Tribes in the NWFP area are connected to a diverse range of ecosystems from the mountains to the sea, encompassing marine, estuarine, riverine, valley, wetland, grassland, foothill, montane, and alpine environments that collectively offer a wide range of places and resources valued by tribes (Suttles 1990, Turner et al. 2011). This synthesis focuses on forested ecosystems while considering other interconnected ecosystems, including grasslands, meadows, wetlands, estuaries, bays, and the Pacific Ocean that collectively sustain many species of special concern to tribes. Tribal well-being is strongly connected to the condition of entire terrestrial and aquatic ecosystems across federal, tribal, state, county, and private lands. Development and environmental degradation of areas and waterbodies outside of present-day tribal lands has limited the ability of tribal communities to access desired resources (Donatuto et al. 2014, Norgaard et al. 2017). Consequently, working across broad scales and boundaries is critical for sustaining tribal ecocultural resources. A focus on watershed processes is particularly important because many of those resources depend on flows from mountain peaks to coastal zones and because many tribes in the NWFP area reside in coastal areas and river valleys (fig. 11-5A and 5B). Federal land management planning emphasizes such a watershed perspective, which helps to consider how forest management may affect downstream aquatic systems and related uses that are important to tribes. There are also important cross-boundary issues involved in terrestrial systems, especially because tribes have treaty harvesting rights and interests in ancestral lands beyond their present-day reservations, opportunities to treat adjacent national forest lands under the Tribal Forest Protection Act of 2004, and concerns for transboundary ecological processes such as wildfire. There are also complex land management situations such as the Quinault Special Management Area, which is managed by the Forest Service with 45 percent of proceeds from the sale of forest products to be provided to the Quinault Indian Nation (Vinyeta and Lynn 2015). Tribes that have been displaced from their ancestral homelands often have strong interest in lands that are distant from their current residences (Cronin and Ostergren 2007). In particular, some reservations are governed by confederated tribes whose members originated from broad territories and held a wide range of traditions and cultural practices. For example, descendants from the Rogue River tribes are now members of the Confederated Tribes of the Siletz Indians and the Confederate Tribes of the Grande Ronde Community who currently reside in northwestern Oregon, but they retain interest in forest management activities in their ancestral territory on the Rogue-Siskiyou National Forest in southwestern Oregon. As another example, the Nez Perce Tribe, whose reservation is in Idaho, retained rights to fish within the NWFP area. These examples demonstrate how maps of both contemporary tribal lands and ceded territories, such as in figures 11-5A and 11-5B, underrepresent tribal interests across the region.

What Ecocultural Resources and Associated Ecosystems Have Special Value to Tribes in the NWFP Area?

In this section, we highlight resources and associated ecosystems that emerged in our review as particularly important to tribes across the NWFP region. Land management agencies have long focused on archaeological sites and artifacts as the subjects of cultural resource protection, but increasingly there has been a recognition that living resources are critical cultural resources (Catton 2016). Tribes generally hold that all elements of the natural world have cultural significance, or as described by one Pacific Northwest tribal leader, "The Creator made all things one. All things are related and interconnected. All things are sacred. All things are therefore to be respected" (Turner and Berkes 2006: 499). The chapter provides only examples of the profound and varied relationships between tribes and nonhuman entities that have been especially prominent in

scientific literature. To characterize the significance of all species, ecosystems, and places from the perspective of dozens of tribes would require a far more extensive report than can be provided here. However, the chapter includes citations that offer more breadth and depth.

Water and waterbodies—
Water has tremendous material value that can be measured in terms of quality, quantity, and availability, as well as nonmaterial values that are discussed further below. Tribes and federal land management agencies have been involved in conflicts regarding water rights, dams, diversions and instream flows to sustain fisheries (Gosnell and Kelly 2010). Because the construction of large dams in river basins of the Pacific Northwest has greatly reduced anadromous fish populations and availability of traditional fishing sites (Gosnell and Kelly 2010, Hamilton et al. 2005, McClure et al. 2003), reservoir dam removal is an important issue discussed further below.

Ancestral and sacred places—
Like streams of water, tribal ancestral ties permeate and connect the diverse landscapes of the Pacific Northwest. The antiquity of resource uses is evident in sites across the NWFP area, including camas roasting pits dating to more than 7,000 years ago, berry processing camps dating back 3,000 years, scars in cedar trees that are hundreds of years old, and many other features that are discernable to experienced observers (Turner 2014). Lands and bodies of water support a variety of tribal values beyond their importance as sustenance and habitat for people, plants, and animals, including historical and spiritual values (Colombi 2012, Russo 2011, Russo and Zubalik 1992). Such values are recognized as cultural ecosystem services under the planning rule (USDA FS 2012). American Indians commonly place high priority on the cultural and spiritual values of public lands and in maintaining undeveloped conditions, while still recognizing that human activities such as maintaining roads and resource management are important to sustaining traditional relationships to the land (Flood and McAvoy 2007). Many areas considered sacred by tribes are likely to have a history of caretaking, productivity, and diversity (Hughes and Jim 1986), which could render them high priorities for conservation and restoration.

Focus on keystone species—
Several groups of organisms represent prominent tribal ecocultural resources across the NWFP area, including anadromous fish; ungulates; geophytes; fungi and lichens; trees that provide nuts, foliage, bark, and wood; berry-bearing shrubs; and many other plants and animals used for food, medicine, regalia, and crafts. Many of the plants and animals discussed below are likely to qualify as cultural keystone species for multiple tribes (Garibaldi and Turner 2004) because of their important roles in maintaining cultures and because they were widely used and traded by tribes in the NWFP area (Turner and Loewen 1998). These species can also be ecological keystones owing to their importance in maintaining important ecological processes. Consequently, many of these species warrant consideration as potential focal species under the new forest planning rule, and they would also be important to consider as keystones in an integrated ecocultural context.

Mammals, including ungulates and furbearers—
Columbian black-tailed deer (*Odocoileus hemionus columbianus*), Columbian white-tailed deer (*Odocoileus virginianus leucurus*), elk (*Cervus elaphus*), and antelope (*Antilocapra americana*) are large animals valued for food, hides, and nonmaterial cultural values in the NWFP area. These species depend on forest openings and nonforest communities that were maintained with former tribal burning practices (Anderson 2009, Boyd 1999, Turner et al. 2011). Managers of private forest lands have argued that populations of elk and black-tailed deer have declined without regeneration harvests (Burns et al. 2011). Fuels reduction can enhance the quantity and quality of elk forage (Long et al. 2008). Deer browse the new shoots or branch-tip growth of many of the berry-producing shrubs that are also important to tribes, including salal (*Gaultheria shallon*) (Stockton et al. 2005). In some areas within the NWFP, such as the Gulf and San Juan Islands, black-tailed deer have increased, leading to declines in many understory plants as well as birds (Martin et al. 2011). However, in many other parts of the NWFP area, a decline in elk and deer populations associated with fire exclusion and suppression and forest succession has reduced hunting opportunities and diminished tribal food security (LeCompte-Mastenbrook

2016, MacDougall 2008, MacKendrick 2009). Collaborative landscape efforts designed to restore habitats (e.g., winter range associated with lower elevation oak woodlands, or higher elevation forests) can help address tribal interests in increasing these wild ungulate populations. For example, under a settlement of a lawsuit by the Muckleshoot Indian Tribe, the Mount Baker–Snoqualmie National Forest designated two special management areas for elk forage (LeCompte-Mastenbrook 2016). That action was in part a response to impacts of late-successional reserve designations under the NWFP on elk habitat, which has also been highlighted as a tribal concern in NWFP monitoring reports (Stuart and Martine 2005).

Tribes use many mammals such as river otter (*Lontra canadensis*), American beaver (*Castor canadensis*), mountain beaver (*Aplodontia rufa*), Pacific marten (*Martes caurina*), fisher (*Pekania pennanti*), mink (*Neovison vison*), and porcupine (*Erethizon dorsatus*) in making regalia and other cultural items (Dobkins 2009, Matthews et al. 2013). Many of these species have prominent symbolic roles in tribal cultural traditions as well. Ecological implications of the decline or extirpation of some species, such as wolf (*Canis lupus*) and beaver, are discussed further below under "Species losses," while chapter 6 provides additional discussion of ecology and management of wildlife.

Birds important for food, regalia, and ceremonies— Various birds are important as sources of food and materials for tribal regalia, and many species have special cultural significance in ceremonies, stories, and songs. Turner and Bhattacharyya (2016) provide an extensive review of the cultural significance of birds from the Pacific Northwest, recounting the deeply rooted connections among tribal people, plants, and birds in both corporeal and spiritual realms. They reported common connections among important bird species and plants harvested for fruits and roots. For example, they noted that many tribes identify the Swainson's thrush (*Catharus ustulatus*) as the "salmonberry bird," an important indicator of the ripening of salmonberries (*Rubus spectabilis*) in coastal forests of the Pacific Northwest. Jordan (2015) provides a detailed examination of how the Hupa people have woven the pileated woodpecker (*Dryocopus pileatus*) into their material and spiritual culture by using the feathered scalps to make dance regalia (figs. 11-6 through 11-8) and maintaining a reciprocal relationship with the bird. For example, the Hoopa Valley Tribe has engaged in research to study how forest disturbances influence the species (see "Tribal Ecosystem Services From Dead Trees and Forest Gaps" on p. 864). Other birds that are prominently featured in tribal featherwork include mallard duck (*Anas platyrynchos*), bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos*), mountain quail (*Oreortyx pictus*), California quail (*Callipepla californica*), band-tailed pigeon (*Patagioenas fasciata*), acorn woodpecker (*Melanerpes formicivorus*), and northern flicker (*Colaptes auratus*) (Gleeson et al. 2012). Some species, such as various owls, have cultural



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Figure 11-6—A pileated woodpecker head mounted on a handle made of madrone "curly" wood (with disfigured growth from a honeysuckle [*Lonicera hispidula*] vine) and adorned with woodpecker tail feathers and shells from dentalium (*Dentalium* sp.) and abalone (*Haliotis* sp.). This regalia item, photographed June 2007, was made and used in contemporary tribal (Karuk and Yurok) brush dance and war dance ceremonies.

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Figure 11-7—Lake family regalia photographed August 2016, including a quiver made from fisher adorned with red abalone shells surrounded by men's ceremonial headbands composed of acorn woodpecker scalps sewn on tanned deer hide.



© Dawn Blake, who granted permission for one-time use of this photo in this report

Figure 11-8—Hupa men dressed in brush dance regalia in 2015, adorned with pileated woodpecker scalps along with a variety of other products derived from forest and ocean wildlife.

significance even though members of some tribes in the NWFP area avoid physically interacting with them and their feathers (Gleeson et al. 2012). California condor (*Gymnogyps californianus*) was historically significant, with feathers used in regalia items, and it remains a species of interest for some tribes in the NWFP area (Gleeson et al. 2012).

Forest management and fires affect bird habitat in complex ways, but, in general, increasing forest heterogeneity to include a variety of successional stages can increase avian diversity (Burger et al. 2013). Tribes often emphasize the importance of food webs and habitat to support the range of species on which they depend (Turner and Bhattacharyya 2016). For example, they call attention to the importance of tree cavities and production of nuts, berries, and other foods not only for their own use, but also for wildlife (Long et al. 2016a). Riparian areas are particularly important as harbors for many bird species of special importance to tribes (Turner and Bhattacharyya 2016). Turner and Bhattacharyya (2016) suggested that traditional tribal practices helped to sustain the diversity and productivity of habitats for many important bird species.

Anadromous fish—

Many tribes in the NWFP area value anadromous fish such as salmon and trout (*Oncorhynchus* spp.) (fig. 11-1) and sturgeon (*Acipenser* spp.) as cultural keystones (Benson et al. 2007, Crozier and Zabel 2006, Richter and Kolmes 2005). Lamprey (*Lampetra tridentata*) is another anadromous fish of special value to tribes (figs. 11-1, 11-10, and 11-11) (Close et al. 2002, Larson and Belchik 1998, Petersen Lewis 2009, Sheoships 2014). Eulachon or candlefish (*Thaleicthys pacificus*) (fig. 11-11) is an important traditional food and trade good when smoke-dried or processed

Tribal Ecosystem Services From Dead Trees and Forest Gaps

The Hoopa Valley Tribe recently partnered with Humboldt State University researchers to examine the effects of tree damage caused by black bears (*Ursus americanus*) (Mendia 2016). They found that bear damage in 40- to 60-year-old stands of Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*) was significantly correlated with dead and decaying trees larger than 10 in (25.4 cm) diameter at breast height. While the damage to trees negatively affected the lumber value of the stand, it created dead wood that would normally be found in older stands and was associated with increased observations of pileated woodpecker, a culturally important species used by tribal members for regalia, as well as red-breasted sapsucker (*Sphyrapicus ruber*) and other cavity-nesting birds. The researcher also observed deer browse on new growth of western swordfern (*Polystichum munitum*) in the canopy gaps resulting from killed trees (fig. 11-9). Consequently, this study found that the small-scale disturbance caused by bears promoted provisioning and cultural ecosystem services associated with biodiversity and tribal spiritual values.

Shannon Mendia



Figure 11-9—Canopy gap resulting from black bear damage to trees in a second-growth redwood stand on the Hoopa Valley Indian Reservation.

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Figure 11-10—Alme Allen (left) and Eugene Coleman hold lampreys caught with a modern wire and rim basket trap along the Klamath River, near Orleans, California, May 2005.

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Figure 11-11—Lamprey (top), candlefish (bottom), and night smelt (*Spirinchus starksi*) (center) harvested by Yurok Tribal members on a basket tray made from sandbar willow (*Salix exigua*), March 2014.

into oil (Larson and Belchik 1998, Mitchell and Donald 2001); the species was listed as threatened in the NWFP area in 2010 (chapter 7). These anadromous species, and their safety for human consumption, have been affected by increasing freshwater temperatures, drought, parasites, and toxins (Benson et al. 2007, Crozier and Zabel 2006, Richter and Kolmes 2005). Norgaard et al. (2013) studied trace metals in three species used by the Karuk Tribe in the Klamath River (salmon, steelhead trout, and freshwater mussels) and found that the foods were deemed safe even at the comparatively higher levels of consumption in traditional tribal diets. A recent Environmental Protection Agency (EPA) study found that 91 percent of lakes in Washington, Oregon, and Idaho had mercury levels in fish tissue that were dangerous to people who consumed high levels of fish (about six fish meals/week) (Herger and Edmond 2012). An earlier EPA study (USEPA, n.d.) conducted with the Columbia Intertribal Fisheries Commission also found high levels of toxins. They found that levels were higher in resident fish than many of the anadromous fish species listed above, except for white sturgeon (*Acipenser transmontanus*), which had some of the most hazardous levels of contamination. They also reported that health risks were far greater to American Indians than to the general public because their fish consumption was 6 to 11 times greater. This study demonstrated the importance in tailoring risk assessments to particular tribal contexts, as well as to consider the potential impacts of releases of toxic substances in sediments stored behind reservoir dams.

Amphibians and mollusks—

Frogs have tribal cultural significance, as portrayed on totem poles and in traditional stories, where they are often represented as supernatural beings that carry important messages and should not be harmed (Barbeau 1930, Turner and Berkes 2006, Wassen 1934). Freshwater mussels (e.g., *Margaritifera falcata, Gonidea angulata,* and *Anodonta californiensis*) are important tribal sources of food (Davis et al. 2013), and they provide other important ecosystem services, including sustaining water quality and food webs (Vaughn et al. 2008). They have a very patchy and reduced abundance in the region particularly resulting from declines

in host fish species associated with degraded physical habitats, nonnative fishes, and reduced connectivity resulting from dams on the Klamath, Columbia, and other large rivers (Box et al. 2006, Davis et al. 2013, Howard 2010). Other mollusks, including terrestrial snails and slugs (see chapter 6), have special values to tribes.

Nut-bearing trees—

Tree species that were traditionally valued for nut production include hardwood species such as tanoak (figs. 11-2 and 11-12) (Bowcutt 2013), California black oak (*Quercus kelloggii*) (Long et al. 2016a), Oregon white oak (*Q. garryana*) (Hosten et al. 2006), and California hazel (*Corylus cornuta* var. *californica*) as well as conifer species such as sugar pine (*Pinus lambertiana*) (Anderson 2005) and whitebark pine (*P. albicaulis*) (Mack and McClure 2002).

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Figure 11-12—Chris Peters harvesting acorns, near Orleans, California, November 2012.

Many of the hardwood species are capable of resprouting following fires, but the loss of mature crowns retards nut production for long periods in several species (see chapter 3). There is greater potential for lost nut production in many of these species because fire exclusion, conifer encroachment, and increased fuel loading have increased the potential for high-severity fire (Cocking et al. 2012, Devine and Harrington 2006). However, Sadler's oak (*Q. sadleriana*) is a shrubby oak also valued for nut production, but which can respond to fire with vigorous acorn production. Sudden oak death is a fungal disease that threatens many of the hardwood species (Cobb et al. 2012, Ortiz 2008) (see chapter 3), while white pine blister rust threatens sugar pine and other white pines (Samman et al. 2003). Strategies to promote forests that are more resilient to mortality agents, especially in more frequent-fire forest types, include reducing fuel loads, restoring fire regimes, reducing tree density, and shifting composition toward more fire-adapted native plants (see chapter 3 and Long et al. 2014a).

Trees used for material and medicine—

Many other tree species have special values to tribes for materials, medicines, and other traditional cultural purposes, including various pines (*Pinus* spp.), spruces (*Picea* spp.) (fig. 11-13), Pacific yew (*Taxus brevifolia*), Port Orford cedar (*Chamaecyparis lawsoniana*), coast redwood (*Sequoia sempervirens*), Alaska yellow-cedar (*Callitropsis nootkatensis*), red alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*), bitter cherry (*Prunus emarginata*), cascara (*Rhamnus purshiana*), black cottonwood (*Populus trichocarpa* ssp. *trichocarpa*), and many other species (Turner and Hebda 1990, Turner and Loewen 1998). The Pacific crabapple (*Malus fusca*) is a native pome-bearing tree that grows in riparian wetlands and was an important traditional source of food, medicine, and wood for tribes across the coastal range of the NWFP area (Turner and Turner 2008). Western redcedar (*Thuja plicata* Donn ex D. Don) has been particularly highlighted as a cultural keystone species, reflecting its many uses, including canoes (fig. 11-14), totem poles, hats, clothing,

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Figure 11-13—Deanna Marshall (right) with her mother Laverne Glaze, harvesting Sitka spruce (*Picea sitchensis*) roots for basketry material, July 2006. This rain forest species is used by tribes in the coastal zone of the Northwest Forest Plan area.

Dale Northup



Figure 11-14—Carvers Frank Harlow and his nephew Ben Harlow carved four canoes from a large western redcedar tree near Queets, Washington, circa 1932.

baskets, and other crafts (Barbeau 1930, Garibaldi and Turner 2004, Stewart 1995). Western redcedar has been the subject of restoration partnerships involving the Forest Service and tribes (Smith and Farque 2001). The use of some conifers for material, such as cedar trees peeled for bark, have produced culturally modified trees that retain evidence of intentional alteration by American Indians. Because such trees have scientific and cultural value as records of activity by past generations of American Indians, they are important to consider when planning harvest and fire management (Eldridge 1997, Turner et al. 2009). Populations of both hardwoods and conifers are threatened by diseases, a rapidly changing climate, and associated disturbances (see "Climate change" on p. 873).

Understory plants for material items, floral greens, medicines, berries, and other foods—

A wide variety of understory plants are important for maintaining the health, diet, lifeways, and cultural traditions of tribal communities (Lynn et al. 2013, Rogers-Martinez 1992, Turner 2014). Many of these plants produce berries, including huckleberries (fig. 11-2), cane fruits and brambles (*Rubus* spp.), elderberries (*Sambucus* spp.), buffaloberries (*Shepherdia* spp.), strawberries (*Fragaria* spp.), and serviceberry/saskatoon berries (*Amelanchier alnifolia*) (Kellogg et al. 2009, Turner and Turner 2007).

Several species of huckleberries, especially *Vaccinium membranaceum, V. deliciosum*, and *V. ovatum*, have historically been and today remain a prominent first food and trade item for many tribes across the NWFP area (Deur 2009, LeCompte-Mastenbrook 2016, Mack and McClure 2002). Some of these huckleberry species have yielded substantial market values for their berries or foliage. The production of huckleberries from a good site near Mount Adams in Washington state was reported to be as much as 100 gal/ac (935 L/ha), with a value of $11/gal ($2.90/L) suggesting an estimated value of $1,100/ac ($2,700/ha) in 1977 (Minore and Dubrasich 1978). Arnette and Crawford (2007) reported that wholesale prices in 2007 were about $18/gal ($4.76/L) (which is within the range of prices in the U.S. Forest Service Pacific Northwest (Region 6) special forest products appraisal system database). These figures indicate that huckleberry production can be valued at several thousand dollars per acre or hectare. For many decades, the high socioeconomic value of these berries to tribal members has been recognized, along with conflict with commercial harvest by non-American Indians (Carroll et al. 2003, Hansis 1998, Richards and Alexander 2006). However, there has been untapped potential for land management to enhance the productivity of such resources to support multiple benefits (Von Hagen and Fight 1999), including enhanced suitability for tribal harvest.



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Figure 11-15—Lillian Rentz (left) harvesting cluster-lilies (*Brodiaea coronaria*) with LaVerne Glaze near Somes Bar, California, July 2006.

A variety of understory plants provide important material for making baskets and many other traditional items, including willows (*Salix* spp.), sedges (*Carex barbarae* and *C. obnupta*), cattails (*Typha latifolia*), tule (*Schoenoplectus* spp.), dogbane (*Apocynum cannabinum*), and many others. Salal is an important shrub harvested by tribal members for edible berries and medicine, and workers from many ethnic groups also harvest it commercially for the floral greens industry (Ballard et al. 2008). Many geophytes, including camas (*Camassia* spp.), cluster-lilies (*Brodiaea* spp.) (fig. 11-15), biscuit roots (*Lomatium* spp.), onions (*Allium* spp.), and lilies (*Lilium* spp.), are important traditional foods. Improving camas production was the goal for prescribed burning as part of the Camas Prairie Restoration Project in prairie habitat on the Willamette National Forest, Oregon (Nabhan et al. 2010, Smith and Farque 2001). Tribal harvesters use the leaves of another important geophyte, beargrass (*Xerophyllum tenax*) (fig. 11-16), to make baskets and tribal regalia items; treatments to promote those uses have been the subject of joint Forest Service and tribal partnerships (Hummel et al. 2012, Shebitz et al. 2009a).

Many understory plants are associated with disturbances, such as fire, that create or maintain canopy gaps and open understory environments. Canopy gaps allow light to reach the understory, and burning often promotes characteristics desired by harvesters, such as long, supple stems, larger roots, and increased fruit production, as well as ease of access for harvesting. For example, research indicates that tribal harvesters prefer beargrass from stands with fewer, larger trees and less down wood, which are conditions that can be promoted through thinning and frequent fire (Hummel and Lake 2015). However, such

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Figure 11-16—LaVerne Glaze holding harvested beargrass (*Xerophyllum tenax*), July 2005.

relationships can vary greatly among closely related species. For example, Kerns et al. (2004) found that red huckleberry (*Vaccinium parvifolium*) foliage growth (not necessarily fruiting) would likely benefit from thinning young conifer stands. Similarly, Keyes and Teraoka (2014) found red huckleberry to be more dominant in second-growth than old-growth redwood stands in northern California. On the other hand, the more shade-tolerant evergreen huckleberry (*V. ovatum*) appeared more abundant in closed-canopy forests along the Oregon coast in a study by Kerns et al. (2004). In addition, Halpern and Spies (1995) had found that cover and frequency of big huckleberry (*V. membranaceum*) were greater in old-growth or mature forest stands in the Cascade Range of Washington. While speculating that thinning in such stands might cause declines in vegetative growth, Kerns et al. (2004) cautioned that they were unable to determine a relationship between stand condition and fruiting patterns, and they concluded that more site-specific investigations informed by tribal harvesters would improve understanding of favorable management practices. While forestry and botanical research typically evaluate vegetative abundance, tribal harvesters evaluate additional characteristics that affect harvest suitability, such as fruit abundance, size, and taste, when recommending management strategies for particular stands.

Wetland plants—

Tribes have valued and tended several kinds of plants found in wetlands, including tules, cattails, sedges, willows, and wapato (*Sagittaria* spp.). Tribes in Oregon and on the Olympic Peninsula in Washington have long harvested small cranberry (*Vaccinium oxycoccos*) from bogs and used fires to deter encroaching trees and shrubs and to stimulate the plants to produce more fruit (Anderson 2009). Bog Labrador tea (*Rhododendron groenlandicum*) is another species used for tea and medicine that has a similar history of tribal burning; the plant resprouts from stems following low-intensity fires and from deep rhizomes following more severe fires (Anderson 2009). Klamath tribal members cultivated marsh edge areas to harvest seeds from the yellow pond lily (*Nuphar polysepala*) (Deur 2009). Another example is the rare western lily (*Lilium occidentale*), a threatened species. As described in a 5-year status report (USFWS 2009), this plant is endemic to the coast of northern California and southern Oregon, where it occupies freshwater wetlands, coastal prairie and scrub, and the edges of Sitka spruce forests. Declines in habitat quality for the species have been linked to reductions in tribal burning and ungulate grazing, which historically was provided by elk but for which cattle can be a useful surrogate (USFWS 2009). Imper (2016) asserted that within the coastal region, disturbances such as grazing and burning are important to deter encroachment by sedges and conifers into open wetland habitats that support populations of the rare lily, along with many other rare plants.

Fungi and lichens—

Many species of fungi are important sources of food, medicine, and income for tribal members, including matsutake (*Tricholoma magnivelare*), morels (*Morchella*

spp.), chanterelles (*Cantharellus* spp.); hedgehogs (*Hydnum* spp.), boletes (*Boletus* spp.), *Hericium* spp., and oyster mushrooms (*Pleurotus* spp.) (fig. 11-3) (Anderson and Lake 2013). Many of these species produce fruiting bodies following fire and other disturbances to trees and soils (Anderson and Lake 2013). For example, recent research outside the NWFP area found that profuse morel production in the first year following the Rim Fire in the Sierra Nevada mountains could sustainably support "relatively liberal harvest limits" (more than 4 L/day) by recreational and subsistence harvesters (Larson et al. 2016). Wila or horsehair lichen (*Bryoria fremontii*), which scientists recently described as a "macrolichen symbiosis" of a fungus, algae, and yeast (Spribille et al. 2016) is a "first food" for tribes particularly in the interior of the Pacific Northwest, where edible varieties have been harvested from forests and distinguished from the inedible ones using tribal traditional knowledge (Crawford 2007). Chapter 6 includes more information about responses of fungi and lichens to fire and management.

Tribal ecological knowledge systems— Tribal cultures across the NWFP area constitute a great diversity of languages, knowledge systems, practices, and traditions that reflect the ecological diversity of their ancestral territorial homelands (Kroeber 1920, Suttles 1990, Turner 2014). Many parts of the region, such as the Klamath Mountains, have distinctive mixes of species and ecosystems that also occur in the Coast Range, Cascade Range, and California provinces. Tribal knowledges reflect similar mixes, as tribes of northern California have cultural knowledge and practices of species that extend from the Great Basin, Pacific Northwest, and California floristic biomes (Kroeber 1920). Meanwhile, tribes along the lower Columbia River depend upon and have knowledge of plants and animals found both in the Pacific Northwest and on the Columbia Plateau. Tribal knowledge systems have evolved with an understanding of conditions across bioregions and habitats, which makes them particularly valuable for informing adaptation. Maintaining these knowledge systems requires managing resource conditions and accessibility through applications across large geographic areas (Dobkins et al. 2016, Trosper 2003, Turner et al. 2003).

Although tribes living in similar environments may represent different language groups, they tend to exhibit similarities in cultural practices. For example, tribes along the coast from British Columbia to northern California used and still depend upon many similar resources (Suttles 1990). Although many tribes use the same species for similar purposes, their stewardship methods differ based on culturally specific knowledge and customs, as illustrated in the case of Pacific lamprey (Close et al. 2004, Petersen Lewis 2009). Similarly, all the tribes have rich basket weaving traditions, and many use primarily the same few species, such as hazel and beargrass as central components. However, just as tribes have distinctive weaving techniques and designs, they also have distinctive cultivation and harvesting practices (Hummel et al. 2012, Hummel and Lake 2015). The distinctions in how tribes use and manage forest resources are important for planning, prioritizing, and implementing strategies for managing large landscapes (Stumpff 2006), as each interested tribe may have specific values attributed to particular places. Tribal knowledge can guide and inform resource management for a suite of similar habitats and species, but specific prescriptions and treatments may be needed to promote desired conditions for specific sites. For example, many tribes may want to use fire within a landscape, but they may have different approaches regarding the timing of burning in particular habitats (see "Reestablishing fire regimes" on p. 885). Consequently, consultation, coordination, and communication by federal agencies with individual tribes is important to address landscapes, habitats, and species of interest, rather than expecting that generalized prescriptions will serve the needs of all tribes in an area (Raish et al. 2007).

What Factors Are Influencing the Quality and Availability of Tribal Ecocultural Resources?

Factors influencing the availability of ecocultural resources range from harvesting rights to biophysical factors that influence the quality and quantity of production. The periodic monitoring reports under the NWFP (Harris 2011, Stuart and Martine 2005, Vinyeta and Lynn 2015) considered how tribes evaluated the accessibility and condition of important resources and places on public

lands. While devoting much attention to legal and bureaucratic constraints, the reports also discuss how competition with non-Indians affects their capacity to obtain desired resources. While those reports note that some tribal respondents regard the NWFP as having improved the condition of terrestrial and aquatic ecosystems by providing protections for old-growth forest and aquatic habitats, many also note that fire suppression and strict preservation approaches linked to the NWFP have inhibited restoration of conditions desired by tribes. Similarly, research by LeCompte-Mastenbrook (2016) recounts how members of the Muckleshoot Tribe regard the institutionalization of "minimal disturbance" under the NWFP as having had negative effects on tribal ecocultural resources such as huckleberries and elk. Such perceptions are consistent with trends discussed in chapter 12, namely, that the Plan has encouraged managers to limit intentional disturbance while extending the legacy of fire suppression, which has led to reduced composition and productivity of many resources that are not favored by dense conifer forests. Beyond the accessibility and productivity of ecocultural resources, tribal members are also concerned about obstacles to applying tribal stewardship practices themselves on their ancestral lands. Having such opportunities enables them to enhance not only resources, but also traditional ecological knowledge and community capacity.

Changes in tribal socioeconomic conditions and resulting effects—

A broad historical perspective is helpful for understanding how changes in the lands and waters are associated with changes in the well-being of the indigenous peoples of the Pacific Northwest. While tribes throughout the region have maintained close connections to land, many of them underwent a shift from subsistence to market-based economies by the start of the 20th century. During that shift, many tribal members sought employment in regional fisheries as well as agriculture- and timber-based industries (Mondou 1997). Tribes and their members have long faced challenges in attempting to maintain both economic security and traditional cultural practices. Many tribal economies remain strongly linked to forest industries and management through activities such as harvesting timber and nontimber forest products, firefighting, and positions with land management agencies. As employment in timber and fishing industries have declined, tribal members have relied on more restoration-based jobs or harvesting of nontimber forest products (MacKendrick 2009). The Jobs in the Woods Program, set up to mitigate socioeconomic impacts of the NWFP by providing restoration-based jobs for workers from timber-based communities, appeared particularly effective in tribal contexts by supporting effective retraining, valuable jobs, increased economic security, aquatic habitat improvement, and cultural capacity through projects on tribal lands (Harris 2011, Middleton and Kusel 2007).

During much of the 20th century, local tribes had little influence over resource management on federally managed lands for a variety of reasons, including less developed tribal institutions, dismissal of tribal traditional knowledge and concerns, and inconsistent federal recognition and policies (Catton 2016, Record 2008). As noted by many tribes, public lands management during that era, including suppression and punishment for tribal burning and harvesting, engendered considerable distrust of land management agencies, while degrading the quality and quantity of important tribal ecocultural resources (Dobkins et al. 2016, Lake 2013, Norgaard 2014a). Various land management policies, including removal of tribal stewardship, fire exclusion, commercial timber harvest, and protections for threatened species and wilderness areas, have contributed to denying tribes the benefits they derived from ancestral lands, which in turn has depressed tribal community well-being and engagement in forest management (Freedman 2002, LeCompte-Mastenbrook 2016, Norgaard 2014b).

Access for harvesting forest products—

As discussed in the "Federal-Tribal Relationship" on p. 854, some tribes have legal rights to harvest various forest products from public land areas. More generally, the Farm Bill of 2008 authorized the Secretary of Agriculture to provide any trees, portions of trees, or forest products to Indian tribes free of charge for "traditional and cultural purposes," for which the Forest Service adopted a final rule on September 26, 2016 (USDA FS 2016). Previously, the requirements for such collections widely varied through time and across the different national forest districts and other

jurisdictions in the NWFP area (Catton 2016). A recent study of the Northwest Native American Basketweavers Association found that American Indian harvesters of special forest products encountered a range of obstacles to harvest on public lands, including gates, closed or poorly maintained roads, requirements for obtaining permits, fees for access, and insufficient support in agreements (Dobkins et al. 2016). Similarly, access to suitable logs to construct river- and ocean-going canoes (fig. 11-14) has been a limiting factor for larger contemporary tribal traditions and celebrations (Johansen 2012). The Quinault Indian Nation reported difficulty in procuring logs from adjacent national forest lands to use in river restoration efforts (Harris 2011). Tribes have faced obstacles in obtaining logs from national forests across the NWFP area owing to limited availability, constraints associated with late-successional reserves and special status and sensitive species, disputes over fees, and other procedural hurdles (Catton 2016, Harris 2011, Vinyeta and Lynn 2015). Some tribal members have criticized various bureaucratic processes associated with obtaining information and approvals or permits to harvest forest products as being unduly burdensome, and some have described the expectation of having to obtain permits as an affront to religious freedom, tribal rights, and other values (Dobkins et al. 2016, Flood and McAvoy 2007). The economic impacts of fees on low-income and minority populations are also discussed in chapter 10. Strategies to address tribal concerns over policies that constrain resource access are discussed further below.

Competition for harvesting nontimber forest products— Harvesting of nontimber forest products (also known as special forest products) represents a substantial socioeconomic activity in the Pacific Northwest (see chapter 10), with commercial harvest of products such as floral greens and mushrooms valued in hundreds of millions of dollars (Alexander et al. 2011, Von Hagen and Fight 1999). An important practical constraint on tribal resource use has been a limited supply to meet tribal needs (Findley et al. 2001), which reflects environmental degradation as well as competition for that production especially from nontribal commercial harvesters (Dobkins et al. 2016). Competition and outright conflict over nontimber forest products on public lands has occurred between tribal members and nonlocal groups from nontribal minority and low-income populations, especially immigrants from Southeast Asia and Latin America (Charnley et al. 2008a, Hansis 1998). During the early 1990s, tribal concerns over non-American Indian harvest of matsutake mushrooms, particularly by Southeast Asian immigrants from distant urban areas, triggered protests of national forest management of commercial harvest on the Happy Camp district (Richards and Creasy 1996). The researchers explained that such groups had strong incentives to overharvest the resource as they were not likely to recoup the benefit of leaving it, while the tribal harvesters had cultural practices that were more likely to favor sustainability. Hansis (1998) similarly reported that nontribal itinerant groups had disincentives to harvest various resources sustainably across other parts of the NWFP area. As noted in chapter 10, management designed to support commercial harvest and tribal cultural harvest may differ for a number of resources, including beargrass, as the qualities preferred by those groups may differ. Furthermore, the fact that some tribal members harvest products for sale as well as subsistence adds complexity to issues regarding permits and competition. In addition to impacts of nontribal harvesters, recreationalists can also affect tribal hunting, fishing, trapping, plant harvesting, and ceremonies. Various strategies to address nontribal impacts to tribal resource use through seasonal closures or special-use areas are discussed below.

Illegal marijuana cultivation— Marijuana cultivation on national forests and other public lands has proliferated since the 1990s, especially in northwestern California (Bauer et al. 2015), but increases have also occurred in Oregon and Washington (National Drug Intelligence Center 2007). This activity is merely a subset of a larger problem of illegal activities on public lands that poses concerns for public safety, access, and resources; for example, methamphetamine labs and dump sites also significantly increased since the late 1990s (Tynon et al. 2001). However, the particularly rapid and extensive growth of marijuana cultivation has had widespread social and ecological impacts, including harm to culturally important wildlife species. For example, illness and deaths in fisher

populations in southern Oregon and northern California, including on and around the Hoopa Valley Reservation, have recently been linked to the use of rodenticides in marijuana cultivation (Gabriel et al. 2012). Other researchers found that the rodenticides cause direct or indirect mortality to wildlife species of cultural significance such as black bear, fisher, bobcat (Serieys et al. 2015), owls, and other predators or scavengers that consume rodents laced with the toxic compounds (Hosea 2000, Stone et al. 1999). Additionally, Bauer et al. (2015) found that water diversion associated with illegal marijuana cultivation in several California watersheds negatively affected the health of salmonids and amphibians. Finally, these operations pose safety concerns for forest users and land managers responsible for treating, monitoring, and protecting forests (Tynon and Chavez 2006). Some tribes have expressed safety concerns for tribal harvesters who encounter illegal marijuana cultivation sites on federal and tribal lands.

Climate change—

Changes in climate can potentially jeopardize tribal ecocultural resources, and the well-being of tribal communities more generally, by exacerbating droughts, extreme storms and runoff events, wildfires, and outbreaks of insect pests and plant pathogens (see chapter 2). In addition, rising seas, melting glaciers, and associated flood hazards are affecting tribes in low-lying and coastal areas (Papiez 2009), which increases the importance of federal lands for sustaining tribal communities. As discussed in chapter 2, there is considerable uncertainty regarding how climate, fire, invasive species, and other influences will affect species composition and habitat at fine scales, but climate trends such as reduced water availability in soils and streams are expected to have greater impacts within inland and southern portions of the Pacific Northwest region. Such changes threaten the availability of traditional foods, medicines, and materials to tribes, which in turn can harm diets, health, and other important dimensions of community well-being (Bennett et al. 2014, Lynn et al. 2013). Because tribal communities in the Pacific Northwest are so strongly associated with large rivers and the Pacific Ocean, they can be affected by climate change even well outside of their current lands. Impacts of changing climate are compounded by other stressors, including insect pests, plant pathogens, hydrologic alterations, changes in fire regimes, and increases in tree densities and fuel loads (Pfeiffer and Voeks 2008, Spies et al. 2010). For example, Turner and Clifton (2009) identified examples of declines in amphibians, fishes, forest health, and tribal ecosystem services in British Columbia, adjacent to the NWFP area, which they attributed to changes in climate, intensifying droughts, and outbreaks of insect pests and plant diseases.

When assessing vulnerability to climate change and other stressors, focusing attention on tribal values helps to evaluate threats and identify stressors and needs for adaptation. Tribes have been engaged in a number of initiatives to evaluate vulnerability to climate change and support adaptation actions (see "Tribal Engagement in Climate Change Initiatives" on p. 885). MacKendrick (2009) worked with the Hoopa Valley and Coquille Indian Tribes to evaluate priority concerns regarding vulnerability to climate change, many of which involve transboundary issues with public lands such as wildfire hazard and water quality in shared streams. In cases where Western scientific knowledge of climate-habitat-species relationships is available for species of significance to tribes, they can be crosslinked with tribal knowledge to better forecast and anticipate threats to tribal uses (Turner et al. 2011) and to identify possible refugia (Carroll et al. 2010a, Olson et al. 2012). Various tree species that have special tribal importance have been studied to assess their vulnerability to projected changes in climate. For example, Alaska yellow-cedar and Oregon white oak both rank as particularly vulnerable species (Case and Lawler 2016, Coops and Waring 2011, Hennon et al. 2012). Conversely, California black oak, tanoak, bigleaf maple, and western redcedar appear highly adapted and more likely to expand their ranges under the warmer and more fire-prone conditions that have been commonly predicted (Case and Lawler 2016, Coops and Waring 2011). Tribal members often depend upon large, long-lived trees with particular characteristics to obtain nuts and special wood products. Consequently, predictions of range expansion for important species do not sufficiently gauge the sustainability of ecosystem services for tribal communities.

Species invasions—
Invasive species are affecting the condition of ecosystems within the NWFP area (see chapter 3), and they are also degrading the ability of American Indians to harvest ecocultural resources. Although there are too many to list in this report, specific examples of invasive plants that have degraded tribal gathering areas include Scotch broom (*Cytisus scoparius*), yellow starthistle (*Centaurea solstitialis*), and Himalayan blackberry (*Rubus armeniacus*) (Pfeiffer and Ortiz 2007, Pfeiffer and Voeks 2008, Senos et al. 2006). Tribes have undertaken restoration efforts to combat exotic knotweeds (*Fallopia* spp.) (Harris 2011); those invasive plants can have profound and persistent effects on the structure, functioning, and diversity of riparian forests by displacing native species (Urgenson et al. 2009). Furthermore, legions of invasive fishes, snails, and plants such as purple loosestrife (*Lythrum salicaria*) also negatively affect native salmonids and other native aquatic resources (Sanderson et al. 2009).

The spread of the sudden oak death pathogen (*Phytophthora ramorum*) is having profound implications for ecological processes (see chapter 3) and tribal ecocultural resources in the northern California and western Oregon coastal region. The disease has killed many large tanoak and black oak trees, and it infects many other species of special value to tribes, including California bay laurel (*Umbellularia californica*), California hazel (*Corylus cornuta*), huckleberries (*Vaccinium* spp.), and salmonberry (*Rubus spectabilis*) (Cobb et al. 2012, Ortiz 2008). Although infection does not necessarily kill those understory plants, it reduces their suitability for tribal use owing to lesions and may prompt land managers to remove infected plants, especially California bay laurel, to protect tanoak stands (Swiecki and Bernhardt 2013).

The spread of a closely related pathogen, *Phytophthora lateralis*, has affected populations of the Port-Orford cedar within its range in northwestern California and southwestern Oregon. This riparian species not only holds special ecocultural value but also has high market values and plays an important ecological role, especially on ultramafic soil areas (Hansen 2008). Because roads are an important vector for the spread of the pathogen, road closures have been used to restrict its spread (Hansen et al. 2000). Although intended to benefit forest sustainability, such closures can also affect tribes' ability to access resources.

Species losses—
When cultural keystone species are reduced or eliminated from a tribe's ancestral territory, then the associated cultural traditions, knowledge systems, and material well-being of tribal communities suffer in turn (Colombi 2012). California condor is a tribally important species for which reintroduction within the Pacific Northwest has been considered (Walters et al. 2010). In general, federal land management agencies such as the Forest Service and BLM do not have primary roles in wildlife reintroductions, but they are often cooperators in such efforts by addressing habitat needs for those species.

Some species losses have altered ecosystem functions in ways that land managers consider in designing treatments. For example, recent decades have seen growing interest in the reintroduction of beaver. Ponds formed by beavers provide important habitat for coho salmon (Pollock et al. 2004). Structural treatments designed to mimic beaver dams and facilitate beaver recolonization known as "beaver dam analogues" have been undertaken within the three states of the NWFP area (Pollock et al. 2015). One recent study from Oregon's John Day watershed reported enhancements in steelhead habitat and juvenile growth following placement of such structures (Bouwes et al. 2016). Another example of the potential impacts of species losses and reintroductions involves top predators such as wolves. The gray wolf was extirpated in the Pacific Northwest, but populations have returned to parts of the region owing to efforts led by the Nez Perce Tribe (Donoghue et al. 2010). Beschta and Ripple (2008) suggested that reintroduction of wolves could have cascading influences on ecosystems in the Pacific Northwest. Their work built upon extensive research in Yellowstone National Park's Lamar Valley, where they contend that removal of wolves triggered an increase in elk herbivory on woody riparian plants, which in turn contributed to streambank erosion, channel incision and widening, and loss of wetlands and beaver

habitat (Ripple and Beschta 2004). Along several rivers of Olympic National Park, where elk hunting is prohibited, they found reduced recruitment of black cottonwood and bigleaf maple, as well as greater channel braiding and bank erosion, as compared to riverine sites within the Quinault Indian Reservation where humans have continued to hunt elk. As a result, their analysis not only suggests possible ecological effects of removing or reestablishing wolves, but also suggests that predation by American Indians had important effects on the dynamics of those riverine systems. Reinforcing that point, Hutchings and Campbell (2005) contended that American Indian hunters influenced the vegetation and morphology of riparian-aquatic environments such as deltas of large rivers such as the Nooksack in Washington by altering ungulate and beaver populations. While hunting and management of wildlife populations are generally not under the purview of national forest managers, an understanding of these dynamics is important for understanding historical conditions and restoration strategies.

Alterations of hydrologic regimes—
Changes in hydrologic regimes resulting from past land use practices include decreases in low flow, increases in peak flow, and increases in water temperature (Beechie et al. 2013). Under warming climates, reduced snowpack, loss of glaciers, and increased rain-on-snow are expected to intensify those impacts, with negative consequences for coldwater fishes such as salmon and trout (Abdul-Aziz et al. 2011). Habitat fragmentation and elevated water temperatures have had a great impact on salmon fisheries (Coates 2012). Tribes are concerned about the threats such impacts pose to anadromous fishes that are critically important to many tribes' traditions and livelihoods (Dittmer 2013). Because reservoir dams are a leading cause of altered hydrology throughout the NWFP area, removal of such dams has become an important restoration strategy and subject of research (see "Removing reservoir dams" section on p. 890). Other hydrological alterations include intentional draining of wetlands that formerly sustained important ecocultural resources (Deur 2009).

Alterations of fire regimes—
Wildland fire affects the physical, biological, and sociocultural components of landscapes in ways that can benefit or damage tribal ecocultural resources. Fire has cascading effects, beginning with direct combustion and heating that can damage sites or resources, and extending to second-order physical effects such as soil erosion following severe fires, as well as third-order impacts to cultural values, which can result from tangible and intangible resource change, loss, or damage (Ryan et al. 2012). Tribal members often have strong concerns about the threat of wildfire to their lands (MacKendrick 2009). Fire management activities themselves, such as fireline construction (mechanically and manually) that results in physical removal or modification of vegetation and soil, can also degrade tribally valued resources (Timmons et al. 2012, Welch 2012). Tribal members have also cited instances when fire retardant applied aerially during wildfire fighting has affected harvesting areas (Norgaard 2014a). Retardants contain fertilizing chemicals that can cause eutrophication and fish toxicity when entering waterbodies; studies have suggested that they have very low toxicity to human firefighters and birds but can irritate eyes, skin, and respiratory tracts (Giménez et al. 2004, Kalabokidis 2000, Vyas et al. 2009). Although impacts from fire management are important concerns to tribes, advance planning in consultation and collaboration with tribes to prevent and manage wildfires can reduce the potential for harm to tribal ecocultural values by identifying favorable control strategies and tactics within particular landscapes (Ryan et al. 2012). Such efforts are currently the focus of the Western Klamath Restoration Partnership (see box on p. 888) in the southern portion of the NWFP area.

Fire regimes in many regions, especially dry forests but also in some wetter coastal environments, have been altered by frequent suppression of lightning fires and reductions in aboriginal burning (Boyd 1999, Kimmerer and Lake 2001, Skinner et al. 2009) (see also chapter 3). Tribal members also have stated that their ability to harvest forest products such as acorns, berries, beargrass, and hazel has declined owing to reduced resource quality, quantity, and accessibility, which they often attribute to

lack of frequent fire and tribal stewardship as well as other changes in forest management, such as establishment of tree plantations (Charnley et al. 2008a, Dobkins et al. 2016, Halpern 2016, Long et al. 2016a). Lack of fire-associated forest products has reduced the quality of life for American Indians who depend on those resources (Norgaard 2014a).

Fire exclusion along with changing climate appears to be increasing the likelihood of very large fires (Stavros et al. 2014), which tend to have large stand-replacing burn patches (Miller et al. 2012, Reilly et al. 2017). Severe burns in turn threaten tribal ecocultural resources associated with mature trees and archaeological sites (such as rock art and obsidian artifacts) that can be particularly sensitive to high-intensity fire (Ryan et al. 2012). Fuel accumulations under fire exclusion have complicated efforts to reintroduce fire without risking such losses.

Changes in stewardship regimes—
Historical tribal stewardship practices that include plant harvesting, tilling, weeding, pruning, moving plant propagules, burning, raking debris, removing fuels, and hunting have been displaced and altered throughout ancestral tribal lands of the NWFP area (Anderson 2005, 2009; Deur 2009, LeCompte-Mastenbrook 2016). These practices affected ecosystems from patches to landscapes, and they evolved into a complex agroforestry system that tribes have used to maintain the quality and availability of ecocultural resources (Anderson 2005, Rossier and Lake 2014, Turner and Bhattacharyya 2016, Turner et al. 2013). Consequently, the disruption of traditional practices has perpetuated a cycle of degradation with various elements:

- Displacement of tribes from ancestral lands through confinement onto reservations was followed by land allotment and termination, which limited tribes' ability to practice land-tending traditions such as burning.
- Resource quality and quantity has declined.
- Areas are no longer suitable for harvesting desired foods.
- Community members suffer poorer health as well as food and economic insecurities.
- Intergenerational transmission of traditional ecological knowledge is impeded as elders have fewer opportunities to practice the traditions and teach them to youth, as well as reduced incentive to do so.
- Lands become feral and inhospitable "wilderness" (Anderson 2005).
- People's understanding of reference conditions becomes distorted as experience with past conditions is replaced by exposure to present degraded conditions, or "shifting baseline syndrome" (Papworth et al. 2009).

These effects further deter tribal members from reestablishing traditional practices. The elements of this cycle of degradation are described in several published studies that refer in particular to public lands within various parts of the NWFP area (Anderson 2005, Deur 2009, LeCompte-Mastenbrook 2016, MacKendrick 2009, Norgaard 2014c, Richards and Alexander 2006, Shebitz 2005, Wray and Anderson 2003). Understanding these patterns is important to avoid falsely assuming that a lack of present-day attempts to harvest resources indicates a lack of interest. All the other stressors discussed in this section have exacerbated this cycle by reducing the availability of ecocultural resources or constraining access by tribal members, as noted in tribal vulnerability assessments across the NWFP area (Donatuto et al. 2014, MacKendrick 2009, Sloan and Hostler 2014).

Implementation of policies since the Northwest Forest Plan—
During the initial development of the NWFP, many tribes did not contribute directly to the preparation of the alternatives, and the Bureau of Indian Affairs (BIA) represented tribal interests to the Forest Service. However, federal-tribal collaboration on land and resource management has evolved considerably in recent decades as laws and policies have developed; as tribes' political, economic, and sociocultural capacity has burgeoned; as agencies have increasingly appreciated tribes' knowledge about forest management; and as agencies have invested more in tribal liaison positions (Breslow 2014, Catton 2016, Record 2008). Tribes have increased the capacity of their natural resource institutions, in many cases using authorities provided by the 1975 Indian Self-Determination

and Education Assistance Act (Pub. L. 93-638) and the Tribal Self-Governance Act of 1994 to assume control over natural resource programs that were previously overseen by the BIA (Catton 2016, Strommer and Osborne 2014). In addition, significant progress has been made in developing institutional platforms to address sensitive issues regarding resource management on federal lands (Jurney and Hoagland 2015).

Despite such advances, tribes have criticized some federal attempts at consultation since the NWFP as little more than notification of planned federal actions, followed by unilateral decisionmaking and inadequate attention to resolving disputes (Harris 2011, Vinyeta and Lynn 2015). In addition, tribes have expressed concerns that special designations have limited forest thinning, and that public lands management has inhibited use of fire more generally. Tribal members have contended that management under the NWFP has allowed declines in important tribal ecocultural resources (e.g., elk, huckleberries, beargrass, and black oaks) as a consequence of measures to avoid possible harm to late-successional forests, riparian reserves, the northern spotted owl, and various survey and manage species (Harris 2011, LeCompte-Mastenbrook 2016, Vinyeta and Lynn 2015). That concern appears generally consistent with findings described in chapter 12 and elsewhere in this report. Researchers studying public lands management in the United States have noted the tensions between addressing specific statutory requirements under the Endangered Species Act with strategies designed to promote landscape-scale resilience (Benson and Garmestani 2011) or tribal self-determination (Schmidt and Peterson 2009). A special case of this general issue is the Quinault Special Management Area, a 5,460-ac (2210 ha) area of forest land managed by the Forest Service that was established as partial compensation for the loss of territory that was supposed to have been included in the Quinault Reservation. The tribe has a right to 45 percent of the revenue generated in this special area, but constraints for Survey and Manage species have reduced harvests and revenues below what the tribe expected under this arrangement (Vinyeta and Lynn 2015). Another special case is the Coquille Indian Tribe, to whom Congress transferred lands but with the requirement that NWFP rules be applied to forest management (see "Coquille Indian Tribe" on p. 882).

How Has the Diminishment of Tribal Influence Affected Ecocultural Resources and Associated Ecosystems?

Understanding historical tribal practices for stewarding ecosystems is important for restoring conditions that sustain biophysical and cultural ecological services important to American Indians and tribes (Turner et al. 2013). In the sections below, we highlight how diminishment of tribal influences within the NWFP area has reduced the frequency and extent of low-intensity fire and, consequently, the availability of many species of high cultural-use value. Such shifts have far-reaching implications, yet we must also consider uncertainties in our understanding. Complex dynamics within coupled human-ecological systems make it difficult to understand and study the myriad potential effects of these influences over millennia. Much past research relied upon single-disciplinary approaches in ecology or ethnography, with or without tribal perspectives or information, which can lead to findings that appear inconsistent or conflicting. Interdisciplinary approaches that integrated multiple lines of evidence have led to greater consilience about where indigenous influences were most profound and where current conditions have deviated most sharply from conditions prior to Euro-American colonization (Crawford et al. 2015, Lightfoot et al. 2013). Furthermore, engaging tribes in research efforts has helped in our understanding of historical cultural influences on ecosystems (Lepofsky and Lertzman 2008).

Broad-scale fire history studies in the Pacific Northwest region have found American Indian influence on fire to be associated with climate and population density. For example, Agee (1993) concluded that evidence for large-scale American Indian burning was greater in inland areas, with much patchier burning in wetter coastal environments. Perry et al. (2011) found that American Indian burning likely shifted mixed-severity fire regimes to more frequent, low-severity fire regimes in areas with dense populations of American Indians, such as northern California and the Umpqua National Forest. Many sampling methodologies lack the resolution to recognize or distinguish human influence on fire regimes (Conedera et al. 2009). Consequently, studies of fire history sometimes

subsume American Indian influences under the natural regime (e.g., Halofsky et al. 2011). The analysis used to develop the map of fire regimes in chapter 3 revealed that the fire frequencies in coastal forests of northern California before Euro-American settlement were higher than expected based upon temperature and moisture factors across the NWFP area. This finding indicated that historical American Indian influence on fire regimes was particularly significant within that region.

Scientists have published extensive evidence regarding how tribal burning and other practices modified vegetation within small patches; however, larger scale, longer term effects are more difficult to elucidate (Lepofsky and Lertzman 2008, Turner et al. 2013). Lewis and Ferguson (1988) described both areal "yards" burned by American Indians as well as linear "corridors" associated with streams, trails, and ridges. The maintenance of such corridors and yards would have promoted heterogeneity and connectivity for access by humans, ungulates, and other species at multiple scales (Lake 2013, Storm and Shebitz 2006, Turner et al. 2011). However, there remain questions regarding how much human influence modified fire regimes and vegetative communities beyond areas of intensive activity such as village sites, camps, harvesting and processing sites, and major trails (Lake 2007, 2013). Evidence of past caretaking by American Indians, including fire scars, culturally modified trees with bark selectively removed for use, and artifacts and features associated with resource processing serves to identify culturally modified landscapes (Turner et al. 2009). However, many decades of displacement and land use by Euro-Americans have obscured much of the evidence of such activities (Turner et al. 2013), in particular by developing the areas of greatest influence by American Indians. For example, Zybach (2003) in his dissertation concluded that areas of the Oregon Coast Range that were most likely subjected to regular burning by American Indians have been extensively developed, while areas that burned less frequently and more intensely have been maintained as forests by corporations, states, and federal agencies.

Hardwood communities and old trees— American Indians have cultivated a variety of hardwood communities, including California black oak (Long et al. 2016a), Oregon white oak (Lepofsky and Lertzman 2008), Pacific madrone (*Arbutus menziesii*), and tanoak (Bowcutt 2013). Areas near hardwood woodlands have long been favored for human settlements in the Pacific Northwest, but these areas have been reduced in extent and degraded in quality by fire exclusion, land development, conifer encroachment, and exotic invasive species, in addition to reductions in tending and burning by American Indians (Hosten et al. 2006). Stands of old-growth hardwoods have similarly declined within conifer-dominated forests, owing especially to the lack of low-intensity fire (see chapter 3) (Cocking et al. 2012, Devine and Harrington 2006). Traditional tribal activities in many woodlands and forests include frequent use of low-intensity fire to support harvest of nuts and desired understory species (Huntsinger and McCaffrey 1995, Long et al. 2016a). By reducing fuels and stand densities, such practices may have extended the longevity of trees, especially oaks and sugar pines, which were key resources (Anderson 2005). Genetic study of the Pacific crabapple suggests that American Indians may have had a key role in distributing it across the region (Routson et al. 2012), and tribal elders have recounted how Euro-American colonization reduced tribal orchards of the species (Turner and Turner 2008).

Grasslands, meadows, wetlands, and forest gaps— Nonforest communities that are dependent on fire to persist are important to sustaining tribal ecocultural resources. Even regions dominated by wet forests with an infrequent, high-severity fire regime had areas that were burned by American Indians more frequently than what occurs today (Boyd 1999). For example, burning by American Indians maintained bogs, prairies, and balds within areas otherwise dominated by high- and mixed-severity fire regimes, including the northwestern (Anderson 2009, Wray and Anderson 2003) and southeastern parts of the Olympic Peninsula in Washington (Peter and Shebitz 2006), redwood forests in northwestern California (Underwood et al. 2003), and the Coast Range in Oregon (Zald 2009).

Similarly, within the Willamette Valley, researchers have found that evidence of increased fire was positively associated with periods and areas of greater American Indian habitation, including more open environments that support key resources such as oaks, berries, and camas (Walsh et al. 2010). Grasslands and meadows have been declining across the region owing to reduction of aboriginal burning, changing climate, and other factors (Zald 2009) (also see chapter 3). Evidence such as a lack of biological legacies (i.e., large woody debris, stumps, snags, and remnant trees), dominance by graminoids rather than shrubs, and presence of disjunct and endemic plant species suggests that many of these communities were persistent, not an ephemeral, early-successional stage (Zald 2009). A description of practices by the Tolowa, Yurok, Karuk, Tututni, and Wiyot within redwood-dominated forests in northern California and southern Oregon indicated that human-created forest clearings were small, with the largest being only 0.25 mi (0.4 km) wide, and located in resource-poor parts of the landscape (Lewis and Ferguson 1988). Similarly, the abstract for Wills and Stuart (1994) summarized pre-Euro-American conditions in Douglas-fir-dominated stands within the Klamath National Forest as "exceptionally patchy, containing complex mosaics of different age and size." This patchy configuration was actively maintained through frequent fire. One forest surveyor described the entire Klamath River reservation belonging to the Yurok Tribe as being "over-run by fire" in 1912, when the U.S. government authorized rewards for stopping "incendiarists" responsible for setting those fires (Huntsinger and McCaffrey 1995). The ensuing era of fire suppression has reduced the occurrence of high-severity, stand-replacing fire, especially in moist forests, as well as low-severity fires, especially in dry forests (Miller et al. 2012, Reilly et al. 2017); these changes in fire regime have inhibited both the establishment and maintenance of early-successional or nonforest communities (see also chapter 3). For example, research by Peter and Shebitz (2006) within the southeastern Olympic Peninsula (Skokomish River Basin) indicated that ecosystems there had openings ranging from about 0.1 ha to many hectares, with few snags or down logs, in aerial photos from 1929, prior to any timber harvest. These conditions suggested that these openings had been maintained by tribal burning, and that lodgepole pine (*Pinus contorta*) and Douglas-fir had encroached into them starting over a century ago as a result of fire exclusion. Anzinger (2002) similarly described lodgepole pine encroachment into huckleberry meadows that had previously been maintained by tribal burning on the Mount Hood National Forest in the Oregon Cascade Range.

These nonforest communities support a range of tribally valued resources, including elk (*Cervus elaphus*) and deer (*Odocoileus* spp.); berries; edible geophytes; brackenfern (*Pteridium aquilinum*); and many other plant, fungi, and wildlife species (Huntsinger and McCaffrey 1995, Lepofsky and Lertzman 2008, Lewis and Ferguson 1988, Norton 1979). Wildfire and tribal burning have supported biodiversity by deterring homogenization through encroachment by dominant species, facilitating reproduction and vegetative persistence of rarer species, and maintaining hydrologic and nutrient cycling (Anderson 2009, Turner et al. 2011, Wray and Anderson 2003, Zald 2009). For example, tribal burning deterred trees from encroaching on open bog habitat that support cranberries and swamp gentian (*Gentiana douglasiana*); those plants in turn are key foods for the rare Makah copper butterfly (*Lycaena mariposa charlottensis*) (Larsen et al. 1995, Wray and Anderson 2003). Similarly, the range of the Puget blue butterfly (*Icaricia icarioides blackmorei*) has declined with losses of forest gaps and lowland prairies that support its host, sickle-keeled lupine (*Lupinus albicaulis*) (Larsen et al. 1995). Regular burning of meadows maintained the abundance and desired qualities of culturally important species, including various berries (*Vaccinium* spp*., Rubus* spp., etc.) and beargrass for traditional food and basketry uses (Peter and Shebitz 2006, Turner et al. 2011). The steep reduction in burning has caused conversion of grasslands to forested environments (Peter and Shebitz 2006, Zald 2009). The combined losses of former grassland areas owing to forest encroachment and land development have greatly diminished their socioecological benefits to tribal communities (Breslow 2014).

What Strategies Can Promote Tribal Ecocultural Resources and Effectively Engage Tribes in Forest Planning and Management?

Developing institutional capacity and agreements— Tribes have had increased opportunities to influence management on national forests through agreements, compacts, and stewardship contracts under the Tribal Forest Protection Act and related authorities (McAvoy et al. 2005, Murphy et al. 2007). Examples of some of these agreements are featured in the "Promoting collaboration" section below. Donoghue et al. (2010) characterized different types of tribal-federal collaborative agreements, ranging from less formal working agreements to mutually dependent comanagement in which tribes participate in management decisions. Through these institutional arrangements, many tribes have greater capacity to actively engage in research, planning, and management to support collaborative landscape restoration efforts (Catton 2016, Vinyeta and Lynn 2015).

Addressing sacred sites protection and access— Progress in federal-tribal relations has occurred despite several major disputes in recent decades in which federal land and water management decisions supported roads, mountaintop developments, and reservoirs. Such decisions were made despite tribal protests and lawsuits under the American Indian Religious Freedom Act of 1978 (P.L. 95-341) regarding the impacts of such developments on tribal sacred sites and religious values (Erickson 2009, Welch 1997). In 1996, Executive Order 13007, "Indian Sacred Sites," directed federal agencies to accommodate tribal access to and ceremonial use of sacred sites. Since then, Congress has passed legislation for specific areas to protect tribal access for traditional religious and cultural purposes through measures such as temporary closures to exclude nontribal visitors and restrictions on land use (Nie 2008). An example is the Northern California Coastal Wild Heritage Wilderness Act (P.L. 109–362) of 2006, which designated wilderness areas on the Mendocino and Six Rivers National Forests within the NWFP area with such stipulations. In addition, the departments of Agriculture, Energy, the Interior, and Defense, along with the Advisory Council on Historic Preservation, jointly adopted a memorandum of understanding (MOU) in December 2012 to improve the protection of and tribal access to American Indian sacred sites (USDA Office of Communications 2012).

Ensuring meaningful consultation— The NWFP federal-tribal monitoring reports illustrate the importance of MOUs and memorandums of agreement (MOAs) to formalize consultation protocols and strengthen government-to-government relationships. For example, Vinyeta and Lynn (2015) found that such agreements clarify expectations and result in greater accountability in consultations by specifying how often federal-tribal meetings would occur, and who is to be involved in the meetings. They also found that such agreements provide opportunities for greater tribal participation in agency planning and decisions. Drawing on interviews with 27 tribal natural resources staff from within the NWFP boundary, they found that consultation is more effective when it includes formal protocols that are individualized to each tribe's unique needs, laws, practices, policies, and responsibilities to membership. That report includes recommendations for strengthening consultation, addressing tribal rights and access to cultural resources, and improving the compatibility of federal and tribal approaches to forest management, including the development of protocols for projects that involve traditional knowledge.

Promoting collaboration— National forest planning has increasingly emphasized collaborative approaches, and experts have emphasized the value of participatory approaches throughout the life of projects, including research, monitoring, planning, implementation, maintenance, and review (Charnley et al. 2014). These trends generally complement tribal interests, while recognizing that tribes have a unique relationship with federal land management agencies. Intentions to promote collaborative relationships between federal agencies and communities that have been historically marginalized, including tribes, need to consider legacies of mistrust and inequity (Cronin and Ostergren 2007). Encouraging tribal participation in the full life cycle of projects can facilitate cooperation, trust, knowledge reciprocity, and

accountability. Facilitating development and retention of staff with good understandings of tribal relations is also important, because staff turnover is commonly cited as an obstacle to encouraging vibrant partnerships (Bussey et al. 2016, Vinyeta and Lynn 2015). The success of several tribal programs supported by Jobs in the Woods funding demonstrates the opportunities to jointly address social, ecological, cultural, and institutional objectives in forest and watershed restoration (Middleton and Kusel 2007).

Tribes have expanded efforts to influence ecosystem conditions through a variety of formal partnerships to address climate change, watershed and fisheries restoration, hazardous fuels reduction/forest thinning, and landscape forest restoration (Senos et al. 2006). Federal policies, authorities and directives, including the National Fire Plan (2000), Tribal Forest Protection Act (2004), Healthy Forest Restoration Act (2005), and Federal Land Assistance, Management and Enhancement Act (2010), have encouraged tribal participation in Forest Service land management activities. Concurrently, several notable community-based efforts, such as watershed and fire safe councils in northern California and southern Oregon (Senos et al. 2006), and nongovernmental organizational programs (e.g., The Natural Conservancy's Fire Learning Network), have supported tribal participation in restoration- and conservation-based efforts in the Pacific Northwest. Many of these efforts started as habitat or species-specific projects but grew into larger collaborative restoration partnerships with tribes as co-leaders (Cronin and Ostergren 2007). Some collaborative efforts have guided management and policy based upon the integration of tribal traditional knowledge and Western science (see "Coquille Indian Tribe" on p. 882). Another example is the Tapash Sustainable Forest Collaborative, in which the Yakama Nation has collaborated with the Okanogan-Wenatchee National Forest, Washington Department of Natural Resources, Washington Department of Fish and Wildlife, and The Nature Conservancy. The collaborative has planned and undertaken a variety of restoration projects on portions of forest land within 1.63 million ac (660 000 ha) managed by various entities (including tribes) in central Washington (Schultz et al. 2012, Urgenson et al. 2017).

Fostering cooperative management—
An important pathway for upholding and respecting tribal sovereignty, treaty rights, and culture is cooperative management of off-reservation lands and resources, which may also be described as "concurrent" or "collaborative" management or "co-management" (Diver 2016). These terms apply to varying degrees of tribal and federal influence on land management in an area (Nie 2008); however, a recent definition of co-management adopted by the U.S. Fish and Wildlife Service (see "Glossary") requires each entity to have legally established management responsibilities. For example, treaties that reserve the right to manage or control access to natural resources constitute a legal authority for co-management (Goodman 2000). A strong legal basis has been important in making co-management initiatives between tribes and state agencies focused on salmon particularly successful in conserving resources in the Pacific Northwest (Kellert et al. 2000).

Proposals for co-management between the Forest Service and tribes have had to address legal requirements for federal agencies to have final decisionmaking power over federal lands (Nie 2008). Federal decisionmakers have been concerned about creating expectations that collaborators will have a say in management decisions while retaining responsibility for those decisions, as well as in negotiating procedural requirements associated with advisory groups (Butler 2013). In Canada, and especially in British Columbia, there have been examples of devolving some management authority over public lands to local communities under the umbrella of "community forestry," and many of those involved co-management with indigenous communities (Charnley and Poe 2007, McCarthy 2006). There are also examples of community forests established by tribes through acquisition of private lands, such as the Yurok Tribe's acquisition of ancestral tribal lands along Blue Creek from the Green Diamond Resource Company in 2011. However, such designations have not been adopted for Forest Service lands (Charnley and Poe 2007, McCarthy 2006). Some environmental groups have resisted community forestry initiatives on public lands in the United States over concerns that such efforts would favor local timber industries, undermine environmental protections, and limit public input (McCarthy 2006).

Coquille Indian Tribe

The Coquille Indian Tribe has reacquired forest lands that were originally reserved for them and other tribes in an 1855 treaty that was never ratified. Following termination in 1954 and rerecognition in 1989, the tribe sought the return of its ancestral lands. They received 5,400 ac (2185 ha) of forested land from the BLM, which were placed into trust status in 1989 with the requirement that the lands meet the standards and guidelines of adjacent federal forests under the NWFP (MacKendrick 2009). The tribe (fig. 11-17) has adopted a forest management plan that upholds traditional values through the conservation of large trees, snags, and nesting sites of culturally important birds, and management practices that regenerate habitat for culturally significant wildlife following timber harvest (Vinyeta and Lynn 2013). The tribe proposed to extend approaches applied on its tribal lands through its Coos Bay Wagon Road Lands proposal, a collaborative effort with the BLM that incorporated silvicultural principles recommended by forestry experts Jerry Franklin and Norm Johnson (Franklin and Johnson 2012). For this coastal wet-forest environment, the proposed plan included provisions for new riparian management approaches; harvesting biofuels; retention of biological legacies such as large trees, coarse woody debris, and snags; variable-density thinning; long rotations; and regeneration harvest to maintain early-successional conditions (USDI BLM 2012).

Frank K. Lake



Figure 11-17—Coquille tribal members at Euphoria Ridge near North Bend, Oregon, spring 2003. Chief Don Ivy (left, with hat) addresses the group on a field trip to discuss tribal forest management and restoration strategies.

United States government policies, including the government-to-government relationship, constitute a distinctive legal basis for cooperation with tribes that recognizes their unique relationships to their ancestral lands. The U.S. Congress and presidents have established important laws and policies authorizing tribes to provide specific guidance to public lands management, which undergird some of the most substantive co-management arrangements on federal lands (Nie 2008). For example, the Santa Rosa and San Jacinto Mountains National Monument Act of 2000 stipulated that the U.S. Secretaries of the Interior and Agriculture "shall make a special effort to consult with representatives of the Agua Caliente Band of Cahuilla Indians regarding the management plan during the preparation and implementation of the plan" and authorized the use of "cooperative agreements and shared management arrangements with any person, including the Agua Caliente Band of Cahuilla Indians, for the purposes of management, interpretation, and research and education regarding the resources of the National Monument" (114 Stat. 1362 Public law 106-351). The Tribal Forest Protection Act of 2004 advanced such distinctive efforts by authorizing the U.S. Secretaries of Agriculture and the Interior to give special consideration to tribally proposed stewardship contracts, agreements, compacts or other arrangements on Forest Service or BLM land bordering or adjacent to Indian trust land to protect tribal trust resources from fire, disease, or other threats. A recent presidential proclamation established the Bears Ears National Monument in Utah to be managed jointly by the Forest Service and BLM while considering and integrating formal guidance and recommendations, which may be based upon tribal traditional and historical knowledge, from a commission made up of elected officers from five tribes (https://www.whitehouse.gov/the-press-office/2016/12/28/proclamation-establishment-bears-ears-national-monument).

In accordance with laws and policies cited above, the Forest Service has entered into landmark agreements that embody important principles of cooperative management and have recognized the unique stewardship role of tribes on their ancestral lands:

- In the late 1990s, the Lake Tahoe Basin Management Unit established various agreements with and issued special-use permits to the Washoe Tribe of Nevada and California to address tribal interests in managing ancestral lands at Lake Tahoe (Adelzadeh 2006).
- In 2004, the Plumas National Forest awarded a 10-year stewardship contract to the Maidu Culture and Development Group, a native nonprofit dedicated to strengthening Maidu culture and people, to apply traditional land management practices to 2,100 ac (850 ha) of national forest land in the Sierra Nevada (Donoghue et al. 2010).
- The Mount Baker–Snoqualmie National Forest entered into a MOA with the Tulalip Tribes in 2007 that supported cooperative efforts to sustain and enhance areas for treaty harvesting and other cultural practices, focusing on redcedar and huckleberries (LeCompte-Mastenbrook 2016). One particular outcome was establishment of a 1,280-ac (518-ha) "co-stewardship" area in the Skykomish watershed in 2011 to support mountain meadow restoration and huckleberry enhancement. The project has involved (1) removal of small conifers, (2) tribal youth involvement, and (3) maintenance of a road to provide tribal access.
- In 2011, the Fremont-Winema National Forest entered into a master stewardship agreement with the Klamath Tribes of Oregon, along with The Nature Conservancy and the Lomakatsi Restoration Project, in an effort to restore forests, reduce risks of severe wildfires, train the tribal workforce, and enhance wood product processing capacity (Hatcher et al. 2017).
- In 2015, the Forest Service entered into a 10-year master stewardship agreement with the Pit River Tribe and Lomakatsi Restoration Project to conduct treatments on more than 2 million ac within the Lassen, Modoc, and Shasta-Trinity National Forests in northern California (https://www.fs.fed.us/spf/tribalrelations/documents/agreements/15-SA-11052000-056.pdf).

Such cooperative arrangements have not only helped serve tribal communities, but they also can bring added expertise to public land management efforts, including better understanding of reference conditions and financial resources.

Integrating traditional ecological knowledge in collaborations—
Collaborative projects involving traditional ecological knowledge or native knowledge provide unique opportunities to enhance research and management, while also posing unique challenges for tribes and tribal-knowledge holders (Mason et al. 2012). There are many examples in which tribes and their members have seen benefits from working with researchers and land managers to inform restoration with traditional ecological knowledge, including burning to promote beargrass (Shebitz 2005) and land management planning (Clayoquot Sound Scientific Panel 1995). It is important to recognize also that tribal capacities and interest in conventional Western science have been critical in protecting vital resources such as salmon (Breslow 2014). Some tribes have suggested that agencies pursue collaborations that facilitate tribal application of traditional ecological knowledge to off-reservation lands within the respective tribes' ancestral territories without seeking to transfer or relinquish such knowledge (Norgaard 2014c). The latter is particularly important because many tribal knowledge specialists have expressed concerns that sharing cultural knowledge with nontribal entities could lead to its cooptation or misuse, such as loss of control by tribes or profiting by nontribal entities, as explained by Brewer II and Warner (2014) and the CTKW or Climate and Traditional Knowledges Workgroup (CTKW 2014). These authors, along with tribal representatives contributing to the NWFP 20-year monitoring report (Vinyeta and Lynn 2015), recommended taking steps to ensure that collaboration with tribes provides reciprocal benefits, minimizes risks to tribes, and recognizes inherent tribal rights and responsibilities to their communities. In particular, they suggested adopting agreements and principles such as "cause-no-harm;" ensuring "free-prior-and-informed-consent;" and protecting sacred, sensitive, or confidential information such as the locations of particular sacred sites, or specialized uses of fungi, plant, and animal species. Another approach is to establish stewardship agreements or compacts in which tribes can apply traditional ecological knowledge and applicable cultural practices on federal lands, such as the agreements between the Klamath Tribes and the Fremont-Winema National Forest (Hatcher et al. 2017).

Promoting tribal adaptive capacity—
Forest planning presents opportunities to support the continuity of traditional ecological knowledge across generations by maintaining culturally vital resources and tribal communities. In turn, tribal knowledge of historical and current ecological processes (Colombi and Smith 2012), and the seasonality of natural patterns, can help predict and prepare for future changes in habitats and species' distributions. Because traditional tribal cultures emphasize the interconnected nature of the human and nonhuman systems of the Earth, they are particularly well-adapted for addressing climate change (Heyd and Brooks 2009). Maintaining cultural keystone species such as salmon and safeguarding cultural keystone places are important for maintaining adaptive capacity, including memory and practices (Colombi 2012, Cuerrier et al. 2015). Maintaining cultural diversity in the form of tribal worldviews and languages regarding the natural world is also important for sustaining ecosystems and human communities (Pretty et al. 2009). Tribes continue to rely on historical intertribal networks that facilitate exchange of resources, cultural practices, and knowledge systems as a source of adaptive capacity (Papiez 2009, Trosper 2003, Turner and Cocksedge 2001). Many tribes across the region maintain such networks through summits, ceremonies, conferences, intertribal councils, and annual "canoe journeys" that support environmental governance and ecocultural revitalization (Norman 2012, Tveskov 2007). Federal land management agencies can support adaptive capacity by forming partnerships with tribes that value traditional tribal knowledge (see "Promoting collaboration" on p. 880), supporting monitoring and restoration of ecocultural resources, and engaging with intertribal resource management organizations (Whyte 2013).

Tribal Engagement in Climate Change Initiatives

In 2009, the Secretary of the Interior issued Order 3289, "Addressing the Impacts of Climate Change on America's Water, Land, and Other Natural and Cultural Resources," which established climate science centers (CSCs) and landscape conservation cooperatives (LCCs). The CSCs provide scientific information, tools, and techniques that resource managers and others can use to anticipate, monitor, and adapt to climate change impacts. The LCCs are landscape-scale conservation science partnerships that disseminate applied science, tools, and resources that support the management of cultural and natural resources. Within the NWFP area, the Northwest CSC, the North Pacific (NP) LCC and the Great Northern LCC have taken steps to facilitate tribal involvement. The Northwest CSC has a Tribal Engagement Strategy that provides opportunities for tribal engagement in each of its five core elements: executive services, science services, data services, communication services, and education and training services.

The North Pacific Landscape Conservation Cooperative has tribal participation on the NPLCC steering committee, a tribal/first nation committee, and a subcommittee on science and traditional knowledge. The U.S. Department of Agriculture has also established regional climate hubs (https://www.climatehubs.oce.usda.gov/) to develop and deliver scientific information and technologies regarding climate to natural resource managers, including tribes. The science and resources developed by the LCCs, CSCs, and climate hubs can inform the management of culturally important tribal resources. Through funding support from Northwest CSC and the North Pacific LCC, tribes are fostering partnerships to bridge traditional knowledges and Western scientific knowledge (a complete list of tribal engagement projects is included on the Northwest CSC website and the NPLCC website). An example from within the NWFP is "Utilizing Yurok traditional ecological knowledge to inform climate change priorities" (Sloan and Hostler 2014).

Promoting multiscale temporal and spatial diversity in terrestrial habitats—

From stand to landscape scales, maintaining a diversity of plant communities that support tribal ecocultural resources is important for increasing resilience to wildfire, drought, pathogens, and insect pests (Churchill et al. 2013, Kauffman and Jules 2006). Efforts to promote heterogeneity within stands and across larger landscapes are likely to promote ecological diversity (see chapter 12), which in turn is important for maintaining traditional tribal livelihoods and lifeways (Lake 2013, Turner and Cocksedge 2001, Turner et al. 2011, Underwood et al. 2003). Traditional tribal burning practices that maintained nonforested habitats in both areal and linear arrangements were important for promoting diversity at different scales (Lewis 1982, Underwood et al. 2003). Tribal management has long accentuated transitional habitats, such as the edges between forest and nonforest habitats (Turner et al. 2003), to promote opportunities to obtain diverse resources. Although early-successional and nonforest communities are highly valued, maintaining large areas of old-growth forest is also important for sustaining tribal ecocultural values (Russo 2011, Yazzie 2007). Some wildlife species of special tribal value, including marten and pileated woodpecker, are associated with older forests, large decadent or dead trees, and dense tree canopies (Aubry and Raley 2002) (see chapter 6). Others are associated with young forests and more open forests that support vibrant understory plant communities and associated animals (e.g., porcupine and many Neotropical birds) (Carey 1996). Furthermore, arranging early successional patches in proximity to mature or old-growth patches is also important to promoting tribal uses (Rogers-Martinez 1992, Swanson et al. 2011). Thomas et al. (2006) recognized the importance of maintaining all structural stages across the landscapes of the NWFP area, which is a theme featured in chapters 3 and 12.

Reestablishing fire regimes—

A key principle for restoring landscapes in the NWFP area is the reestablishment of fire regimes in fire-adapted forest types through burns to accomplish resource objectives (Odion and Sarr 2007, Ryan et al. 2013) (see chapters 3 and 12). This approach reflects the strategy of managing or

emulating "natural" disturbance regimes to promote ecological resilience (North and Keeton 2008, Odion and Sarr 2007). Restoration of fire regimes also remains one of the central elements of a strategy to promote tribal ecocultural resources and opportunities for ecocultural revitalization across the NWFP area. The importance of restoring fire is particularly prominent in the large areas marked by a frequent fire regime from northern California to central Washington (see chapter 3), but it is also important for sustaining woodlands, forests, prairies, and wetlands within regions characterized by less frequent fire regimes (Boyd 1999, Hamman et al. 2011). Because treatments to maintain tribal ecocultural resources often require more frequent and targeted applications of fire than would be expected through lightning ignitions alone, they depend on intentional burning (Turner 2014, Turner et al. 2011). Alterations of fire regime can be somewhat mitigated through harvest disturbances that emulate some fire effects (Anzinger 2002), but those surrogates cannot replicate all of the beneficial effects (see "Beneficial Effects of Fire for Ecocultural Resources" on next page).

In particular, frequent fires combined with other tending practices perpetuate ecocultural resources such as large hardwoods, camas, beargrass, and huckleberries in conditions that support tribal use (Hummel et al. 2015, Long et al. 2016a, Minore and Dubrasich 1978). More severe, stand-replacing fires also create or rejuvenate tribally ecoculturally important hardwood stands (Cocking et al. 2012), huckleberry fields (Anzinger 2002), riparian areas (chapter 7), and other early-successional plant communities. Such severe burns therefore provide opportunities to reinitiate tribal caretaking regimes; however, for many decades they also reduce important ecosystem services such as providing nuts and habitat for many species (Long et al. 2016a). Large and severe burns also pose serious threats to human lives, health, and property, and they can negatively affect downstream aquatic resources (see chapter 7). Applying managed fire for resource objectives in concert with other silvicultural treatments helps to promote the desired fine-scale patchwork of successional conditions rather than a hands-off strategy that relies on unmanaged wildfires for disturbance. For example, treatments that reduce the likelihood of high-severity fire can mitigate threats to riparian areas and their associated fauna (Stephens and Alexander 2011). Efforts to maintain and restore tribal ecocultural resources will depend upon understanding how different spatial arrangements, frequencies, seasonalities, and severities of fire are likely to produce a favorable range of resources and ecosystem services (Storm and Shebitz 2006). Furthermore, understanding those fire effect patterns can help to predict which tribally valued resources will occur at specific places on the landscape over time (Lake 2013).

Strategies that involve greater use of fire will have to overcome a range of constraints, including air quality constraints, concerns for wildlife impacts, funding, crew availability, cross-boundary management, and public acceptance (Ryan et al. 2013). Chapter 12 considers these challenges given their relevance throughout this report. Weisshaupt et al. (2005) found that tribal members from central and eastern Washington were more likely to support prescribed burning than several nontribal groups because of their experience and cultural traditions of using fire. However, some tribal members and leaders share concerns about the risks of wildland fire with the general public. Such attitudes in part likely reflect lack of exposure to its traditional use (Carroll et al. 2010b, Norgaard 2014a). In addition, tribes with large reservations and extensive forestry operations have incentives to treat forests using harvest, which has historically supported jobs and other economic benefits.

Incorporating cultural burning—
Many tribes emphasize distinctions between cultural burning and prescribed burning, the latter of which is often practiced by public land management agencies. Cultural burning is planned to promote an array of ecocultural resources over time, often through relatively frequent applications (Burr 2013). Agency prescribed burning has often had a strong emphasis on reducing fuels, including residues from timber harvest or thinning, with frequent use of pile burning, cooler out-of-season burning, and other deviations from traditional fire regimes (Ryan et al. 2013). Such strategies can support restoration by phasing such fuels reduction activities prior to reintroducing more traditional use of fire (Lake and Long 2014, Long et al. 2016a); however, nontraditional treatments, which may include spring burning, may conflict with some tribal values and concerns for wildlife, as documented in the Klamath region of northern California (Halpern 2016). Furthermore, Anzinger (2002) suggested that restoring

Beneficial Effects of Fire for Ecocultural Resources

- Reducing the accumulation of forest fuels, which in turn can moderate the effects of stand-replacing wildfires without damaging large and old trees (Stevens et al. 2014, Waltz et al. 2014) (see chapter 12 for further discussion).
- Promoting understory diversity (Perry et al. 2011).
- Smoke-induced germination of species such as beargrass (Shebitz et al. 2009b).
- Reduction of pests such as filbert worms and weevils (Halpern 2016).
- Stimulation of fire-following fungi such as some morels to produce mushrooms (Larson et al. 2016, Pilz et al. 2004).
- Curbing the encroachment of conifers (Engber et al. 2011) and other more shade-tolerant or dominant plants into other desired and diverse vegetative communities.
- Producing plant structures and ground conditions that facilitate tribal harvesting and use (Lake and Long 2014).
- Lowering summer stream temperatures to sustain salmonids in particular areas through shading by smoke during critical summer periods (Lake and Long 2014). Robock (1991) previously demonstrated that smoke from wildfires lowered summer surface temperatures in the valley of the Klamath River.

huckleberry patches on the Mount Hood National Forest would require stand-replacing disturbance, such as high-severity burns or large patch cuts applied in conjunction with broadcast burns. Such examples demonstrate how strategies to promote ecocultural resources using fire will differ across the diverse array of tribal ancestral lands.

Many tribes desire a more active role in the implementation of cultural prescribed burns rather than leaving stewardship solely to the federal agencies and nontribal organizations (Eriksen and Hankins 2014). In 2003 and 2004, the Skokomish Indian Tribe worked with Olympic National Forest to restore beargrass and other native species using thinning and burning (Shebitz et al. 2009a). In 2006, the Quinault Indian Nation performed its own burn modeled after this project (Charnley et al. 2008b). Within the area of the Western Klamath Restoration Project (see box on p. 888), Karuk and Yurok tribal members and employees conducted prescribed burns in 2014 through the Klamath River Prescribed Fire Training Exchange (TREX) program (which was initiated by The Nature Conservancy and several federal agencies in 2002), in order to reduce hazardous fuels along an important road in the wildland-urban interface, increase tribal access to traditional food resources (e.g., acorns), and support research treatments; however, the project was limited to private and tribal lands rather than including Forest Service lands owing to a temporary agency ban on burning that summer (Harling 2015). Other projects have continued in the area (fig. 11-18), representing contemporary applications of traditional burning to achieve multiple tribal resource objectives (Lake et al. 2017).

Managing fires across jurisdictions—
To plan and implement fire-focused restoration treatments at the landscape scale requires cross-jurisdictional coordination (Lake et al. 2017). Revision of national forest plans provide new opportunities to coordinate with tribal communities developing community wildfire protection plans (often through Fire Safe Councils) and tribes developing integrated resource management plans. Fire management policy is allowing land managers to pursue more flexible approaches to use fire for resource objectives through managed natural ignitions and prescribed fire, including cultural burns. The U.S. Forest Service Pacific Southwest Region and The Nature Conservancy established an MOU to facilitate burning across public and private boundaries to achieve goals of the National Cohesive Wildland Fire Management Strategy (Harling 2015). Building upon such cooperative instruments, tribal groups are leading efforts to restore fire regimes through coordinated, landscape-scale burning, such as the Western Klamath Restoration Partnership. Such proactive coordination is important when allowing or curbing the spread of wildland fires across boundaries to meet the resource objectives of different landowners.

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Figure 11-18—Klamath River Training Exchange prescribed burn on a privately owned area for experimental research and tribal harvesting near Orleans, California, October 2015. Yurok and Karuk tribal members ignited an area under tanoak trees that had previously been treated (manually thinned in 2011, pile burned in 2012, and prescribed burned in spring 2013) to reduce hazardous fuels and improve acorn accessibility and quality (by reducing pests).

Western Klamath Restoration Partnership

The Orleans-Somes Bar Fire Safe Council, Karuk Indigenous Basketweavers, and Karuk Tribe initially partnered in 2001 (with funding through the National Fire Plan) to integrate tribal knowledge with hazardous fuels reduction and prescribed fire treatments on private and tribal lands between portions of the Six Rivers and Klamath National Forests in northern California (Senos et al. 2006). Building upon that foundation in recent years, the Karuk Tribe and Mid-Klamath Watershed Council have co-led the Western Klamath Restoration Partnership in designing and implementing landscape-scale integrated restoration strategies to reduce vulnerability of the environment and human communities to climate change, as well as to support tribal ecocultural revitalization efforts. The project area encompasses approximately 1.2 million ac (480 000 ha). Since 2013, the partnership has brought together tribes (Yurok and Karuk), tribal community groups (e.g., Indigenous Peoples Burning Network, Karuk Indigenous Basketweavers, Yurok Cultural Fire Management Council, and California Indian Basketweavers Association), The Nature Conservancy, federal and state agencies, and local fire safe/watershed councils to conduct hazardous fuels treatments and prescribed burns in and around several communities. As a demonstration project under the National Cohesive Wildland Fire Management Strategy, treatments have been designed to reduce fuel loading around homes, along critical emergency road routes, and ridges to facilitate use of fire across larger landscapes, as well as to enhance access to tribal basketry and food resources (Harling 2015, Senos et al. 2006). These projects have featured tribal workforce training and incorporated traditional ecological knowledge into prescriptions to promote tribal values. Early implementation steps for the partnership include prescribed burns under the TREX program (fig. 11-18) and the "Roots and Shoots" burn on September 29, 2016, to promote ecocultural resources, which was authorized under a fire management agreement between the Six Rivers National Forest and the Karuk Tribe.

Integrating tribal objectives into silvicultural approaches—

Many tribes harvest trees on their own lands as an economic activity and as a means of promoting desired resources, as a complement to fire to create canopy gaps and shift fuel conditions that facilitate the return of a more natural fire regime (Healey et al. 2008). Naturally formed canopy gaps from tree mortality create distinctive heterogeneity by forming pit and mound topography, broken tops and branches, and downed logs, which in turn stimulate understory diversity (Pollock and Beechie 2014) and associated wildlife communities (see "Tribal Ecosystem Services From Dead Trees and Forest Gaps" on p. 864). Various silvicultural approaches, including variable-density thinning treatments, can be important for recreating such natural stand heterogeneity and facilitating return of fire when restoring and maintaining woodlands and other nonforest areas encroached by trees (Carey 2003a, Devine and Harrington 2006, Hummel and Lake 2015). Chapter 3 features more discussion of restoration silviculture.

Many tribal silvicultural and related forest management approaches address sociocultural, economic, and ecological values with integrated management plans (Gordon et al. 2013), and these contribute to landscape diversity (see "Coquille Indian Tribe" on p. 882). The Pacific Northwest is particularly fertile ground for placing greater emphasis on the joint production of forest products in order to enhance community well-being, while also supporting biological diversity, recreation value, and aesthetic appeal (Von Hagen and Fight 1999). However, it is important to reconsider how constraints on harvest and thinning treatments imposed under the NWFP on forests over 80 years old in late-successional reserves, in addition to other restricted areas, have limited the opportunities for such treatments (Nelson 2015, Vinyeta and Lynn 2015).

Across many national forests of the NWFP area, historical logging has replaced mature forests with plantations (Healey et al. 2008). Many tribes have concerns over the effects of such plantings in terms of effects of chemical herbicides and alteration of successional pathways away from valued early-successional plant communities. Strategies for managing plantations have often focused on growth of commercial tree species, but strategies are increasingly directed toward promoting resilience to climate change, fire and pests, while concurrently providing services, including wildlife habitat, forest products, and tribal subsistence (Carey 2003b, Charnley et al. 2007, Franklin and Johnson 2012). Chapter 3 discusses these strategies for postfire management in more detail; Long et al. (2014b) also discussed reseeding for emergency erosion control, which could potentially affect understory plants used by tribes.

Proactively addressing use of chemicals in forest management—

National forest management uses herbicides, pesticides, fire retardant, and other chemicals for forest and resource management objectives, including accelerating growth of planted conifers and control of invasive species (Shepard et al. 2004). Many American Indians and tribes have registered concern over such use of chemicals because tribal harvesters are profoundly concerned about potential for exposure to environmental toxins (Huntsinger and McCaffrey 1995, Norgaard 2007, Segawa et al. 1997). These concerns are particularly strong for terrestrial and aquatic food resources and nonforest products such as foods and basketry materials that people place in their mouths. Researchers collaborated with the California Indian Basketweavers Association to study potential exposure to several common herbicides (glyphosate, hexazinone, and triclopyr) used to promote conifer growth on four national forests in the Sierra Nevada region of California (Ando et al. 2003, Segawa et al. 1997). They found that herbicides were detectable on several plant species that are likely to be gathered by American Indians for many months (a range of 4 to 130 weeks), and in some cases beyond the targeted treatment areas owing to drift or precipitation. In addition to ensuring that risk assessments properly consider the special vulnerabilities of tribal members (Burger et al. 2008), strong working relationships, including effective consultation, with tribes and harvesters are important to proactively understand and avoid potential for exposure of tribal members to harmful chemicals.

Actively managing riparian areas—
Promotion of tribal ecocultural resources within riparian areas depends on periodic disturbance to maintain gaps and understory production. Especially in drier areas with more frequent fire regimes, disturbances such as managed fire and removal of trees can be important for restoring desired conditions. Streams in mid-successional forests often can be more productive than those in old-growth forests under certain circumstances; therefore, active management may be important to sustain productivity of aquatic ecocultural resources such as fish (Reeves et al. 2006). On the other hand, researchers have suggested that removing trees from riparian areas could reduce suitability of associated streams for coldwater fishes (McClure et al. 2013). Considering regional and site-specific contexts, such as current temperature regimes, can often reconcile such potential tradeoffs, as discussed further in chapter 7.

Some tribes have expressed concern that restrictions in riparian reserves, which were intended to protect those sensitive areas adjacent to streams (Naiman et al. 2000), would impede their ability to maintain traditional harvesting and burning practices. For example, members of the Karuk Tribe expressed concerns that the Aquatic Conservation Strategy of the NWFP would impose restrictions on cutting willows in riparian reserves (Charnley et al. 2008a). However, several projects have included cutting and burning willows in riparian zones along the Klamath River (Lake 2007). Nevertheless, the tendency to leave riparian areas untreated, as discussed in chapter 7, can chafe tribal interests in promoting understory plants or shade-intolerant trees, such as large oaks and pines growing on river terraces adjacent to historic village sites (Hosten et al. 2006).

Restoring aquatic systems—
Given the importance of anadromous fish species such as salmon, lamprey, and sturgeon to tribes, a very broad approach is important to address their complex life stages that depend on diverse and interconnected habitats (Close et al. 2002, Miller 2012, Wang and Schaller 2015). Free-flowing stream networks from forested headwaters are also important for supplying driftwood to tribal riverine and coastal communities (Lepofsky et al. 2003). Recovery of tribally valued fish, waterfowl, and aquatic plant species heavily depends on restoration of hydrologic regimes and physical habitats through removal of reservoir dams that impede fish migration; restoration of degraded meadows; removal or relocation of roads, levees, and diversions; and other actions to restore the eco-hydrological system through more natural flows of water, sediment, wood, and organisms (Beechie et al. 2013, Nehlsen et al. 1991) (see chapter 7). Treatment of invasive exotic plants in wetlands and riparian areas may also be a priority for restoration of ecocultural resources. Such active measures can help to ameliorate the predicted effects of climate change (Wade et al. 2013). In particular, enhancing connectivity among native fish populations is important for increasing the potential for wildfire to benefit them rather than cause extirpations (Falke et al. 2014, Flitcroft et al. 2016).

Removing reservoir dams—
Although large reservoirs are an important part of infrastructure in the Pacific Northwest, removal of dams that form such reservoirs has become increasingly common as many aging dams require expensive modifications. In the last decade, several major dams have been intentionally breached within the NWFP area, notably the Elwha and Glines Canyon Dams in the ancestral lands of the Lower Elwha Klallam Tribe on the Olympic Peninsula (Pess et al. 2008), and the Condit Dam on the White Salmon River. More removals are anticipated, with the 2016 Klamath Power and Facilities Agreement set to remove four dams on the Klamath River. Such efforts will affect national forest lands and tribal ecocultural resources, and they are likely to increase the importance of upstream watershed conditions as stream reaches are reopened to migratory fish (Pess et al. 2008). Existing research points to a variety of anticipated benefits for migratory fish and associated mollusks; however, dam removals can also release accumulated sediments, nutrients, toxins, and other pollutants (Pess et al. 2008, Poff and Hart 2002, Stanley and Doyle 2003), which can temporarily disrupt downstream habitats of sensitive organisms such as freshwater mussels. An additional concern is the potential spread of invasive species upstream (Hart et al. 2002). Dam removal could also affect tribal concerns by exposing traditional sites, burials, and artifacts.

Therefore, although dam removal is expected to be critically important in restoring aquatic organisms of special significance, its potential for both beneficial and harmful effects should be considered. Because of the diversity of watershed settings, the recency of large dam removal, and short duration of post-removal studies, scientists are working to understand the longer term benefits and possible impacts of such actions (Hart et al. 2002, Poff and Hart 2002). In the meantime, large dam removal provides opportunities for integrated restoration of tribally valued riparian plants such as willows, berry plants (e.g., *Rubus parviflorus*) (Michel et al. 2011), and birds (Gelarden and McLaughlin 2013). As one example of how forest management can complement dam removal, McLaughlin (2013) recommended maintaining or increasing large woody debris within the riparian zones to encourage use by birds, which in turn disperses seeds across the bare sediments.

Managing roads—
Roads and associated water crossings can degrade aquatic resources by increasing erosion and creating barriers to movement as discussed in chapter 7. Tribes have successfully sued the state of Washington to demand remediation of culvert impacts on fish passage to support their treaty fishing rights (Breslow 2014). This lawsuit not only demonstrated the legal power of tribal treaty rights to shape environmental management across jurisdictions, but it also highlighted the importance of road management on tribal ecocultural resources. Tribes have partnered with national forests and BLM districts to implement and study road decommissioning to restore habitat for native salmonids (Burnson and Chapman 2000). One study that involved the Nez Perce Tribe found that road recontouring, rather than passive recovery following road abandonment, accelerated recovery of ecological and hydrological properties, including carbon storage (Lloyd et al. 2013).

Although roads can exact a toll on terrestrial and aquatic resources, aesthetics, and other values, they also provide access for tending forests, managing fire, hunting, fishing, plant harvesting, and other activities that are important to tribal members. Tribes have emphasized their interests in both access and watershed management (Vinyeta and Lynn 2015), so consultation is particularly important when making plans regarding roads. In particular, tribal members have noted that a lack of road maintenance and road closures can limit access to desired resources, especially for many elders and families with young children who rely upon vehicle access (Dobkins et al. 2016, LeCompte-Mastenbrook 2016). Consequently, intergenerational transmission of knowledge in part depends on suitable road systems. Because roads also offer access to nontribal members, they also have potential to exacerbate resource competition in preferred gathering areas.

Facilitating tribal access to forest products—
National forests have adopted various policies regarding regulation of harvesting by tribal members on ancestral lands (Catton 2016). Within the Sawtooth Berry Fields on the Gifford Pinchot National Forest, Hansis (1998) stated that "American Indians do not need to obtain permits to harvest huckleberries as part of their treaty rights" (Hansis 1998: 78). In a northern California example, the Six Rivers and Klamath National Forests established an MOU with the Karuk Tribe under which tribal members were not required to obtain permits from the Forest Service to harvest special forest products for subsistence (Stuart and Martine 2005). Many national forests provide fee waivers for tribal members to gather firewood on national forests; for example, the Fremont-Winema National Forest established an MOA with the Klamath Tribe that allowed tribal members to camp and gather firewood within former reservation lands (Catton 2016). Other remedies proposed to lessen the burden from permitting requirements include using tribal identification cards in lieu of permits (Wrobel 2015) or having tribal organizations rather than the Forest Service issue the permits (Dobkins et al. 2016). For example, as outlined in an MOU with several national forests in Michigan, Wisconsin, and Minnesota, the Great Lakes Indian Fish and Wildlife Commission has issued permits to members of several tribes to harvest wild plants and nontimber forest products, as well as to camp, on national forests (Wrobel 2015). The permitting system allows the commission to monitor and report on tribal harvest of various forest products.

Addressing conflicts with nontribal communities over access and use—
Public managers have implemented various strategies to address conflicts between tribal members and nontribal people, including recreationists and nontribal harvesters of forest products, regarding impacts to ecocultural resources. Forest Service policy (FSH 2409.18.80) restricts issuance of commercial permits when there are shortages to ensure that tribal use can be accommodated. As Alexander et al. (2011) pointed out, most collectors of nontimber forest products gather for personal or subsistence use, so records from commercial permits provide a very incomplete picture of demand. The Forest Service's National Tribal Relations Program Task Force recommended a variety of measures to improve tribal management of lands under federal care, including providing the Forest Service with the authority to close federal lands to the public for tribal traditional uses (Nie 2008). When supplies of desired resources are limited, land managers can regulate access through seasonal area closures that do not restrict access and harvest by tribal members. Numerous examples suggest that successful resolution of conflicts over access depends upon a strong and proactive working relationship between land managers and tribes that recognizes their unique status (Catton 2016). In an important precedent, the Gifford Pinchot National Forest designated a long-standing berry-harvesting area for exclusive use by American Indians under its land management plan (see box on next page). A similar approach was formalized under an MOU between the Mount Hood National Forest and the Confederated Tribes of the Warm Springs Reservation (Catton 2016, Wang et al. 2002).

Sustaining timber harvest and mill capacity—
Tribes with interest in commercial timber harvest from their lands, such as the Quinault Indian Nation, have expressed concern that cutbacks in harvest on federal lands have caused declines in mill capacity and other resources needed to allow them to manage and receive income from their working forest lands, as well as to protect their homelands from hazardous buildup of fuels (Vinyeta and Lynn 2015). In some parts of the NWFP area, such as the mid-Klamath region, declines in the timber industry have been partially offset by tribal leadership in economic development (Charnley et al. 2008a). These examples demonstrate interconnections among federal forest management and tribal and local economies, as well as opportunities for federal-tribal partnerships to promote mutual interests (Corrao and Andringa 2017, Mason et al. 2012). For example, the Yakama Nation's milling facility has processed logs resulting from the Tapash Sustainable Forest Collaborative forest restoration project.

Considering effects of special designations—
A variety of special designations, such as experimental forests, research natural areas, wild and scenic rivers, and wilderness areas can constrain activities on federal lands. As mentioned earlier in this chapter, sites recommended for special designations based upon distinctive qualities and limited degradation are likely to be significant to tribes (Hughes and Jim 1986). Consequently, proposals for special land management designations, including reserves, can impede tribal access to important resources and culturally important places (Freedman 2002) as well as the use of tools that could aid restoration. Past efforts to impose designations such a wilderness areas without tribal support have been a source of much consternation to the affected tribes (Catton 2016). Recent wilderness legislation has included special provisions to protect tribal religious concerns (see "Addressing sacred sites protection and access" on p. 880). Nevertheless, concerns persist among tribal communities that special designations for conservation purposes may limit their access and use (Baldy 2013, Nie 2008, Papiez 2009). For example, an analysis reported by Nelson (2015) noted that 47 percent of Mount Baker–Snoqualmie National Forest lands have wilderness status, 5 percent more are administratively withdrawn, and 36 percent are allocated to late-successional and riparian reserves, so only 10 percent remain as matrix or adaptive management areas where timber harvest is less constrained. These designations could limit active silvicultural management to enhance

Forest Service-Yakama Nation Handshake Agreement to Access Huckleberries

An important historical instance of federal-tribal collaboration is the 1932 Handshake Agreement between the Yakama Nation and the U.S. Forest Service. In response to growing pressure on wild huckleberries from the unemployed migrant workers during the Great Depression, J.R Burkhardt, then Gifford Pinchot National Forest supervisor, met with tribal representatives and agreed to reserve 2,800 ac (1130 ha) of off-reservation huckleberry patches for exclusive use by the Yakama Nation during huckleberry season (Richards and Alexander 2006). This agreement has been honored since, although it was only put into writing as recently as 1990, prior to the adoption of the Northwest Forest Plan (Fisher 1997, Richards and Alexander 2006). This case set an important precedent for upholding the federal trust responsibility and the rights of the Yakama Nation to harvest on public lands. However, there have still been conflicts when non-Indians have harvested in the exclusive area, which is signed and bounded by a road (fig. 11-19) (Hansis 1998).



Leslie Seaton

Figure 11-19—The Handshake Agreement sign denoting area set aside for tribal harvest of huckleberries in the Indian Heaven Wilderness, Gifford Pinchot National Forest, Washington, August 2012.

huckleberry, elk, and other tribal ecocultural resources to a very small percentage of their potential habitats (LeCompte-Mastenbrook 2016). Excluding wilderness and reserve areas from harvest both constrains and increases the importance of fire to sustain these resources.

An alternative type of special designation is contemporary tribal use or stewardship areas. Several national forests have designated landscape areas as tribal heritage districts, zones, or areas. These areas have a documented history of tribal uses and are conceptually similar to traditional cultural properties designated under the authority of the National Historic Preservation Act of 1966. Such tribal landscape area designations are linked to federal policies that facilitate consultation and coordination for heritage management (Wang et al. 2002). Agreements can guide permissible management actions, protect heritage or cultural resources, and foster tribal care and use of ecocultural resources for traditional and cultural purposes. As explained above, these approaches can address not only the ecological condition of forests, but also help to sustain tribal knowledge and social capacity. The concept of tribal stewardship areas bears some resemblance to previously mentioned "community forests," which are managed for the benefit of particular communities (see "Fostering cooperative management" on p. 881). There have been several examples of such designations in the NWFP area:

- Nearly two decades ago, the Mount Baker–Snoqualmie National Forest settled a dispute with the Muckleshoot Indian Tribe regarding its exchange of culturally significant tribal ancestral territory to a private corporation, by designating "special management areas" for protection of cultural and historical features and for promotion of elk forage, portions of which were subsequently targeted for huckleberry enhancement (LeCompte-Mastenbrook 2016).
- In recent decades, the Mount Hood National Forest has set aside huckleberry tracts for exclusive tribal use and cooperatively managed the areas with the Confederated Tribes of the Grande Ronde Community of Oregon and Confederated Tribes of the Warm Springs Reservation of Oregon using prescribed fire and thinning on competing vegetation (Anzinger 2002, Gerwing 2011, Wang et al. 2002).
- A 2012 agreement between the Klamath and Six Rivers National Forests and the Karuk Tribe supported restoration of the Katimiin Cultural Management Area through application of cultural practices, including reintroduction of fire (Lake and Long 2014). Revisions to the Klamath National Forest Land and Resource Management Plan had provided for such special designations (Diver 2016).

Supporting adaptive management— Researchers have recommended greater use of adaptive management frameworks as a way to better understand the complex responses of socio-ecological systems to management strategies (Franklin and Johnson 2012, Gray 2000). The NWFP called for using adaptive management areas (AMAs) to allow land managers the flexibility to try new and innovative management strategies and treatment practices as experiments to reduce uncertainty of subsequent management actions (Bormann et al. 2007, McClure et al. 2013). Many tribal practitioners believed that such approaches shared a common perspective with traditional tribal systems (Catton 2016), which have been described as an aboriginal form of adaptive management (Berkes et al. 2000). Adaptive management efforts can support tribal engagement in monitoring, assessment, implementation, and evaluation of treatments to promote desired conditions (Stein et al. 2013). Such efforts can complement and propel larger landscape restoration strategies (Berkes 2009), as well as build capacity among tribes, stakeholders, and agencies (Fernandez-Gimenez et al. 2008). In an example from the NWFP, land managers of the Northern Coast Range AMA established agreements with the Confederated Tribes of the Grande Ronde Community of Oregon to facilitate cohesive management of a watershed that included 10,900 ac (4400 ha) of federal land (Gray 2000). Some projects in AMAs specifically addressed tribal ecocultural resources; for example, the Cispus AMA in Washington included a project to study beargrass production under different forest canopy levels (Blatner et al. 2004). However, many of the bureaucratic challenges that appear to have limited implementation of adaptive management, including limited staff and

funds, cumbersome environmental reviews, and institutional momentum (Gray 2000), have frustrated tribal partnerships as well (Catton 2016). Such challenges, including reduced support for monitoring and review of proposed management changes, were specifically cited by tribal respondents in the 20-year monitoring report as inhibiting adaptive management (Vinyeta and Lynn 2015). The challenges in making formal adaptive management projects successful have encouraged less formal approaches that emphasize observation, communication, and explicit review of ecological changes and adaptation actions (Peterson et al. 2011).

Research Needs

There are many topics regarding tribal ecocultural resources and engagement that warrant research, and collaborating with tribes to identify cultural keystones could be especially helpful in setting priorities. There are valuable examples of collaborative research regarding tribal ecocultural resources in the NWFP area (e.g., beargrass, pileated woodpecker, huckleberries, and black oaks as mentioned previously), but more studies and expanded monitoring are needed to address the many interests of diverse tribal communities. Although many of these species have been studied, research designed by ecologists may not target the conditions used by harvesters, as explained by Kerns et al. (2004) in a study of huckleberries. Beatty and Leighton (2012) highlighted several common themes in tribal research priorities based upon a survey of tribal forest resource managers and decisionmakers, including (1) research related to water, fisheries, and other nontimber values from forests; (2) collaboration and cooperation, especially concerning the integration of traditional knowledge with Western science; and (3) adaptation of research projects to address local tribal concerns. More specifically, there is considerable need for monitoring and research in cooperation with tribes on the suitability and availability of ecocultural resources for tribal use. Norton-Smith et al. (2016) identified a need to research whether and why cultural keystone species are moving beyond tribal access. Research on reintroducing possible cultural and ecological keystone species such as condors, wolves, and beavers can evaluate not only the ecological effects within the NWFP area but also the effects on tribal cultural values.

A particularly important need is for research that is collaborative and integrative in evaluating the benefits of active forest management (Hummel and Lake 2015). In a report by the Karuk Tribe, Norgaard (2014b) prioritized the need for such socioeconomic research, in addition to research on the effects of climate change on tribal sovereignty, identification of effective contracting and agreement mechanisms, and study of carbon implications of tribal burning. Considering vulnerability and developing adaptation strategies in cooperation with tribal entities is important for understanding the effects of ecological change on tribal communities (Dittmer 2013, Norgaard 2014c, Petersen et al. 2014). Chapter 3 discusses the need to better understand the effects of applying ecological forestry strategies designed to reestablish or emulate natural disturbance regimes. It is particularly important to consider how a lack of active management is likely to affect tribes given current and expected future disturbances, including forest densification, dieback, and wildfire (Norton-Smith et al. 2016). Although this synthesis demonstrates such impact in qualitative terms, more precise understanding of the magnitude of those impacts would help to make better investments.

In many cases, information to quantify reference conditions, such as the abundance of particular resources and forest structure in pre-Euro-American times, is lacking, particularly at fine scales. Expected declines in both ecocultural resources and harvester knowledge of those resources increases the likelihood of "shifting baselines syndrome," mentioned above, under which current generations of harvesters and decisionmakers may no longer have an accurate understanding of past conditions. Collaborative partnerships in planning, research, and monitoring provide opportunities to better quantify and achieve appropriate desired conditions (Hummel et al. 2015, Long et al. 2016a).

Research is also needed on the socioeconomic, cultural, and ecological effects of resource harvests (potentially both recreational and commercial), road closures, and permitting systems on tribal ecocultural resources and the communities that harvest them (LeCompte-Mastenbrook 2016). Monitoring is important to help answer these questions. For example, Nelson (2015) suggested that a nonobstructive permit system would be useful in quantifying recreational

harvest of huckleberries, while monitoring of resources such as cedar logs on public lands would help track inventories and supply tribal needs (Vinyeta and Lynn 2015).

Attention to the ethics of participatory research, including consideration of appropriate roles and relationships, open and transparent communication and decisionmaking, and facilitating opportunities for engagement in all stages of an effort, is important in encouraging community participation and promoting the likelihood of mutually beneficial outcomes that build capacity to solve problems (Fernandez-Gimenez et al. 2006, Long et al. 2016b, Walker et al. 2002). Tribes may support collaborative efforts that engage members, from youth to long-term harvesters, in monitoring, research, and restoration (LeCompte-Mastenbrook 2016). Through such efforts, tribal practices based upon traditional knowledge, such as cultural burning, can be studied, implemented, and evaluated for their effects on valued species, ecological integrity, and ecosystem services.

Conclusions and Management Considerations

Based upon the literature reviewed in response to the guiding questions for this chapter, including the original question posed by managers regarding the sustaining of first foods, we found the following conclusions for consideration by land managers:

1. Ecocultural resources and causes of degradation
    - Ecosystems of the NWFP area support a wide array of tribal ecocultural resources, including various foods, medicines, materials, and nonmaterial values.
    - Both social and biophysical factors detract from the ability of tribes to obtain ecocultural resources from public lands in the desired quality and quantity.
    - Degradation of important tribal resources, including a variety of "first foods," is attributable to shifts in fire regimes away from frequent fire, conifer encroachment and densification, invasions by exotic species, alterations of hydrologic systems, species extirpations, reductions in tribal tending, and other historical legacies.
    - Examples of highly desired biological resources that depend on restoration of disturbance regimes include numerous trees and shrubs that produce edible nuts and fruits, geophytes that produce edible roots, fungi that produce edible mushrooms, and grasses that produce nutritious seeds and forage for ungulates. Many important plants and fungi used for medicine, foods, and crafts are associated with nonforest communities and forest gaps, some of which constitute short phases of succession, and others which can be persistent. Other important resources came from woodlands and forests that were dominated by old trees but often maintained with fire.
    - Historical displacement of tribal influence in the region has contributed to the reduction in frequency of fire in many parts of the region, particularly in relatively drier inland areas and locations near historical tribal settlements, trade and travel routes, and harvesting and hunting areas. Many of these locations were in ecological transition areas, such as edges between forests and grasslands or wetlands, which were maintained by tribal use.
2. Land management approaches to promote tribal ecocultural resources
    - In general, ideas to promote tribal ecocultural resources are consistent with emerging directions in forest management, including seven core principles for restoring fire-prone inland Pacific landscapes suggested by Hessburg et al. (2015).
    - Restoring large landscape areas that span traditional areas still used by tribes can help to ensure long-term sustainability and availability of resources, with important socioeconomic benefits such as food security and restoration-related work opportunities (see "Western Klamath Restoration Partnership" on p. 888).

- Remediation of forest road systems and culverts constitutes a priority for restoring aquatic systems where forest management activities have impeded fish passage and flows of wood, water, and sediment. However, road systems are important for maintaining tribal access to resources and intergenerational transmission of knowledge.
- Active forest management, including understory and variable overstory thinning and greater use of fire, is vital to improve the productivity and availability of many tribal ecocultural resources. Active management strategies can be integrated with efforts to conserve large, old trees, cultural sites, and other ecocultural resources that might be vulnerable to severe disturbances.
- Reintroduction of ecocultural keystone species that have been extirpated, in conjunction with restoration of their habitat, is also important for sustaining tribal material uses, cultural values, biological diversity, and ecological processes.
- Development of burn strategies and prescriptions in cooperation with tribes can help to reestablish traditional cultural burning and produce desired fire effects. Such an emphasis is a greater need in drier ecosystem types that evolved with more frequent fire, but it is also important at fine scales within wetter ecosystem types. This finding is consistent with the principals suggested by Hessburg et al. (2015) to emulate disturbance regimes.

3. Engaging tribes in forest planning and management
   - Given the widespread interests of tribal communities in forest ecosystems of the NWFP area, tribal engagement, including formal consultation as well as broader partnerships, is important to achieve land management objectives set forth in the forest planning rule, to uphold tribal rights and federal responsibilities, and to recognize the importance of tribal ecocultural resources on ancestral lands.
   - The concepts and principles of adaptive management and restoration forestry are consistent with efforts to promote tribal interests.
   - Collaborative partnerships with tribes, encompassing consideration of native knowledge, in planning, researching, implementing, and monitoring treatments within an adaptive ecosystem management framework fosters adaptive capacity of tribes and the partnering institutions.
   - Such partnerships can build upon the legal foundations that provide for explicit tribal engagement and cooperative management.
   - In particular, designation of special tribal stewardship areas of cultural importance to tribes can achieve both social and ecological objectives of both tribes and federal land management agencies.

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A field tour with the Lakeview Forest Landscape Collaborative in the Fremont-Winema National Forest. Photo by Tom Spies, USDA Forest Service.

Chapter 12: Integrating Ecological and Social Science to Inform Land Management in the Area of the Northwest Forest Plan

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> "We are drowning in information, while starving for wisdom. The world henceforth will be run by synthesizers, people able to put together the right information at the right time, think critically about it, and make important choices wisely."
>
> —E.O. Wilson, *Consilience: The Unity of Knowledge* (1988)

Introduction

Long-term monitoring programs and research related to Northwest Forest Plan (NWFP, or Plan) goals, strategies, and outcomes provide an unprecedented opportunity to examine how the scientific basis and socioecological context of the Plan may have changed during the 23 years since its implementation. We also have a prime opportunity to reassess how well the goals and strategies of the Plan are positioned to address new issues.

The NWFP was developed in 1993 through a political process involving scientists in an unusual and controversial role: assessing conditions and developing plan options directly for President Bill Clinton to consider with little involvement of senior Forest Service managers. The role of Forest Service scientists in this planning effort is different—scientists are now limited to producing a state-of-the-science report in support of plan revision and management (USDA FS 2012a), and managers will conduct the assessments and develop plan alternatives.

Implementation of the NWFP was followed by monitoring, research, and expectations for learning and adaptive management; however, little formal adaptive management actually occurred, and the program was defunded after a few years. The goals of the NWFP were daunting and set within the policy and ecological context of the time. President Clinton's question to the Forest Ecosystem Management Assessment Team (FEMAT) was "How can we achieve a balanced and comprehensive policy that recognizes the importance of the forest and timber to the economy and jobs in this region, and how can we preserve our precious old-growth forests, which are part of our national heritage and that, once destroyed, can never be replaced?" (FEMAT 1993). The 1982 planning rule guided land management planning on National Forest System lands, emphasizing conservation based in part on maintaining population viability of native species.

Although many conservation concerns have not changed, new science and challenges have emerged. For example, since the Plan was developed in the early 1990s, the invasive barred owl (*Strix varia*) has become a major threat to populations of the northern spotted owl (*S. occidentalis caurina*) (chapter 4), the number of Endangered Species Act (ESA)-listed fish species has gone from 3 to more than 20, and the frequency and extent of wildfires in dry forest portions of the Plan area have increased substantially in response to climate warming (chapter 2) (Reilly et al. 2017a, Westerling et al. 2006).

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The policy context and social dimensions of the NWFP have also changed. For example, the 2012 planning rule (USDA FS 2012a) places more weight on managing for ecological integrity (an ecosystem or coarse-filter approach) and less weight on population viability of individual species (a species or "fine-filter approach) (Schultz et al. 2013) than did the 1982 rule. The Plan's evaluation of societal influences did not address the emergence and expansion of collaborative processes throughout the NWFP region (Skillen 2015), and the FEMAT assessment itself (1994) largely focused on commodity-based economic development and support for maintaining stability of local and regional economies (Charnley 2006a). In addition, many but not all local economies of the region have diversified away from dependence on federal timber, and the forest products industry has largely moved away from using and valuing large logs, favoring instead the use of small-diameter trees (Haynes 2009).

Scientists in the Plan region also now more fully understand that the social and political context of the NWFP had a strong influence on the setting and attaining of the ecological goals of the Plan—opinions and debates about federal forest management in the region were as much about social values and conflict resolution as they were about science (Lange 2016, Spies and Duncan 2009). Given this context, it is important to have realistic expectations for how this science synthesis might contribute to the assessments and subsequent revision of individual forest plans and forest management. Scientific findings alone will not resolve political debates about the use of natural resources. Reducing scientific uncertainty will not necessarily reduce political uncertainty; and politics will always outweigh science because "science does not compel action" (Pielke 2007). However, providing the latest scientific information and reducing scientific uncertainty are expected to lead to better management decisions within the context of social and political constraints.

There is also an increased emphasis on the social dimension of planning today compared to when the NWFP was developed. Federal managers increasingly use collaboratives, stewardship contracts, and local participation in decisionmaking (Leach 2006, Urgenson et al. 2017). The 2012 planning rule also emphasized that plans must provide for "social, economic and ecological sustainability." This increased emphasis on integrating social and ecological aspects of forest planning coincides with the developing science of coupled human and natural systems or "social-ecological systems" (Liu et al. 2007) (fig. 12-1).

This socioecological perspective goes well beyond the ecosystem management framework that guided development of the NWFP by accounting for interactions between social and ecological systems to help deal with system complexity (fig. 12-1), surprises, and unintended outcomes from policies (Spies et al. 2014). For example, the relationship of federal forests to community well-being has changed since initiation of the Plan. Many communities no longer depend on the economic contributions of wood products as they once did (Charnley 2006a). There is growing recognition of the economic benefits of public lands to communities from recreation and tourism (White et al. 2016a) and nontimber forest products (Alexander et al. 2011), and recognition that ecosystems provide many benefits to human communities beyond timber and nontimber resources. Many studies indicate that the impact of humans on the environment in the NWFP area is much broader than the effects of natural resource extraction. Furthermore, it is clear that the timber industry has also experienced changes throughout the NWFP region, many of which are independent of management decisions on federal lands (e.g., fluctuations in national and global markets for wood products, transformations in how forest products companies are structured, and adoption of new technologies for wood processing) (chapter 8). At the same time, researchers and managers better understand connections between the organizational capacity of agencies, mill infrastructure, and business capacity in the private sector (e.g., a skilled workforce) in achieving forest restoration goals (chapter 8).

The fundamental assumption of the NWFP was that the breadth of the biological and socioeconomic strategies would achieve its biodiversity conservation and socioeconomic goals, and that those goals were also compatible with each other. Scientists and managers now have the perspective afforded by 23 years of research, monitoring, and field experience to suggest that these assumptions were

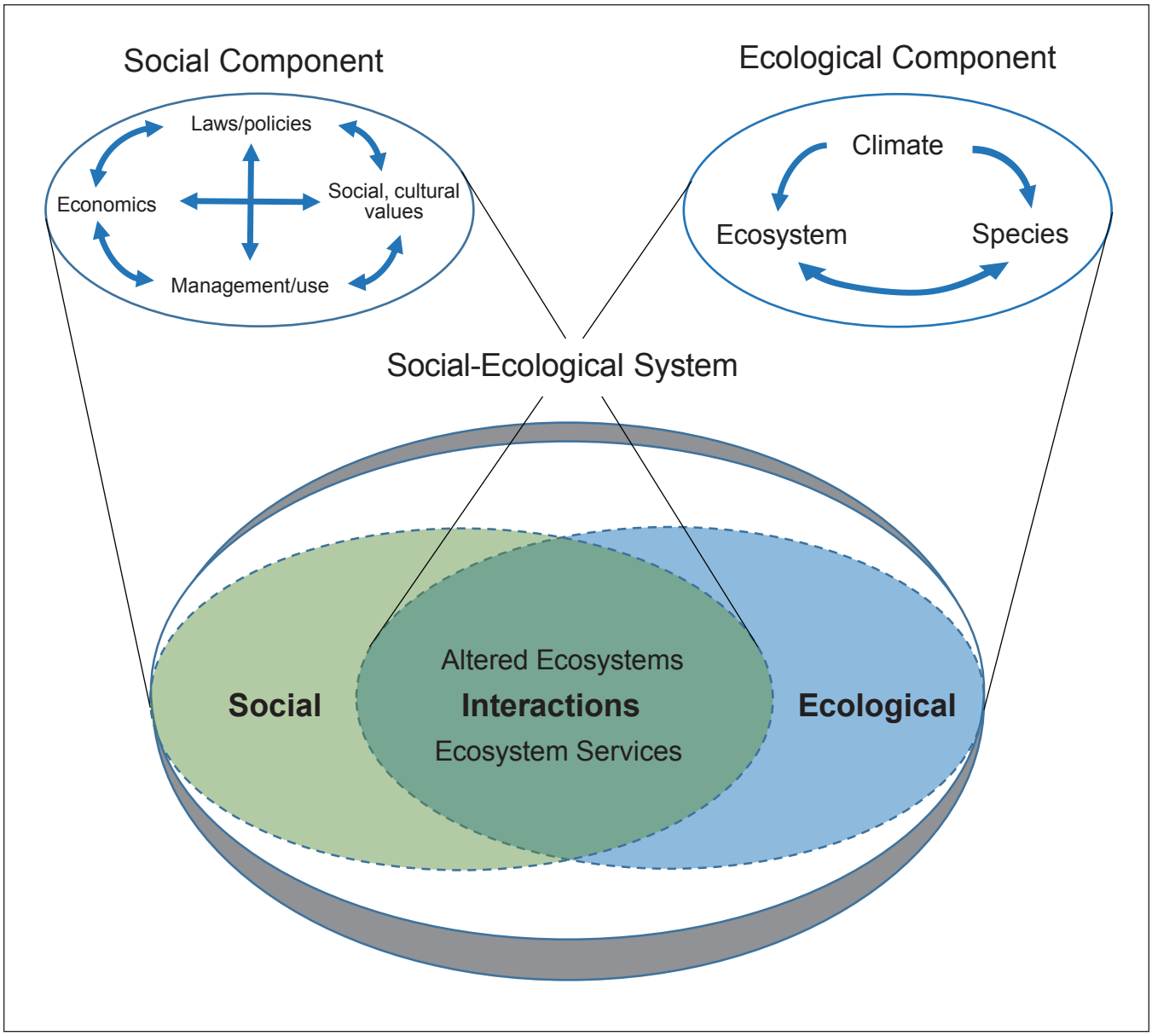


Figure 12-1—Major components and interactions in the Northwest Forest Plan social-ecological system.

only partially correct. In this chapter, we explore these assumptions in depth, using the lens of socialecological systems, and we identify new issues and concerns. We have four major objectives in this chapter:

1. Set the broader context of the NWFP goals and conservation approaches in terms of the science of socialecological systems.
2. Increase awareness of the diversity of ways that humans have influenced forest ecosystems, landscapes, and species of the Pacific Northwest.
3. Characterize how the conservation, restoration, and socioeconomic strategies of the NWFP interact, and how well they meet the original goals and new issues that have arisen since the Plan was established.
4. Identify key scientific uncertainties, research needs, and management considerations.

Guiding Questions

The guiding questions for this chapter are partly based on the questions from the managers (chapter 1), which are addressed more directly in individual chapters, and on cross-cutting questions and issues identified by the authors. The guiding questions for this chapter are:

1. What are the latest findings and perspectives on how global environmental change (including climate, land use, and invasive species changes) is altering forest and aquatic-riparian ecosystems, and their disturbance processes, and how relevant is this science to the NWFP area?
2. What are the latest scientific perspectives on reserve management for species conservation, given new understanding of ecosystem dynamics, and the influences of global environmental change?
3. What are key social components and drivers of the social-ecological systems in the NWFP area?
4. How compatible are the goals and strategies of the NWFP, and how well have the goals been met?
5. How compatible are coarse- and fine-filter approaches that simultaneously guide management for forest ecological resilience and single species viability across the range of disturbance regimes in the NWFP area?
6. What are new concerns within the social-ecological system of the NWFP area, and how well are the original Plan goals and strategies positioned to deal with them?
7. What is known about the tradeoffs of restoration actions across a range of conservation and community socioeconomic well-being goals?
8. What are the current and projected regional-scale issues and challenges associated with the goals of the NWFP?
9. What planning and management approaches are available for dealing with uncertainty in complex-social-ecological systems?
10. What are uncertainties, research needs, and management considerations related to plan revision in the area of the NWFP?

Key Findings

Perspectives on Conservation in an Era of Global Environmental Change

Overview of human influences on Northwest Forest Plan forests and aquatic-riparian ecosystems—The effects of humans on forest ecosystems in the Plan area go well beyond timber management impacts and often originate from Earth system processes outside the region. The impacts of human activity to the global environment have become so pervasive that many scientists are beginning to argue that we are in a new geological epoch called the "Anthropocene" (Crutzen 2006, Steffen et al. 2007). Beginning in the early 1800s, this period of rapid industrialization, population growth, and global trade and transportation led to dramatic increases in atmospheric carbon, land use change, altered disturbance regimes, and introduction of nonnative species. (Carey 2016, Corlett 2015, Creed et al. 2016, Lewis and Maslin 2015, Lugo 2015, Sun and Vose 2016, Wohl 2013).

Americans Indians had managed landscapes in the NWFP area for 10,000 years to create conditions that favored food resources and other cultural values; fire was their most important environmental management tool (Charnley et al. 2007, Robbins 1999, White 1993). However, human activity since development of industrial society in the 19th century has brought many additional large changes to species, forests, streams, and landscapes of the Plan area. Although the ecosystems of the NWFP area are relatively unaltered by recent human activity compared to much of the United States, little if any area of the Plan area could be considered uninfluenced by humans. Forests and landscapes have been altered from pre-Euro-American conditions by human activity including logging, plantation management, building roads and trails, dam and levee construction, and fire exclusion. Even forests and watersheds in designated wilderness areas and in large unroaded areas (Strittholt and DellaSala 2001) have been influenced by humans, climate change, introduced diseases, fire suppression, and other factors (chapter 3) (Hessburg et al. 2016).

Nearly all forests within the NWFP area depend on fire to different degrees. Fire exclusion in dry forests, which occupy 43 percent of the Plan area, has had a profound

effect on forest structure and composition, native biodiversity, and resilience to fire and climate change (chapter 3). Although fire activity has increased since the NWFP was implemented, most fire-prone forest landscapes are still running a fire deficit in comparison with conditions prior to the mid to late 1800s when fire frequency declined across the dry-forest zone (chapter 3) (Parks et al. 2015, Reilly et al. 2017a). Burned area is also less than would be expected under the current warming climate (chapter 2), for both moist and dry forests, as a result of fire suppression (chapter 3). The decline or elimination of intentional burning by American Indians is also part of altered disturbance regimes and ecosystems in many areas (chapter 11). The wildland-urban interface is also expanding rapidly in the Plan area. This expansion creates challenges to conservation and management including balancing fire protection and fire restoration goals (Hammer et al. 2007, Paveglio et al. 2009), both of which have implications for biodiversity conservation (McKinney 2002).

Biotic changes are also altering the ecosystems of the NWFP area. The extirpation of top predators and invasions by other species have altered food webs and the trophic structure and dynamics of terrestrial and aquatic ecosystems (Beschta and Ripple 2008, 2009; Wallach et al. 2015) across the region. Invasive species such as the barred owl are having significant effects on the northern spotted owl, and the sudden oak death pathogen (*Phytophthora ramorum*) is altering community structure and fire behavior across large areas of northern California and southern Oregon (Metz et al. 2011). Many of these biotic changes are challenging to deal with in a forest-management context because they are rooted in biological processes (e.g., demography, dispersal, and competition), whose control is often beyond the scope of federal forest land managers.

Finally, climate change is increasingly warming all parts of the NWFP region to levels that may exceed climate conditions experienced in the past 1,000 years (chapter 2). These conditions will continue to alter disturbances, ecological processes, plant and animal community structure, and biotic diversity (chapter 2) (Watts et al. 2016), and they will change the expected outcomes of NWFP conservation strategies (chapters 2, 3, 6, and 7).

In summary, forests, watersheds, and biotic communities in the Plan area have been influenced by native peoples for millennia, while human activities during the past 150 years have not merely altered them but reduced their resilience to natural disturbances. This reality has at least three major implications:

1. Some ecological conditions, even in old-growth forests, that are perceived as "natural" have been influenced by human activity.
2. Restorative actions may be needed to achieve goals for desired species and levels of resilience of forests and aquatic ecosystems to climate change and disturbances.
3. Knowledge of historical ecology can help guide us to the future, but management cannot recreate historical conditions.

Conservation in the Anthropocene

Unprecedented ecological shifts or alterations that have occurred across the globe are also described by an emerging concept of "novel" ecosystems, which describes systems that have "departed entirely and irreversibly from their historical analogs" (Hobbs et al. 2009, 2014; Radeloff et al. 2015). One implication of this perspective is that society may have to accept and manage for some of these novel or "hybrid" (seminatural) states, where it is impractical to change existing conditions. Pressures to maintain the status quo of altered conditions will most likely occur where current conditions provide values (supporting local livelihoods, quality of life, or habitats of desired species) that may not have occurred there historically.[2] This perspective does not mean that maintenance or restoration of native communities or historical dynamics could **not** be a goal—only that many scientists increasingly recognize that restoring and maintaining ecosystem integrity based on the historical range of variation of ecosystem attributes may not be attainable in some places, for ecological or social reasons. Sayer et al.

[2] There is a precedent for this in the National Forest Management Act: "…fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area" (36 Code of Federal Regulations, sec. 219.19, app. 13).

(2013) and Hobbs et al. (2014) recommended using landscape approaches (e.g., spatially based planning over large and heterogeneous areas and long time frames) that recognize the social dimensions of the problem (e.g., see Cissel et al. 1999, Hessburg et al. 2015, 2016) to identify where it is possible to retain or restore native biodiversity, and where acceptance or management for some novel or "hybrid" (seminatural) qualities or ecosystems might be desirable.

Recognizing the realities of altered ecosystems in the current era has implications for using the 2012 planning rule (USDA FS 2012a). The rule is based on managing for ecological integrity—ecosystems that "…occur within their "natural range of variation[3] and can withstand and recover from most perturbations." The rule also includes the concept of resilience[4] as related to ecological integrity, in the sense that ecosystems with integrity are resilient and able to recover from disturbances (Bone et al. 2016). Given the pace and scale of environmental change, it may be tempting to assume that history or the historical range of variation are no longer relevant to conservation and management; however, this is not necessarily the case (Higgs et al. 2014, Keane et al. 2009, Safford et al. 2012). In conservation and management, the question is not the fundamental value of history, but how it is used (Keane et al. 2009, Safford et al. 2012). Knowledge of the past can inform management in several ways: (1) history as information for how ecosystems function, or as a reference, (2) enriching cultural connections to the land, and (3) revealing possible futures (Higgs et al. 2014). Using history to set precise reference information and targets may become less important and even have negative consequences (in the case of precise targets) as climate and landscape changes continue, but other types of historical information may become more valuable (Hiers et al. 2016, Higgs et al. 2014). Information about the historical range of variation may be derived from simulation and statistical models and from empirical reconstructions of ecological history and its variations (Hessburg and Povak 2015). Safford et al. (2012) provided several recommendations on the use of history in restoration and conservation including the following:

- Do not ignore history; to understand where an ecosystem is going, you must understand where it has been.
- Do not uncritically set management objectives based on historical conditions and avoid aiming for a single, static target.
- Historical conditions may be a useful short-term or medium-term "waypoint" for management, but they will rarely suffice to prepare an ecosystem for an altered future.
- Plan for the future, but do not forget that the past provides our only empirical glimpse into the range of possible futures.

Our advances in understanding the role of ecological history in a time of global change, notwithstanding the development of guiding principles, clear ecological goals, and metrics, is still a significant challenge and must increasingly consider the social dimensions of environmental problems. Managing for ecological integrity rather than more narrowly for the historical range of variation is considered a more realistic approach, but it is not without its own limitations. Managing for ecological integrity includes significant effort to conserve native biodiversity and promote resilience of species and ecosystems to climate change and invasive species (chapter 3) (Hessburg et al. 2016, Wurtzebach and Schultz 2016). But more importantly, managing for ecological integrity recognizes the importance of ecological processes such as natural disturbance agents that control the dynamics of ecosystems. Managing for ecological integrity and using it to guide monitoring and restoration efforts is a relatively new idea that has yet to be widely applied and evaluated in a land management context (Wurtzebach and Schultz 2016). Ecological integrity also includes managing for ecological resilience, which is the capacity to "reorganize

[3] For our purposes in this chapter, we use "historical range of variability" and consider it synonymous with "natural range of variability." See Romme et al. 2012 for comparisons of the definitions of historical range of variability and natural range of variability.

[4] Resilience is the capacity of a system to absorb disturbance and reorganize (or return to its previous organization) so as to still retain essentially the same function, structure, identity, and feedbacks (see Forest Service Manual Chapter 2020 and see also "socioecological resilience" in the glossary). Broad conceptions of resilience may encompass "resistance" (see glossary), while narrower definitions emphasize the capacity of a system or its constituent entities to respond or regrow after mortality induced by a disturbance event.

while undergoing change so as to essentially maintain the same function, structure, identity, and feedbacks" (Walker et al. 2004). The concept of ecological resilience is increasingly used by the Forest Service, but its use has been ambiguous and open to local interpretation (Bone et al. 2016). "Resilience" can be a useful term and goal only when clarified in terms of "resilience of what, to what?" (Carpenter et al. 2001). A major challenge of managing for ecological integrity or resilience, which are both based on understanding ecological history, is the lack of historical knowledge of ecosystems and their variability in many ecological components and processes. A second challenge is knowing future states: there may be multiple possible alternative states of ecological integrity based on certain realities of climate change, invasive species, and changing social values (Duncan et al. 2010, Romme et al. 2012).

Given changing anthropogenic climate change, land use changes, and changes in societal preferences, it is necessary to acknowledge the critical importance of social systems as both drivers of ecological change and as drivers of policy goals and expectations for forests. The importance of the social system suggests that the concept of resilience or integrity should be broadened to focus on managing for social-ecological resilience to global changes within the inherent capacities of earth life-support systems (Carpenter et al. 2001, Folke 2006). Managing for a broader concept of resilience may be more realistic than managing for a specific range of historical variation (Safford et al. 2012, Stine et al. 2014, Wurtzebach and Schultz 2016) or only a biophysical condition. It means focusing on both ecological and social systems and their interactions, and defining resilience not just in terms of recovery of desired ecological or social conditions (which may not be possible) but also adaptation, transformation, learning, and innovation that may lead to new systems that are better adapted to the current biophysical and social environments. Using social-ecological systems frameworks may provide a pathway toward better recognition of how federal forest management is influenced by the interplay of these two systems and where opportunities and barriers lie to reaching federal land management goals, which typically include both ecological and social outcomes. However, managing specifically with social-ecological resilience in mind is still in an exploratory, conceptual stage (Folke 2006), and it remains to be seen how using this framework could improve the effectiveness of federal management.

Fire exclusion—

Although clearcutting of moist old forests had a major effect on ecosystems in the area of the NWFP, altered fire regimes have also affected species and ecosystems. Fire is a critical ecological process in most of the forests of the Plan area, and this chapter devotes considerable attention to complex and sometimes controversial (see chapter 3) fire-related issues. This emphasis on fire is motivated by several factors: (1) fire is a fundamental process that affects most forest ecosystems, species, and human communities of the region; (2) the scientific understanding of the role of fire in both moist and dry forests has increased significantly since the Plan was developed; (3) the 2012 planning rule emphasized ecological integrity and restoration, which are grounded in disturbance ecology—and fire is generally the most significant and altered disturbance in the region; (4) managers have relatively more influence on fire, through suppression policies and management of vegetation, than do most other disturbance processes (e.g., wind or diseases) in the Plan area, and (5) prescribed fire and fire suppression have become a major component of federal land management efforts in policy and budgets in recent years.

The area of the NWFP encompasses a wide range of forest environments and can be broken into two major forest zones (dry and moist) and four different historical fire regimes (chapter 3; fig. 12-2).

One of the most pervasive anthropogenic effects within the drier forest zone, which makes up almost half of the NWFP area, is a major shift in fire regimes as a consequence of fire exclusion and suppression[5] (chapter 3). Lack of fire in dry forests and moist mixed-conifer forests, which historically experienced frequent to moderately frequent wildfire, altered forest structure and composition, and had cascading ecological effects on ecosystems and species.

[5] Fire exclusion is the minimizing or removal of wildfire as a keystone ecological process, either indirectly as a result of livestock grazing, roads, railroads, agriculture, and development, or directly via intentional fire suppression and prevention activities. Fire suppression is the act of putting out wildfires.

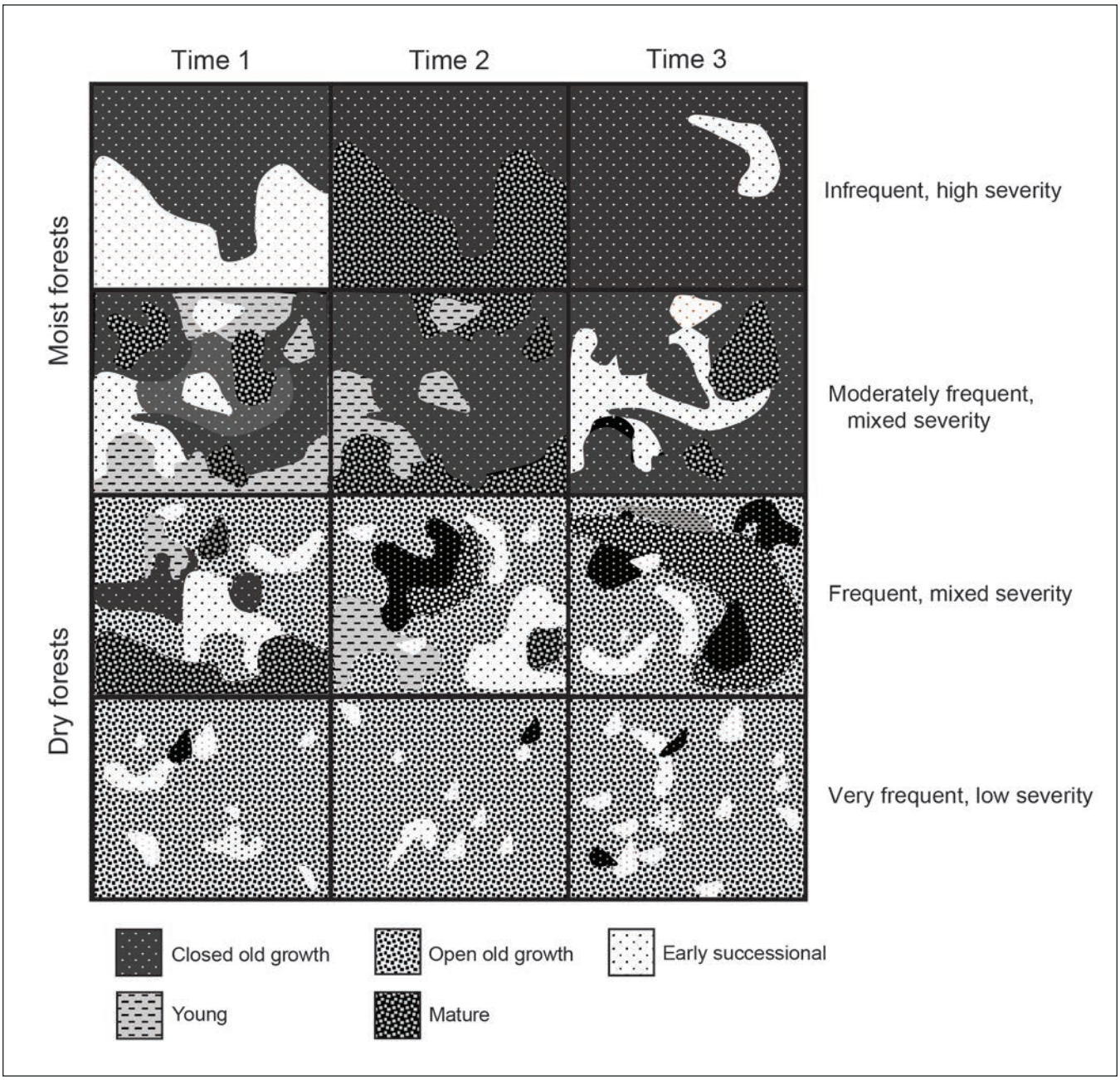


Figure 12-2—Idealized spatial patterns of forest successional stages in the two major forest zones and the four historical disturbance regimes of the Northwest Forest Plan area at three arbitrary points in time. Time 1 and 2 are separated by about 100 years; time 3 is at least 400 years later so that patterns from time 1 and 2 are not evident. See chapter 3 for more information. Illustration adapted from Agee 1998.

These effects include:

- Increased forest density and abundance of shade-tolerant tree species.
- Loss of early-successional, open-canopy young, and open old-growth forest types, and altered successional pathways.
- Increased area of dense, young, multistoried forest vegetation that is used by the northern spotted owl and other late-successional species.
- Decline in habitats for species that use open, fire-frequent forests or early-successional vegetation.
- Less frequent fire, but when fires occur under extreme weather conditions, they can result in uncharacteristically large, high-severity patches of fire.

Larger patches of high-severity fire in this historical regime may have undesirable short- and long-term effects in terms of accelerated upland erosion, loss of forest cover to continuous shrubfields, chronic stream sedimentation, chronically elevated bark beetle populations, and reduction of services from forests of all seral stages (chapter 3). Large patches of high-severity fire in forest ecosystems that historically burned with frequent but low-severity fire can kill many of the large, old, fire-resistant trees that survived fires in the past. Such trees are considered a regionally and globally significant "keystone ecological structure" in a wide range of ecosystem types (Lindenmayer et al. 2014). Extremely large and unusually severe fires also have major social and economic impacts through heavy smoke, evacuations, greenhouse gas emissions, costs of firefighting, lost productivity, and threats to and loss of lives, income, and property. Such social and economic impacts are expected to increase, particularly in the NWFP area, as climate change results in more hazardous fire and smoke conditions (Liu et al. 2016). The landscapes left following extremely large and uncharacteristically severe fires can pose significant management challenges too, as reforestation treatments can be costly and often dangerous in many burned areas. Planting may be needed to avoid persistent loss of forest cover in some areas, yet reintroducing fires while protecting the investment in young, fire-susceptible trees is particularly challenging.

Fire exclusion has also had an effect in moist forests that historically experienced long fire-return intervals. The effects are different than in dry forests, and relate mainly to decreased occurrence of diverse early and mid-successional and nonforest (meadow) vegetation. High levels of fuel accumulation at stand scales and landscape connectivity of fuels are characteristic of moist productive forests that grow for many decades or centuries without fire. However, lack of fire in drier parts of moist forests may lead to more homogeneous stand structures and fuel beds than occurred historically, when infrequent fire created a mosaic of seral stages. The broader ecological implications (e.g., ecosystem function and fire behavior) of these changes are not clear and are in need of further research (Tepley et al. 2013).

Social perspectives on altered forests—
The challenges to managing for ecological integrity, resilience, and desired species in the NWFP area are both ecological and social. In moist forests, where fire was and continues to occur infrequently, uniform plantations, the time required for succession to old growth (centuries), and fragmentation of older forests are key ecological concerns. In dry forests, which historically experienced very frequent and moderately frequent fire-regimes (chapter 3), the ecological constraints on management include the fact that, with build-up of fuels in historical fire frequent regimes, fire often cannot be reintroduced as prescribed fire without first reducing fuels via mechanical means. And, more significantly, climate change and invasive species will continue to alter fire regimes and vegetation dynamics, making these increases in fuels even more consequential.

The social and economic constraints to widespread restoration of fire in fire-frequent ecosystems are large and include agency budgets, limited workforce capacity, air quality regulations, social acceptability of prescribed fire, lack of markets for restoration byproducts, and the risk of losing other values (Charnley et al. 2015; Collins et al. 2010; North et al. 2012, 2015; Ryan et al. 2013) (chapter 8). Public support for restoring fire to the landscape will be required to make progress (North et al. 2015). In addition, the costs of restoring fire through mechanical treatments and prescribed fire are high (Houtman et al. 2013), and to be fully funded by Congress would require significant re-investment in public forest lands at levels beyond current annual wildfire suppression and preparedness funding. For example, the recent Forest Service budget appropriations for hazardous fuels reduction are less than one-fifth what they are for fire suppression (Charnley et al. 2015), and current rates of restoration treatments in many areas of the Western United States are well below what is needed for restoration (North et al. 2012, Reilly et al. 2017a, Spies et al. 2017, Vaillant and Reinhardt 2017). This deficit has led some to call for more use of managed natural ignitions (North et al. 2012). Some initial studies indicate that managed and some unmanaged wildfires have the potential to increase the scale of restoration benefits (Meyer 2015, Reilly et al. 2017b), though the relative benefits and costs of this approach (table 12-1) are not yet fully understood and will likely differ across the fire regimes of the Plan area (chapter 3).

Table 12-1—Summary of possible (known and hypothesized) major tradeoffs (effects) associated with current management activities and original ecological and socioeconomic goals

Management activity	Closed-canopy old-growth structure and function	Northern spotted owls	Marbled murrelets	Other late-successional old-growth species	Aquatic habitats	Timber and nontimber supply	Local economies	Tribal ecocultural resources
Suppression of wildfire	Increases shade-tolerant tree species and canopy cover Protects existing old-growth trees from loss **Reduces open old-growth types and landscape diversity** **Reduces area of diverse early-successional forest** **Reduces resiliency in some fire regimes**	Protects habitat in northern part of range Increases area of nesting and roosting habitat in fire- prone areas **Can increase landscape-scale risk to owl habitat by promoting larger high-severity patches of wildfire** **Can reduce habitat quality in southern part of range where habitat includes smaller patches of early-successional and nonforest vegetation**	Protects habitat	Protects habitat for species that prefer dense multilayered canopies Variable and poorly understood effects	Increases density of trees in riparian areas Can increase shade on streams	Protects forests scheduled for timber harvest Can increase risk of loss of timber resources where forest fuels accumulate Encourages growth of nontimber forest products that favor closed, mature forest conditions	Can provide short-term economic benefit to communities near wildfire Can promote recreation in unburned forests Protects homes and structures	**Reduces quantity and quality of ecocultural resources associated with early-successional forests, nonforest communities, and open old-growth forests**
Variable thinning plantations in uplands and riparian areas	Accelerate development of large trees Increases vegetation heterogeneity, diversity, and understory layers **Can reduce dead wood if trees removed**	Accelerate development of large nest trees and multiple canopy layers May reduce populations of red tree voles, a prey species, in the short term	Accelerates development of crowns with thick limbs **May create habitat for predator species**	Variable effects; some positive and negative short-term and longer term effects	Accelerate large trees Increases vegetation heterogeneity, diversity, and understory layers Effects likely variable with location in stream network **Can reduce dead wood inputs to streams if trees removed** **Can reduce shading and increase stream temperatures**	Can provide wood products and bioenergy and help support local processing infrastructure May favor nontimber forest products (NTFPs) associated with less dense forests **Not sustainable in long run because plantations may become too old or no longer benefit from restoration management**	Creates jobs for local communities	Can enhance ecocultural resources associated with less dense forests

Table 12-1—Summary of possible (known and hypothesized) major tradeoffs (effects) associated with current management activities and original ecological and socioeconomic goals (continued)

Management activity	Closed-canopy old-growth structure and function	Northern spotted owls	Marbled murrelets	Other late-successional old-growth species	Aquatic habitats	Timber and nontimber supply	Local economies	Tribal ecocultural resources
Thinning to restore resilience to fire-suppressed forests	Can help to maintain large, old, fire-resistant trees Can increase old-forest diversity in fire-dependent disturbance regimes Can reduce fire spread rates and reduce sizes of high-severity fire patches	Can protect patches of nesting and roosting habitat from large fires Reduces habitat quality at site level	May reduce loss of large nest trees to wildfire May create habitat for predator species	Same as variable-density thinning	Same as variable-density thinning	Can provide wood for local communities May not be sustainable in long run because restoration may shift toward prescribed fire as stands are repeatedly treated	Creates jobs for local communities Open forests may be preferred by some recreationists Reduces risk of wildfire to wildland-urban interface communities Open, managed forests may not be preferred by some recreationists	Can enhance ecocultural resources associated with less dense forests, including large nut-bearing trees
Prescribed fire	Same as above	Same as above	Unknown	Unknown	Unknown		Can reduce fuel loads and fire risk to local communities Could potentially support local crews dedicated to using managed fire Smoke can cause health and safety concerns	Can enhance eco-cultural resources, including fungi, plants whose germination is enhanced by smoke, and plants affected by insect pests
Early-seral creation in closed-canopy forests over 80 years in matrix to mimic wildfire effects	Can increase habitat diversity and provide habitat for species dependent on open, habitats and dead trees. **Not compatible with dense old-growth forest structure at stand scales** **Cannot fully replace wildfire effects if does not include prescribed fire or occur in older stands**	May not be compatible with habitat in part of the range Can be compatible at landscape scales in southern parts of range	**Not compatible with habitat at any scale**	Likely reduces habitat, but some species may benefit from juxtaposition of old and young habitats	Can increase light to streams and stream productivity Can increase habitat diversity and promote longer term integrity of stream ecosystems **Can decrease shade and increase stream temperatures in some contexts**	Can provide wood products and help support local mill infrastructure Favors NTFPs associated with early-seral forest	Can benefit local economies	Can enhance eco-cultural resources associated with less dense forests, including various understory plants and game animals

Table 12-1—Summary of possible (known and hypothesized) major tradeoffs (effects) associated with current management activities and original ecological and socioeconomic goals (continued)

Management activity	Closed-canopy old-growth structure and function	Northern spotted owls	Marbled murrelets	Other late-successional old-growth species	Aquatic habitats	Timber and nontimber supply	Local economies	Tribal ecocultural resources
Early-seral creation in closed-canopy plantations to mimic wildfire effects	Can increase habitat diversity and provide habitat for species dependent on open habitats and dead trees Does not reduce current area of old growth **Will reduce future amounts of dense old-growth forest structure at stand scales and landscape scales** **Cannot fully replace wildfire effects if does not include prescribed fire or occur in older stands**	**Could have some negative effects on dispersal habitat** May be compatible at landscape scales in southern parts of range	**Does not affect current habitat although it could increase edge and occurrence of nest predators at landscape scale**	Does not likely affect habitat for these species, and some species may benefit from juxtaposition of old and open canopy conditions	Can increase light to streams and stream productivity Can increase habitat diversity and promote longer term integrity of stream ecosystems **Can decrease shade and increase stream temperatures in some contexts**	Can provide wood products and help support local mill infrastructure Favors NTFPs associated with early-seral vegetation	Can benefit local economies	Can enhance ecocultural resources associated with less dense forests, including various understory plants and game animals
Planting after wildfire	Planting of key tree species may benefit forest recovery	Planting of key tree species may benefit longer term recovery of habitat	May benefit long-term recovery of habitat	May benefit long-term recovery of habitat	Planting of key tree species may benefit longer term recovery of habitat	Can benefit long-term recovery of forest resources	Some work for local communities	Recovery of conifer forest may benefit some resources, but recovery of nonconifer species (e.g., hardwood trees and shrubs) are also important concerns, as well as ability to restore frequent fire regime
Salvage after wildfire	**Removal of large dead wood reduces habitat for many wildlife species** **Logging of dead trees can kill regeneration and increase erosion** Removal of small dead trees in fire-excluded forests may reduce impacts on soil if reburn occurs	**Removal of dead trees likely not compatible with habitat**	NA (does not use postfire environments or dead trees)	**Removal of dead wood likely not compatible with habitat for some of these species**	**Removal of dead trees (especially large ones) may work against natural riparan/aquatic recovery processes**	Can provide timber and support local mills	Can provide jobs for local communities	

Table 12-1—Summary of possible (known and hypothesized) major tradeoffs (effects) associated with current management activities and original ecological and socioeconomic goals (continued)

Management activity	Closed-canopy old-growth structure and function	Northern spotted owls	Marbled murrelets	Other late-successional old-growth species	Aquatic habitats	Timber and nontimber supply	Local economies	Tribal ecocultural resources
Road removal	Can reduce spread of invasive species to older forest blocks Can reduce edge effects **Can reduce access for restoration management**	Unknown	May reduce corvid populations that prey on nests	Unknown	Reduces erosion potential Reduces risk of landslides and debris flows Increases fish passages through stream networks	**Can reduce access for timber management and NTFP gathering**	**Can reduce access for recreation and other forest uses** Can improve water quality	Can benefit desired aquatic resources, **but also can limit access to desired ecocultural resources**
Managing wildfire for ecological benefits	Can increase diversity of old-forest types Can increase landscape resilience to future fire **Can destroy old-growth forests and large old trees**	May reduce risk of loss from fire to surviving patches of habitat **Can eliminate habitat**	May reduce risk of loss from fire to surviving patches of habitat **Can eliminate habitat**	Not well known, but likely similar to spotted owl response	Can increase habitat diversity and promote longer term integrity of stream ecosystems **Can decrease shade and increase stream temperatures**	May damage and reduce value of trees that were scheduled for wood production Can reduce fuels and lower risk of loss of unburned forests	Can increase area of habitat for game species and increase hunting use Can reduce future risk of large high-severity fires that threaten local communities	Can promote ecocultural resources by restoring fire and more open structure as above, **but there may also be concerns about effects of large high-severity patches in untended areas on desired resources (e.g., mature oaks)**

NA = not applicable.

Note: Effects in regular type are generally consistent with a goal; effects in boldfaced type are generally not consistent with a goal or have negative effects on other goals not emphasized in the Northwest Forest Plan. Effects may differ with spatial and temporal scale and with geography. The effects are generalized, so they may not apply in all contexts and there may be considerable uncertainty, especially regarding the effects of extreme fires. For detailed discussions of these effects, see individual chapters of this synthesis.

Another social challenge is that some altered conditions of ecosystems in the NWFP area may be desirable to some people, despite being highly departed from historical conditions, and at greater risk to loss from wildfire and drought. For example, the denser forests that have developed in forests with very frequent and moderately frequent fire regimes now support more area of habitat for northern spotted owls and other dense forest species such as goshawks (*Accipiter gentilis*) (chapters 3 and 4) than they did under the historical fire regime. Some groups may favor maintaining some dense stands; for example, the Klamath Tribes expressed a concern for promoting mule deer (*Odocoileus hemionus*) habitat by retaining dense tree patches as deer hiding cover within ponderosa pine (*Pinus ponderosa*) forests that were historically open in their ancestral lands on the Fremont-Winema National Forest (Johnson et al. 2008). Based on discussions with stakeholders who participate in central Oregon forest collaborative groups, we have observed that some stakeholders value the aesthetic and wildlife values of the fire-excluded, multilayered grand fir (*Abies grandis*) and white fir (*A. Concolor*) forests, which appear to fit an idealized old-growth forest based on wetter old-growth types. A study from moist forests (moderately frequent, mixed-severity fire regime) in the western Cascade Range of Oregon indicates that tall, multilayered forests that develop in the absence of fire may buffer climate change effects on the microclimate for wildlife (Frey et al. 2016a, 2016b). It is unknown if that finding applies to fire-excluded dry forests. Finally, such forests may be more desirable to some people simply because they occur without active management (except for suppression), which may be simply mistrusted (e.g., see DellaSala et al. 2013 and "Trust and collaboration" section below).

Although some people see benefits in dense fire-excluded forests, many see the risks (see discussion in Brown 2009). For example, many stakeholders who participate in the central Oregon forest collaboratives mentioned above are concerned about the increased risk of widespread tree mortality resulting from severe fire, drought, and insects, and some see opportunity for economically feasible restoration treatments that would remove established grand fir/white fir established over the past 100 years in favor of fire-tolerant and drought-tolerant tree species.[6]

Invasive species—

Species invasions or range-expansion species native to North America have also affected the native biota of the NWFP region (chapter 6). Invasive species are widespread—more than 50 percent of inventory plots in almost all physiographic provinces of the Plan area contain nonnative plant species (Gray 2008), but most of them do not get much attention. An exception is the barred owl, which is an example of an invasive species (Peterson and Robins 2003) (some have called it a "native invader species") (Carey et al. 2012) that has become a major threat to the viability of northern spotted owl populations (chapter 4). Although the barred owl may be the most prominent example, there are many other examples in the NWFP area of species that may have been exotic or native to the region but are having undesirable effects on other species and ecosystems as a result of landscape and other anthropogenic changes. For example, native corvid (the crow/raven family) populations have expanded as a result of human food waste and human disturbance of vegetation (Marzluff and Neatherlin 2006, Peterson and Colwell 2014), and corvids prey on the nests of marbled murrelets (*Brachyramphus marmoratus*) (chapter 5).

The widespread expansion of true firs into pine forests, where fire has been excluded, could also be termed "native invader" (Carey et al. 2012, Simberloff 2011) species that were once rare or uncommon in a landscape, but now have become so abundant that they are altering community (e.g., through competition) and ecosystem dynamics (disturbance regimes) in undesirable ways. In the case of true firs in dry forests, their expansion has altered forest composition, structure, and fire regimes, and they are difficult to control by virtue of their copious seed rain (Hessburg et al. 2016, Stine et al. 2014), which can lead to rapid recolonization of disturbed areas.

The impact of barred owls on northern spotted owl populations is profound; it is not known if this impact can be reversed or at least stabilized across the spotted

[6] Merschel, A. 2017. Personal communication. Graduate student, Oregon State University, Department of Forest Ecosystems and Society, 321 Richardson Hall, Corvallis, OR 97331.

owl's range through efforts to remove them. An ongoing, large-scale experiment will shed more light on this future (USFWS 2013, Wiens et al. 2016). A proposal to remove an established species to protect another is a major challenge to society from ecological, economic, and ethical perspectives (Carey et al. 2012, Livezey 2010), but it is not unprecedented (e.g., Wilsey et al. 2014). Multiple approaches to northern spotted owl conservation, including large-scale experiments and landscape-scale forest restoration experiments, can provide more learning opportunities and more understanding of ways to promote resilience of the subspecies. In the long run, the northern spotted owl may be locally or completely displaced by the barred owl. From an ecosystem perspective (e.g., productivity, food webs, trophic cascades), the effect of loss of northern spotted owls on the forests and vertebrate communities is unknown, but it is hypothesized that prey species and other competing native predators may experience changes in behavior, abundance, and distribution as a result of predation by the barred owls, which has a broader prey base and occurs at higher densities than the northern spotted owl (Wiens et al. 2014).

Invasive species occur in aquatic and riparian ecosystems as well. Across the Plan area, 63 nonnative species and species groups are identified as regional aquatic-riparian invasive or nuisance species priorities (chapter 7). Of these, 31 (49 percent) species or species groups were designated as "high concern" and inventoried by the NWFP's Aquatic Riparian Effectiveness Monitoring Program (AREMP) in 2016. Nonnative species are not always harmful to native fishes or their habitats, but in many instances they can (1) compete with, prey upon, hybridize with, or infect native species with novel pathogens; (2) greatly alter the structure of food webs; or (3) cause habitat changes that reduce the productivity of desirable aquatic organisms. Climate change will likely influence the expansion of nonnative plant and animal species in the NWFP area, while at the same time either reducing or even extirpating native species (Dale et al. 2001, Garcia et al. 2014, Urban 2015).

Other disturbance agents—
Novel ecological conditions are also a concern where ecosystems are subject to multiple disturbance agents. For example, stands infested by the sudden oak death pathogen have increased potential for high burn severity (chapter 3), while rodenticides used in illegal marijuana cultivation and the spread of barred owls may tax populations of sensitive fishers (*Martes pennanti*) and northern spotted owls, respectively, so that they become more sensitive to other disturbances (Gabriel et al. 2012, 2013) (chapter 6). As an example from aquatic systems, the combination of climate change, severe fire, tree mortality, and floods may increase the potential for debris flows (Cannon and DeGraff 2009) and ensuing debris jams at culverts and bridges. Such flood impacts can threaten life, property, and access; damage expensive infrastructure; and impair stream functions by causing stream bank erosion and channel incision. The challenges to restoring fire and geomorphic disturbances to these ecosystems are daunting. Landscape and social-ecological systems perspectives are needed to meet the broad Forest Service goal (http://www.fs.fed.us/strategicplan) of increasing the resilience of forests and aquatic ecosystems to fire and climate change while meeting the specific late-successional forest goals of the NWFP (Fischer et al. 2016, Hessburg et al. 2015, 2016; Reeves et al. 1995, 2016; Stephens et al. 2013).

Perspectives on Reserves in an Era of Global Environmental Change

Views of the conservation community—
The scientific community's response to the cumulative effects of climate change, land use change, and invasive species has led some to call for new approaches to conservation (Millar et al. 2007, Wiens 2016). Some researchers have affirmed that "tomorrow's landscapes may become so altered by human actions that current management philosophies and policies of managing for healthy ecosystems, wilderness conditions, or historical analogs will no longer be feasible" and will require a new land ethic (Keane et al. 2009). Others have advocated for a new science of conservation rooted in the integrated nature of social-ecological systems (as mentioned above) and designed to promote human well-being as well as biodiversity conservation, particularly where poverty is pervasive, through judicious and sustainable use of ecosystems rather than strict preservation (Kareiva and Marvier 2012). In the conservation ethics

literature, the contrast is often made between humanism, emphasizing the importance of productive human use of natural resources, and biocentrism, emphasizing a primary goal of maintaining ecological integrity (Stanley 1995). These new perspectives have received pushback from some conservation biologists. For example, Miller et al. (2014) and Doak et al. (2014) argued that conservation centering on human values, now often organized using the framework of ecosystem services, is an "ideology" that (1) is not new (e.g., it reflects ideas advocated by Gifford Pinchot a century ago), and (2) does not address the root causes of lost biodiversity, which they described as "unabated consumption and increasing human populations." Instead, they emphasized preservation of biodiversity through large networks of protected lands arranged to foster connectivity and some sense of permanence. They devoted little attention, however, to what such protection means in disturbance-dependent and highly dynamic systems with a strong history of human impacts, or in systems in which invasive species are widespread, or where permanence of certain vegetation, habitat conditions, or biotic communities is simply unattainable.

These debates notwithstanding, nature reserves (also termed "protected areas") including wilderness areas, remain key components of conservation strategies and forest planning around the world (Simončič et al. 2015, Watson et al. 2014). E.O. Wilson, in his book *Half-Earth, Our Planet's Fight for Life* (Wilson 2016), challenged society to set aside half of the Earth's lands and seas to conserve biodiversity in reserves equivalent to World Heritage sites. Other scientists have echoed a similar call in advocating for an extensive reserve network focused on riparian areas across the United States (Fremier et al. 2015). Although we are a long way from these goals (e.g., 10 percent of U.S. land is in a protected area (Aycrigg et al. 2013), the area of wildland reserves or protected areas is growing (Götmark 2013) and have made essential contributions to maintaining populations of threatened species, or have slowed their rate of loss. In the NWFP area, reserves[7] on federal lands constitute about 80 percent of the federal forest area and 28 percent of the total forest area on public and private forest lands (chapter 3). Conservation biologists have argued that protected areas are necessary but not sufficient to meet conservation objectives (Margules and Pressey 2000, Noss et al. 1997, Rayner et al. 2014). Governance and management of reserves are as important as the designation of the reserve on a map. For example, ineffective governance of protected areas in many countries has not kept out detrimental land uses such as development, intensive logging for timber, degradation from invasive species, and illegal hunting (Watson et al. 2014). In addition, reserves may need active management to meet biodiversity goals (Lemieux et al. 2011, Lindenmayer et al. 2000) or to meet needs of local communities that are compatible with biodiversity goals (Watson et al. 2014). Pressey et al. (2007) suggested that appropriate actions within or outside reserves may include "control of invasive species, management of disturbance regimes, quarantine against disease, restrictions on harvesting, and restoration." In summary, the literature provides overwhelming support for the idea that reserves have an essential role to play in conservation (e.g., slowing rates of losses of native biodiversity), if they are effectively managed (Watson et al. 2014).

Many types of reserves—

Globally, there are many types of reserves, depending on a variety of existing conditions and long-term intentions. For example, the International Union for the Conservation of Nature (IUCN) defines seven categories that encapsulate the variety of purposes and specific contexts for a reserve (Spies 2006) (chapter 3). These range from category 1a, "strict nature reserve," which still allows some light human uses, to category 6, which allows sustainable use of natural resources, such as agroforestry. Biosphere reserves defined by the IUCN can include "core areas" or **sanctum sanctorum** which are open only to those with special scientific permits, and are bordered or surrounded by buffer zones with various allowances for ingression and resource use and extraction (e.g., Cumming et al. 2015, Peine 1998, Taylor 2004). These categories of reserve designs differ depending on the amount of human activity and use that is considered compatible with the primary conservation objectives of the reserve (Lausche and Burhenne-Guilmin 2011), although many of the IUCN reserve design architectures, including the core/buffer design, are not implemented as such in the United States.

[7] Designated wilderness areas account for about 42 percent of federal reserves, not including riparian reserves, and encompass roughly 7.1 million ac (including some national parks like Olympic and Mount Rainier National Parks).

In general, reserves are defined in terms of objectives and management actions that are needed or allowed, and in terms of actions that cannot be allowed in order to achieve primary conservation objectives, that is, by specifying human activities that are permitted or excluded. As a result, reserves exhibit a hierarchy of conservation goals, as demonstrated in the NWFP area, in which conservation of functional older forest and northern spotted owl habitat are the top priorities in late-successional reserves (LSRs), at least in the wetter provinces. In the drier provinces, according to the latest U.S. Fish and Wildlife Service recovery plan for the northern spotted owl, restoration becomes an "overlapping goal" with northern spotted owl habitat that must be reconciled (USFWS 2011). In addition, the 2012 planning rule emphasizes managing forests for ecological integrity and resilience to climate change, a goal that is not mentioned in the standards and guidelines for the LSRs (USDA and USDI 1994b). Thus, reserves as they have been conceived and implemented globally and regionally exist along a continuum of uses and management approaches, based on goals and cultural context.

Social controversies around reserves—
Although reserves are a cornerstone of conservation biology, they exist in a larger social context in which they may not be viewed so favorably. The idea of a nature "reserve" is a cultural construct associated with Euro-American notions of humans as distinct from nature (Cronon 1996) (see chapter 11). Rules governing permissible activities in protected areas or reserves differ across the globe (Simončič et al. 2014) and can be controversial (Brockington and Wilkie 2015). Reserves, with strict rules concerning management or resource extraction, have been criticized for threatening livelihoods by denying access to resources, and for not recognizing that nature changes as a result of disturbance and succession (Bengtsson et al. 2003); tribes, in particular, have expressed such concerns about NWFP reserves (see chapter 11). Often, the costs of reserves are experienced by local people, while benefits disproportionately accrue to people some distance away (Brockington et al. 2008). Controversies about reserves have several dimensions:

1. They are often written into the founding stories of a nation or culture (e.g., old-growth forests in the Pacific Northwest (Spies and Duncan 2009) and therefore touch deep emotions.
2. The local effects on people can be beneficial (e.g., amenity values) (Hjerpe et al. 2017, Holmes et al. 2016) or negative (e.g., reserves that restrict access to commodities or subsistence goods and can increase poverty in rural areas (Adams 2004, West et al. 2006).
3. The goals for nature in the reserves can be ambiguous or difficult to achieve given that nature is multidimensional, dynamic, and often influenced directly or indirectly by human activity.
4. Achieving biodiversity goals often requires management, especially given effects of past land use change, invasive species, and climate change, which can be controversial if stakeholders hold different values for reserves.
5. Reserves, which typically occupy a small part of most landscapes, are not sufficient by themselves to provide for biodiversity (Franklin and Lindemayer 2009).
6. They are flash points for politics of conservation related to land use and national and regional debates about values expressed through different interest groups (Brockington and Wilkie 2015).

Reserves in dynamic ecosystems—
Some conservation biologists and legal experts (e.g., see Craig 2010) recognize the problem of conserving biodiversity in fixed reserves, where vegetation structure and composition, disturbances, climatic influences, and plant and animal communities are highly dynamic. Approaches to reserves in dynamic systems fall along a gradient in terms of size and objectives. At one end of this gradient are relatively small fine-filter or coarse-filter (e.g., static vegetation states) reserves that some (Alagador et al. 2014, Bengtsson et al. 2003, Bisson et al. 2003, Lemieux et al. 2011) suggest could be moved in response to changing environmental conditions (e.g., disturbance, invasive species, climate change). Some of the late-successional reserves (LSRs) in the Plan area are small and would fit into this category in terms of size and objective. At the other end of the gradient are large (coarse-filter) reserves that are managed to accommodate dynamic ecosystem processes (e.g., disturbance and succession) (Bengtsson et al. 2003,

Pickett and Thompson 1978). Some of the large LSRs may meet this size criterion relative to fire sizes (chapter 3), but are primarily focused on maintaining or increasing one successional state—dense old-growth forests. The first type of reserve approach—in which new protected areas are established and old ones decommissioned in response to changing environmental conditions—has received little formal evaluation, and we are not aware of any publications that document where a reserve was decommissioned and replaced with a new one or an alternative approach in the United States. However, dynamic habitat conservation approaches (which do not use the term "reserve") are being used for two endangered forest species in fire-prone forests: the red-cockaded woodpecker (*Picoides borealis*), which depends on fire to maintain old-growth pine (*Pinus* sp.) forests of the Southeastern United States, and the Kirtland's warbler (*Dendroica kirtlandii*), which depends on dense young jack pine (*Pinus banksiana*) forests that regenerate following wildfire or logging in Michigan (Moore and Conroy 2006, Spaulding and Rothstein 2009). These cases indicate that alternatives to fixed no-management reserves for conservation of listed species of fire-prone landscapes exist, but examples do not exist for old-growth forests and northern spotted owls.

A simulation study in Quebec (Rayfield et al. 2008) evaluated static and dynamic habitat reserve strategies for American marten (*Martes americana*), a species that uses mature coniferous forests. The results indicated that the dynamic reserve strategy supported more high-quality habitat over a 200-year simulation than did static reserves. The locations of new reserves were constrained by fragmented forest patterns created through logging and wildfires in surrounding non-reserve areas. These findings have two major implications: (1) if reserves are focused on just one successional stage or habitat for a single species, they may not be effective in the long run in fire-prone landscapes; (2) if dynamic conservation strategies are to be successful in the long term, the surrounding nonreserved areas must be managed in a way such that habitat replacement options for target species are available when reserved areas are no longer functioning as intended. They also highlight the importance of investing in and supporting private lands conservation to enable possible future replacement options associated with private lands, and to provide habitat functions for species that are not restricted to reserves, or other species that were not the focus of the reserve.

In contrast to the above species-centric reserves or conservation areas, large reserves based on dynamic coarse-filter objectives (e.g., ecosystem patterns and processes) will more likely meet conservation goals than fixed-area reserves for particular species or vegetation conditions. Large protected areas (e.g., larger than 25,000 ac) (more than 100 of the existing LSRs are larger than 25,000 ac) could better support the full range of natural disturbances within their boundaries than could small reserves (see chapter 3 for evaluation of the dynamics of LSRs as a function of their size). In such cases, it may be more possible to capture inherent ecosystems dynamics—natural and intentional management disturbances used to change the vegetation in ways that match the biophysical and topographic template and contribute to overall successional diversity and resilience. Management may still be needed to achieve specific goals (e.g., creation of fire-resistant forest structures and heterogeneous fuel beds) and could promote resilience of some components of ecosystems components to climate change, drought, and fire.

Challenges to management of small and large reserves are significant. For small reserves with a narrow species or vegetation state objectives, moving reserves dynamically to deal with climate change, disturbance, and other changes may be more effective at maintaining biodiversity than fixed reserves (Bengtsson et al. 2003). However, a dynamic reserve in which adjustments to standards, guidelines, and reserve boundaries would be more difficult to implement, monitor, and govern than one in which reserves are fixed in perpetuity in location and management guidelines. Moving reserves would likely require an ongoing and robust decisionmaking process that involved diverse stakeholders and a high level of trust. In large reserves, with both ecosystem and species goals, there would likely be less need or motivation to move reserve boundaries because there would be fewer options for reserve placement in the larger landscape and because overall vegetation conditions in large reserves would be less likely to change as a result of disturbances.

The management of large reserves for ecological integrity and species goals would require development of standards and guidelines for dealing with natural disturbance events and restoration activities intended to restore ecological processes (e.g., fire and hydrological disturbances) while providing for any other goals (e.g., particular species or vegetation states). In addition, standards and guidelines would need to be flexible enough to deal with unforeseen future issues, such as invasive species or climate change effects that might require different types of intervention to meet ecological goals. Changes to reserve boundaries or to standards and guidelines in both large and small reserves would also involve consideration of environmental justice and equity, especially for people living and working near the reserve.

Although the idea of dynamic reserves, or reserves for dynamic ecosystems, may be relatively new in the literature (e.g., Harrison et al. 2008), the literature also lacks studies of the conservation of late-successional forests (i.e., dense older forests) in reserves within dynamic fire-prone ecosystems, which is the situation in the dry forests of the NWFP area. The NWFP was meant to be adaptive, and changes to reserve standards and guidelines might be considered given climate change, fire occurrence, invasive species, and species movements or other relatively new ecological concerns. See "Reserves" on p. 952 for more discussion of NWFP reserves and challenges of implementing reserves in dynamic ecosystems.

Key Social Components of the Social-Ecological Systems of the Northwest Forest Plan Area

Ecosystem services—

The ecosystem services concept, largely developed since the NWFP was initiated, recognizes that forests and other natural systems support many benefits to human communities beyond timber and water supply that were emphasized at the creation of national forests. The recognition of these diverse benefits is not new (Kline et al. 2013); however, efforts to explicitly recognize them within a broader "ecosystem services" framework is somewhat new, and in the process of being incorporated into federal forest management (Brandt et al. 2014; Bruins et al. 2017; Deal et al. 2017a, 2017b; Long et al. 2014; Moore et al. 2017; Penaluna et al. 2017; Smith et al. 2011). Categories of ecosystem services recognized by the Millennium Ecosystem Assessment are **provisioning services** (e.g., food and fiber), **supporting services** (e.g., pollination, soil formation, and nutrient cycling), **regulating services** (e.g., carbon sequestration and water purification), and **cultural services** (e.g., spiritual, symbolic, educational, heritage, and recreational services) (Wallace 2007). Many resource management systems in the United States took such services for granted until relatively recently, as the limits and vulnerabilities of ecosystems in supporting these benefits have become more apparent. However, ecosystem valuation is often difficult owing to the lack of markets for many collective goods. Forest managers often have difficulty assigning value to many features of the forests they manage in ways that appropriately inform decisionmaking (Smith et al. 2011). Kline et al. (2013) indicated that full development of ecosystem services frameworks for public lands will be constrained by lack of ecological data for planning units and economic capacity in terms of models and staffing. They argue that, given these limitations, efforts to apply ecosystem services concepts should include qualitative methods that can be used with stakeholders even without more detailed quantitative information.

Critics of the ecosystem service concept have argued that it has constrained thought and conservation of nature by focusing on "monetization and financialization of nature" that actually devalues nature by ignoring other values that cannot be monetized, and it creates "make-believe markets" that are not effective in conserving nature (Silvertown 2015). These other values include aesthetic, spiritual values and intrinsic values that might come under the title of "cultural services" but are not suited to an instrumental thinking approach (Batavia and Nelson 2017, Cooper et al. 2016, Winthrop 2014). Others have responded by saying that the ecosystem services concept has value beyond market and monetization, can take many forms (Schröter and van Oudenhoven 2016, Wilson and Law 2016), and is strongly rooted in intrinsic values that include spiritual fulfillment and sacred natural sites. Chapter 11 briefly discusses some of these issues, while Winthrop (2014) reflects on tribal contexts in proposing

"culturally reflexive stewardship" as a useful framework for understanding motivations for conservation based upon knowledge of local ecosystems, a world view that humans are a part of nature, and cultural practices that reflect residence and use over many generations.

Deal et al. (2017b) suggested that the Forest Service is well positioned to make ecosystem services the "central and unifying concept in federal land management." A 2015 presidential memorandum (OMB 2015) directed all federal agencies to develop and institutionalize policies to promote consideration of ecosystem services in planning, investments, and regulatory policy (table 12-2). However, it has been challenging for the Forest Service to describe and value all the potential ecosystem services that public lands provide. No published full accounting of ecosystem services has been conducted for the NWFP area, but some localized efforts have been made (Deal et al. 2017a, 2017b; Kline et al. 2016; Smith et al. 2011,) (see also chapter 9), and a framework as has been proposed (Deal et al. 2017b). This framework includes describing the ecosystem services provided by forest landscapes, examining the potential tradeoffs among services associated with proposed management activities, and attracting and building partnerships with stakeholders who benefit from particular services that the forest provides. According to Deal et al. (2017a), the common needs for advancing ecosystem services as a central framework for the Forest Service include:

- Building staff capacity for the concept and application of ecosystem services.
- Creating and publishing ecosystem service resource and reference materials.
- Aligning agency staffing, funding, and program structures with ecosystem service priorities.
- Integrating and managing data.
- Identifying inventory metrics; defining outcome-based performance indicators; and organizing and linking data.
- Valuing and mapping ecosystem services using current tools and methodologies.
- Communication.
- Policy including leadership support of using ecosystem services as part of a governance framework.

A review of several project-level applications of ecosystem services in Oregon found that place-based applications can highlight the connections between ecosystem conditions and public benefits (Deal et al. 2017b). The review hypothesized that using this approach could help transform the agency into a more effective and relevant organization and will strengthen public investment in Forest Service activities. Key ecosystem services provided by federal forests in the Plan area include water, recreation, wildlife and plant habitat, wood products, and carbon sequestration. The contribution of Forest Service lands to water yield in streams differs regionally and is especially significant in streams that originate in the western Cascade Range and northern California (fig. 12-3). The water supply from many watersheds in the Plan area originates on national forests (Watts et al. 2016), and water from undisturbed old-growth forests can be especially high in quality as a result of high nutrient retention and low erosion (Franklin and Spies 1991). Streamflow in summer, which is typically quite low, is nevertheless higher from old-growth forest watersheds in the western Oregon Cascades than in watersheds dominated by maturing forest plantations (Perry and Jones 2016). Forested streamside buffers have been shown to protect water quality in many parts of the world (Sweeney and Newbold 2014).

The carbon sequestration potential of old-growth forest ecosystems in the NWFP area has received special attention (DellaSala et al. 2015, Hudiburg et al. 2009, Kline et al. 2016, Smith et al. 2013, Wilson et al. 2013). When the forests and soils of this region develop for long periods (hundreds of years) without natural or human disturbances, they can store some of the highest levels of carbon of any region in the United States and the world (fig. 12-4).

The expanded understanding of ecosystem services also reveals that synergies and tradeoffs can occur between and among biocentric and anthropocentric values (Hunter et al. 2014, Kline et al. 2016). For example, certain conservation approaches (e.g., protecting old growth and restoring watersheds) may have the added benefits of increasing carbon sequestration and water quality and providing economic benefits in the form of scenic quality/aesthetics, recreation, or restoration jobs (Brandt et al.

Table 12-2—U.S. natural resource legislation with examples of federal agency responses and applications of ecosystem services for agencies

Legislation	Intent of legislation	Examples of U.S. federal agency responses
Multiple Use–Sustained Yield Act (1960)	Promote sustainable management of natural resources to meet the growing needs of an increasing population and expanding economy	U.S. Forest Service (USFS) and Bureau of Land Management (BLM) directed to manage timber, range, water, recreation and wildlife with equal importance
National Environmental Policy Act (1969)	Encourage harmony between people and the environment, enrich the understanding of the ecological systems and natural resources important to the Nation, and establish a Council on Environmental Quality	Any federal, state, or local project that involves federal funding, work performed by the federal government, or permits issued by a federal agency must take a multidisciplinary approach to decisionmaking, including consideration of alternatives
Federal Land Policy and Management Act (1976) and National Forest Management Act	Establish policy of inventory and planning in accordance with the Multiple-Use Sustainable Yield Act	USFS and BLM develop land management plans in collaboration with the public to determine appropriate multiple uses, develop strategies for resource management and protection, and establish systems for inventory and monitoring to evaluate the status of resources and management effectiveness
National Forest System Land Management Planning Rule 2012	Regulation developed by the USFS to implement planning required by the National Forest Management Act	Rule explicitly requires USFS managers to address ecosystem services in planning to ensure that forests have the capacity to provide people and communities with a range of social, economic, and ecological benefits for the present and into the future. Staff across the agency develop and apply tools to address ecosystem services in land-management efforts.
Presidential Memorandum: Incorporating Ecosystem Services into Federal Decision-Making (OMB2015)	Directs federal agencies to incorporate natural infrastructure and ecosystem services into decision frameworks	National Oceanic and Atmospheric Administration uses ecosystem service valuation to assess benefits of dam removal and coastal rehabilitation, among other projects Natural Resources Conservation Service applies ecosystem service quantification tools to its programs, including watershed rehabilitation and flood mitigation U.S. Fish and Wildlife Service incorporates consideration of ecosystem services into wildlife refuge management Environmental Protection Agency makes ecosystem services the focus of determining adversity to public welfare in review of air quality standards BLM and U.S. Geological Survey collaboratively assess alternative methods and quantification tools for evaluating ecosystem services through a case study in the San Pedro River watershed

Source: Deal et al. 2017b.

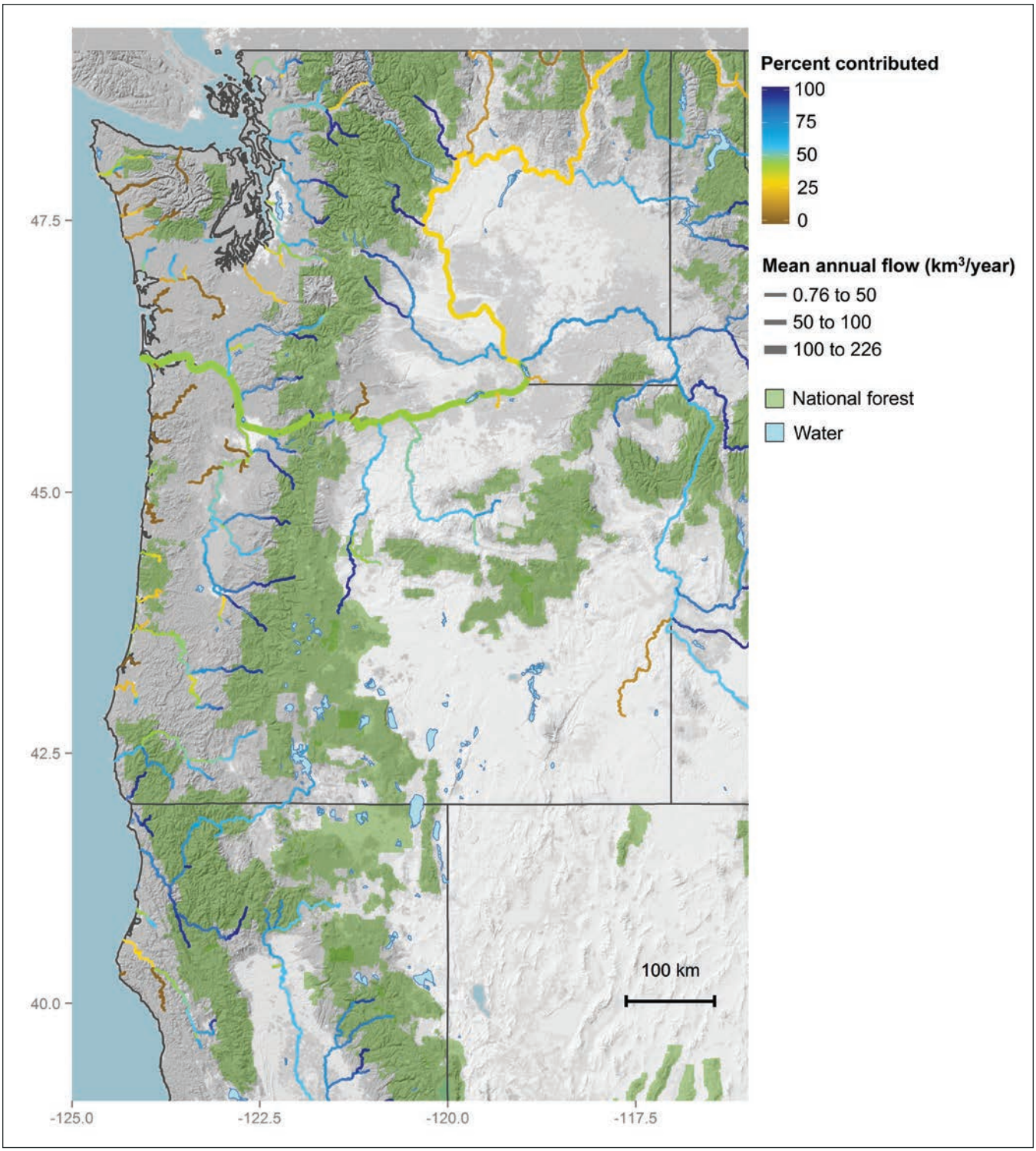


Figure 12-3—Percentage of annual streamflow from U.S. Forest Service lands in Washington, Oregon, and northern California. Data from Luce et al. 2017 (https://www.fs.usda.gov/rds/archive/Product/RDS-2017-0046/.) and https://www.fs.fed.us/rmrs/national-forest-contributions-streamflow-pacific-northwest-region-region-6.

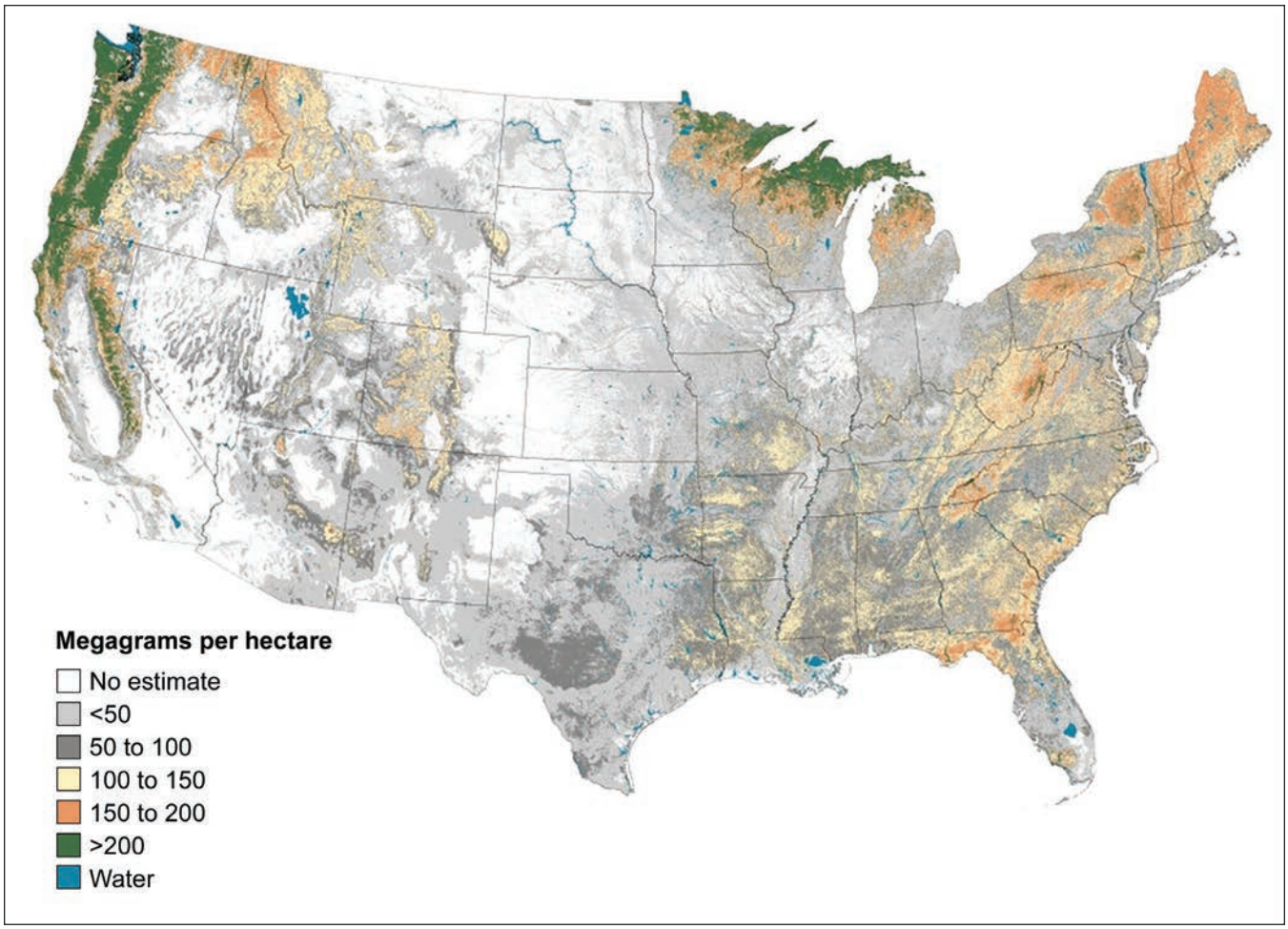


Figure 12-4—Total forest ecosystem carbon density in the United States, 2000–2009. Includes above- and belowground live trees, downed dead wood, forest floor, soil organic carbon, standing dead trees, and understory above- and belowground pools. From Wilson et al. 2013.

2014). In some cases, recreation and restoration benefits may help to offset job losses associated with declines in timber production. However, the economic systems and accounting for federal lands do not yet fully consider the values of carbon sequestration and water supply, and newer economies based on amenity values may not make up for job losses associated with protection of late-successional old-growth habitats and other economic factors in the timber industry (Charnley 2006a) (chapter 8). These variable effects and measures make it difficult to generalize about the ecosystem service impacts of the NWFP or conservation approaches in general. In addition, market forces external to NWFP communities and wood products manufacturing have also transformed since the NWFP was implemented, making it difficult to tease apart the role of federal lands management from other drivers of economic change in influencing community socioeconomic well-being.

Despite its limitations, many scientists consider the ecosystem services framework useful for managing the broad array of benefits that forests provide to people (Deal et al. 2017a, 2017b). Although there are challenges in operationalizing and measuring the entire set of ecosystem services outlined by the Millennium Assessment, the framework gives managers a more diverse set of possible objectives, including managing forests and rangelands for water, pollination potential, carbon, firewood/fuel, cultural heritage, spirituality, solitude, scenery, and many other values.

Institutional capacity—
A key interaction in the social-ecological system lies between the desire to restore forest dynamics and create more resilient forests and the limited capacity of human communities and federal agencies for active management. Although forest management on federal lands was often seen in the past (and still is by some) as a threat to native biodiversity, it is now seen by many ecologists and managers as critical to restoration and conservation of terrestrial ecosystems (Johnson and Swanson 2009). Interestingly, this view is not widely held for aquatic ecosystems (chapter 7). In the past, revenues from timber harvest often subsidized forest management, yet those revenues have declined with reductions in harvesting (chapter 8). Trends of declining agency budgets, increased fire suppression costs, and reduced agency staffing pose challenges to achieving forest management objectives such as ecological restoration, reducing wildfire risk to human communities, promoting habitat for wildlife (chapter 8), and providing diverse opportunities and settings for recreation (chapter 9). Federal agencies lacked the institutional capacity (staff with the required skills, financial resources, management flexibility, and incentives) to fully implement the NWFP's ecosystem management goals (Charnley 2006a). Efforts to maintain species and habitats and restore desired ecological conditions (e.g., old growth) and processes (e.g., succession fire and natural flows) require funding, forest management capacity (e.g., workforce and wood products infrastructure), and public support. The budgets for restoration and the annual rates of treatment are well below what is needed to restore fire to the historical levels found in frequent-fire landscapes (North et al. 2012, Reilly et al. 2017b, Spies et al. 2017). Limited budget and agency capacity has led to innovative approaches to accomplishing restoration, such as stewardship contracting and partnerships with nongovernmental organizations or other government agencies (chapter 8). However, wood processing mills needed to support forest restoration are closing in some regions (especially in less-productive dry forests), where timber supply from both private and public lands is insufficient to keep them in business (chapter 8).

The NWFP represented a dramatic shift in social priorities, from commodity production toward biodiversity conservation, which has been part of a larger national process that has been called "green drift" (Klyza and Sousa 2010) in environmental policymaking in the United States. However, the idea that "working forest landscapes" or "anchor forests" (multi-ownership landscapes that support sustainable timber and biomass production) can provide conservation values, funding for restoration, and support for rural communities has also gained much traction in recent years (Charnley et al. 2014, Corrao and Andringa 2017). Nevertheless, working forest landscapes are subject to the same concerns that have been raised about the balance between conservation and incorporation of human needs—how to reconcile different world views and values. This tension can only be resolved through social processes including public engagement and collaborative efforts that take into account social, ecological, and economic considerations and legislative actions (chapter 9).

Trust and collaboration—
Trust among federal land management agencies and the public is key to restoration and landscape-scale management for multiple goals, but trust is often lacking and difficult to cultivate (chapter 9). Trust among interested parties is essential for developing adaptive management strategies that can nimbly and effectively respond to changing climate, species, disturbances, human values, and markets. Trust can be lost in many ways on federal lands, especially when local-level agreements or collaborative processes are overridden by national-level political decisions (Daniels and Walker 1995), or when local decisions are seen as circumventing federal laws or policies. Researchers and practitioners have characterized public trust as integral to effective natural resources decisionmaking and implementation (Davenport et al. 2007, Pretty and Ward 2001, Shindler and Cramer 1999, Wondolleck and Yaffee 2000). Meanwhile, distrust can be a precursor for natural resource conflict (Nie 2003). Trust and distrust are not inversely related, but rather, trust is multidimensional and can coexist with distrust. Moreover, trust is contextual (depending on the setting or issue) and dynamic (changing based on each encounter or experience) (Lewicki et al. 1998). Trust in

natural resource institutions stems from creating trust in both processes and outcomes, whereas interpersonal trust depends on promoting trusting relationships between the public and agency personnel. For natural resource agencies, some factors shown to constrain the development of trust include unclear communication, limited public involvement opportunities, historical resentments, conflicting values, lack of progress in meeting objectives, lack of community awareness, and high turnover of personnel (Davenport et al. 2007). Trust among conflicting parties in resource management can be elusive, but it can be positively influenced through transparency, having clear processes, stated objectives, clarity of roles, and commitment to engagement (see chapter 9). A desire to build or expand trust is an important motivator for collaboration and conflict resolution (Wondolleck and Yaffee 2000), but "common ground will be elusive in conflicts involving fundamental value differences" (Wondolleck 2009). Frequent turnover among local forest management staff has been cited as a constraint on productive collaborations, particularly within tribal communities (see chapter 11).

Current efforts to enhance trust and generate social learning around restoration and other efforts to meet NWFP and other ecological goals are focused on collaboration among multiple agencies, and stakeholders around projects at various scales, from the watershed level to entire landscapes (chapter 9). Collaboration is touted as a means to achieve ecological goals as well as social benefits, which include conflict resolution, trust, and improved decisionmaking (Wondolleck and Yaffee 2000). Many of these collaborations are occurring in the fire-prone regions of the Western United States, and they are supported by funding related to forest restoration and fire-risk reduction programs. The Collaborative Forest Landscape Restoration Program is having some success in encouraging stakeholders to work together to help plan and implement forest restoration treatments, particularly in dry forests at the landscape scale (Butler et al. 2015, Urgenson et al. 2017).

Two well-established collaboratives fall within or immediately adjacent to the NWFP area: the Deschutes Forest Collaborative in central Oregon and Tapash Forest Sustainable Collaborative in eastern Washington. The Western Klamath Restoration Partnership is another example that builds upon years of collaboration in northern California. In addition to large-scale collaboration, there has been a proliferation of community-based collaborative groups in the Plan area that are engaged in National Environmental Policy Act planning, stewardship contracting, and multiparty monitoring, on both sides of the Cascades (Davis et al. 2015a) and in northern California. Other types of collaboratives in the NWFP area have formed around specific resource concerns, such as California Fire-Safe Councils (Everett and Fuller 2011) and the U.S. Fire Learning Networks (Butler and Goldstein 2010).

Collaborative processes are viewed by natural resource agencies as an effective way to engage stakeholders, provide an opportunity for dialogue and deliberation, and build trust and foster relations among groups that historically have worked in opposition (Butler et al. 2015, Urgenson et al. 2017). For example, the threat of high-severity wildfire in forests of the NWFP area that historically burned frequently may be a "common enemy" that can enable environmental and timber groups to work together with the Forest Service to advance restoration projects on the ground (Urgenson et al. 2017). This approach has emerged in some places such as the Western Klamath Restoration Project on the Klamath and Six Rivers National Forests in northwestern California, where a broad partnership of interests, including tribal communities (chapter 11) are coalescing around landscape-level restoration efforts rooted in returning fire to the system. Efforts like this will potentially be a model in some forest types for making meaningful progress on large-scale forest restoration. Collaboration appears promising, and studies to date have identified positive outcomes associated with social interactional concepts such as trust, social capital, learning, and process (Davis et al. 2017). There has been less emphasis on evaluating outcomes such as improved social and ecological conditions. The tremendous investment in collaborative processes may yield enhanced trust and improved ecological and social conditions. Although the landscape collaborative program in the United States has provided better community engagement in decisionmaking, the long-term benefits of the program have not yet been documented (Butler et al. 2015).

Forest collaboratives have been designed to distinguish the roles of agency staff as decisionmakers who consider input from stakeholder collaborators, rather than devolving decisionmaking to local communities or coopting the process to meet predetermined objectives (Butler 2013) (fig. 12-5). In other words, collaboratives are not engaged in true power sharing, because ultimately the federal agency's line officer makes the final decision. Agency participation in collaborative efforts often takes place at an "arm's length" with agency participants playing the role of "technical advisor" and often not holding roles as voting members of collaborative groups (Butler 2013). In fact, agency (Forest Service) participants in collaborative groups are more often motivated by the need to build social trust, whereas non-agency participants are motivated by the desire to achieve social and ecological outcomes (Davis et al. 2017). Greater decentralization of authority has arisen through co-management or community-based natural resource management efforts, particularly outside of the United States; however, there have been relatively few examples of such efforts in which both resource utilization and biodiversity conservation goals have been achieved (Kellert et al. 2000). Strong legal foundations, institutions, and investments in monitoring may have contributed to these successes, as demonstrated in some examples of tribes and state governments conserving salmon in the Pacific Northwest (Kellert et al. 2000) (chapter 11).

Team Hymas



Figure 12-5—The Forest Service has built upon precedents such as the Handshake Agreement of 1932 by establishing areas that are specially managed to support resources important to tribes within ancestral lands that are now national forests. Many of these approaches embody principles of cooperative management that go beyond collaboration, yet maintain the agency's decisionmaking authority. An area in the Sawtooth Berry Fields was reserved in 1932 by a handshake agreement between Yakama Indian Chief William Yallup and Gifford Pinchot National Forest Supervisor J.R. Bruckart for use by Indians.

Tribal perspectives—

Chapter 11, which addresses American Indian tribal values, vividly describes the integrated social and ecological values of ecosystems in the NWFP area. Tribes value a vast diversity of animals and plants for utilitarian values that include the use of timber, as well as intangible cultural values. The perspectives held by native peoples of the Pacific Northwest, informed by thousands of years of place-based experience, help to internalize many of the tradeoffs between use and preservation, as well as provide a long-term, broad spatial perspective about system dynamics. For example, many tribes want to sustain the legacy of old trees and associated biological diversity while also promoting the productivity and diversity of early-successional communities, nonforest communities, and hardwood communities, and also generating timber and nontimber forest products (fig. 12-6). To achieve such multifaceted goals, some tribes have developed innovative forest management plans that many consider to be fulfilling the promise of the NWFP for addressing both social and ecological goals (e.g., Baker 2003, Hatcher et al. 2017, Johnson et al. 2008). Chapter 11 highlights the critical role of fire in dry and some moist forest types for maintaining desired ecosystem conditions.



Thomas Dunklin

Figure 12-6—Clarence Hostler gathering matsutake mushrooms under tanoak trees on the Six Rivers National Forest, near Orleans, California, November 2013.

What Have We Learned About the Components of the Northwest Forest Plan and Their Compatibilities?

Coarse- and fine-filter approaches to conservation— Both coarse- and fine-filter strategies for conserving biodiversity (Hunter 2005, Noss 1987) are a part of the NWFP and the 2012 planning rule, and the relative importance of the two appears to have shifted toward coarse-filter approaches under the current planning rule. Earlier scientific debate on the pros and cons of single species (e.g., fine-filter) vs. ecosystem (coarse-filter) approaches to management (Casazza et al. 2016, Simberloff 1998, White et al. 2013) have been replaced by recognition that these approaches are complementary, and both are a valuable part of conservation strategies (chapter 6) (DellaSala et al. 2015, Hunter 2005, Noon et al. 2009, Reilly and Spies 2015, Simberloff 1998, Tingley et al. 2014). Meso-filter approaches (e.g., habitat elements like snags and large old trees) also have been included in a conservation approach hierarchy (Hunter 2005). The challenge now, and the source of some debate, is to find an appropriate level or balance of coarse-, meso-, and fine-filter approaches (Schultz et al. 2013). If a plan is weighted too much toward single species, or a particular successional stage, the strategy may succeed "in protecting a few of the actors at the expense of the majority of the cast" (Tingley et al. 2014). If weighted too much to the overarching ecosystem goals, the "stage" may be conserved but the "star actors may not show up" (Tingley et al. 2014).

Although the NWFP was based on coarse- and fine-filter strategies, the "star actor," i.e., providing enough suitable habitat to sustain northern spotted owl populations, had a very large influence on the Plan. The approach of using the northern spotted owl as a surrogate or umbrella for old-forest ecosystems developed "unintentionally," driven mainly by the need to meet the mandates of the ESA and other federal policies (Meslow 1993). The emphasis on the northern spotted owl carried through the development of the Plan, despite the fact that the NWFP was intended to be an "ecosystem management" plan. The single-species focus had unintended consequences for other biodiversity conservation and for management of resilience to fire and climate change across an ecologically diverse region. For example, in dry forests within the range of the northern spotted owl, large portions of the forest conditions that support this species are the result of 100 or more years of fire exclusion that has altered forest ecosystems and their resilience to drought and fire (chapter 3). The emphasis on the fine-filter aspect of the Plan—focusing on the northern spotted owl—challenges the Plan's ability to meet other ecosystem goals under the 2012 planning rule, including ecosystem integrity and resilience to climate change and other stressors.

The congruence of coarse- and fine-filter goals and management approaches varies by disturbance regime (chapter 3). The most congruence between managing for historical range of variation or ecological resilience (i.e., a coarse-filter approach based on ecosystem dynamics) and for species that use dense older forests is in moist forests, where fire was infrequent (frequencies of 200 to >1,000 years), and forests would often grow for centuries without major disturbance. However, in regimes where fire was frequent or very frequent (less than 50 years) and landscapes were dominated by open-canopy forests, it is challenging to manage for both a coarse-filter approach based on landscape-scale ecological integrity, and the fine-filter approach of the NWFP based on maintaining or increasing the area of dense older forests. That is not to say that the two goals cannot be integrated in dry forests, only that the current NWFP strategy in dry forests does not guide management toward ecological integrity, which would emphasize management for the ecosystem-regulating role of fire.

Congruence between the two approaches (ecological integrity and coarse filter based on prioritizing dense, multilayered forests) is intermediate in moderately frequent to somewhat infrequent fire regimes (50 to 200 years) of the drier part of the moist forests where fire exclusion has had somewhat less effect. Here, historical fire regimes created a highly dynamic mosaic of high-, moderate-, and low-severity fire and higher diversity of early, mid- and late-successional stages than in the infrequent fire regime areas (fig. 12-2) (chapter 3). The relative abundances and spatial patterns of different forest states in the fire regimes of the NWFP area create inherently different biodiversity and ecosystem process conditions in the NWFP region. This

ecological and geographic variability means that weighting the plan too much in favor of a single successional stage (e.g., dense older forest) will not likely succeed in maintaining a broader set of goals related to ecological integrity or resilience to climate change and drought.

Northern spotted owl—
The northern spotted owl was listed as threatened under the ESA in 1990. Despite extensive efforts of federal agencies to protect northern spotted owls, conserve remaining habitat, and set aside areas as future habitat, populations have continued to decline (chapter 4). When the NWFP was implemented, northern spotted owl populations were predicted to continue declining for as long as 50 years owing to lingering impacts of previous habitat loss before populations would recover while sufficient area of younger forests grew into conditions that supported the owl (chapter 4). Unknown at the time were the effects that competitive pressure by barred owls would have on spotted owl populations, which have further compounded the challenges faced by northern spotted owls and accelerated their rate of population decline. Without the protections afforded by the NWFP and ESA, northern spotted owl populations would likely have experienced even steeper declines (chapter 4). Clearly, efforts to recover the subspecies are facing multiple challenges related to both habitat management and the barred owl invasion (USFWS 2011). With the continued population expansion of the barred owl within the range of spotted owls, the long-term prospects for spotted owls are not good and remain uncertain.

Although structural definitions of old-growth forests and northern spotted owl habitat are similar in many ways, they are not synonymous (Davis et al. 2016), and strategies to conserve them may differ (fig. 12-7). Additionally, northern spotted owls do not function as an umbrella for **all** or even most other species within the full range of vegetation conditions in the NWFP area (Burnett and Roberts 2015, Carroll et al. 2010), a fact that was recognized at the time of the development of the NWFP and which led to the development of the Aquatic Conservation Strategy (ACS) and additional species protections in the form of the Survey and Manage program (chapter 6) (Carroll 2010, Molina et al. 2006, Raphael and Marcot 1994, Thomas et al. 2006).

Marbled murrelet—
The marbled murrelet has habitat needs that overlap those of the northern spotted owl and that are compatible with many definitions of old-growth forests (fig. 12-7). Thus, plans and strategies that focus on northern spotted owls and old-growth forests are likely to benefit to a large degree the marbled murrelet within its range. However, there are some distinctive habitat differences between marbled murrelets and northern spotted owls that require special conservation considerations (chapter 5). The most obvious difference is that the murrelet is a diving seabird whose foraging habitat is in the coastal marine environment, thus marine conditions must be considered in murrelet habitat needs. Murrelet nesting habitat occurs in coastal forests that typically experienced infrequent, high-severity fire regimes. Within that environment, marbled murrelets preferentially select larger, more contiguous patches of forest throughout their range and tend to avoid edge habitats where risk of nest depredation is greater (Raphael et al. 2015) (chapter 5); therefore, unlike for the northern spotted owl, proximity of early-seral forest is undesirable because it can increase abundance of birds that prey on murrelet nests. Extensive efforts to restore fire-resilient open old-growth forests in the somewhat infrequent to moderately frequent, mixed-severity regimes in the range of the murrelet may reduce habitat quality by increasing the exposure of nests to predators.

Aquatic ecosystems—
Goals of aquatic ecosystems partly overlap with characteristics of old-growth forests, and with habitats for northern spotted owls and marbled murrelets (fig. 12-7). For example, large dead trees and shading from dense patches of streamside conifer forests contribute to habitat quality in stream channels and cool stream temperatures that support salmonid populations (chapter 7). In coastal areas, tall, multilayered conifer canopies can intercept fog and deliver more moisture to streams than can shorter dense forests, mitigating some of the effects of climate change (chapter 7). However, the absence of disturbance for extended periods can result in the decrease in suitable substrates, reducing habitat quality (Reeves et al. 1995) (chapter 7). Riparian and stream environments are also dependent on geomorphic and

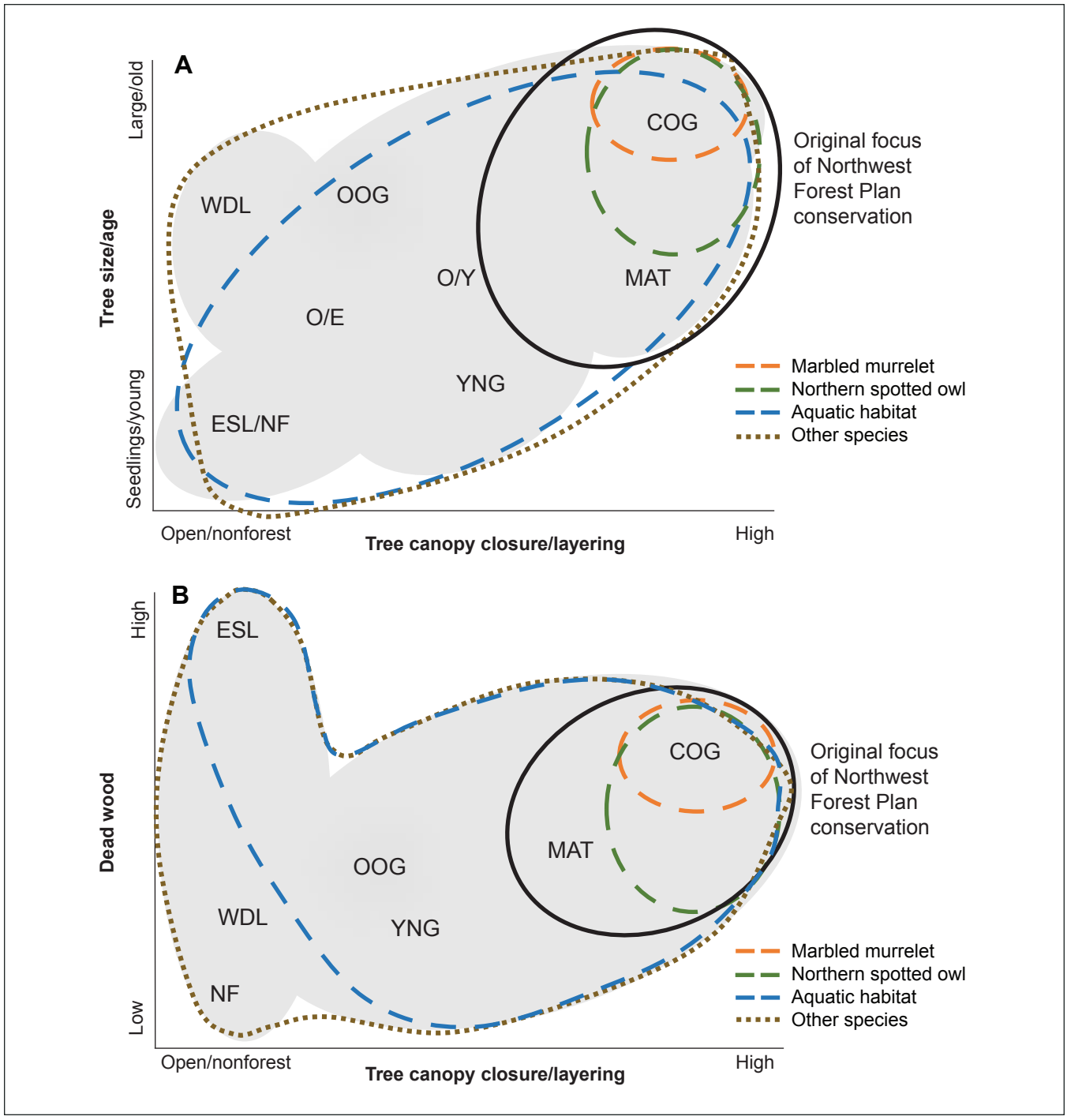


Figure 12-7—Distribution of habitat (dotted line ellipses) in relation to (A) tree canopy closure and tree size and (B) tree canopy closure and dead wood for different biodiversity components in the area of the Northwest Forest Plan. Northern spotted owl habitat refers to forests that are suitable for nesting and roosting. Gray ellipses refer to selected vegetation structure classes: COG—closed-canopy old growth; OOG—open-canopy old growth; YNG—young forest; MAT—mature forest; O/E—early successional with old live trees; O/Y—young forest with old trees; WDL—woodland; ESL/NF—early-seral/nonforest (shrubland, grassland). Conserving and restoring aquatic ecosystems requires a range of vegetation states, including older forest through time, but is not restricted to old growth (chapter 7). Many terrestrial species, including some tribal ecocultural resources, require early-successional and nonforest vegetation. Similarly, salmonid community assemblages differ between recently disturbed streams and undisturbed streams in old-growth forests.

hydrological disturbances that make many riparian areas a mosaic of older conifers, younger conifers, hardwoods, and shrubfields. This mosaic and the disturbance and successional dynamics that drive it means that the range of variation in riparian vegetation habitats may include conditions that do not qualify as old-growth forests (e.g., a lack of old conifer trees) or meet the habitat needs for northern spotted owls and marbled murrelets (fig. 12-8).

Fires burning through riparian areas and surrounding uplands may have reduced some stream qualities in the short term, but these events often improve conditions as large dead trees fall into streams, and as postfire floods, landslides, and debris torrents reorganize streams into more complex habitats (chapter 7) (Bisson et al. 2003). The absence of fire results in the lack of large influxes of sediments and wood, the basic building blocks of habitat for native fish, to the valley floors (Bisson et al. 2003, Flitcroft et al. 2016, Reeves et al. 1995) (chapter 7). Active management will continue to be used to reduce fuels and vegetation that make the forests susceptible to uncharacteristically large and severe wildfires. Such management often strives to prevent disturbances to streams, which can reduce or eliminate the occurrence of periodic disturbances that deliver sediment to the valley bottoms and stream channels. The lack of these disturbances and sediment can have serious unintended consequences to riparian-dependent wildlife and aquatic organisms (chapter 7).

Disturbances such as floods, landslides, and debris flows, which are essential for aquatic ecosystem functions, can be affected by roads that alter disturbance flow pathways and disconnect streams from uplands (Jones et al. 2000). These changes can reduce the resilience of these



Tom Spies

Figure 12-8—Mosaic of vegetation and substrate conditions along the North Fork of the Elk River, which occurs in an unlogged and largely unroaded watershed on the Rogue-Siskiyou National Forest in coastal Oregon.

ecosystems to these natural disturbance events. Decommissioning of roads can also improve passage for fish and other species and help reconnect streams and floodplains and improve water quality. Not all roads are the same, however, in terms of their ecological effects, and knowledge of how road networks are distributed relative to geomorphic processes can aid in the design of more effective road systems and restoration of watershed processes.

The potential of federal lands to contribute to the recovery of listed fish, particularly Pacific salmon, in many parts of the NWFP area is likely more limited than was recognized when the ACS was developed (chapter 7). The primary reason for this difference is that, in many situations, federal lands have a limited capacity to provide high-quality habitat for some of the listed fish. Federally managed lands are generally located in the middle to upper portions of watersheds, which tend to have steeper gradients and more confined valleys and floodplains, making them inherently less productive for some fish (Burnett et al. 2007, Lunetta et al. 1997, Reeves et al. 2016). Federal lands may, however, be major sources of wood, sediment (Reeves et al. 2016), and water (Brown and Froemke 2010, 2012) for downstream nonfederal lands, and will be important for the potential recovery of most populations. Nevertheless, their contribution to recovery may in many cases be insufficient without parallel contributions from nonfederal land ownerships elsewhere in the basin (Grantham et al. 2017).

Other species of late-successional and old-growth forest— The Survey and Manage program (chapter 6) identified and listed many fungi, lichens, bryophytes, invertebrates, and other species groups that were deemed to require specific surveying to help ensure their conservation under the NWFP. Although the NWFP protects 80 percent of the remaining old-growth forest in the region, this amount of old growth may represent only about 15 percent of the historical amounts of old growth that occurred in the moist forests across all lands in the NWFP area (chapter 3). The Survey and Manage program helped reduce the number of species on the list that were originally ranked as having low potential for persistence. The program also helped evaluate other species for potential addition to the lists and to make adjustments to surveys and site protection as needed for conservation of those species. Reduction in survey status or removal from the Survey and Manage species lists resulted from efforts to locate species during "predisturbance surveys" before harvests or other management activities. Since the 2006 synthesis (Haynes et al. 2006), no species have been added to the Survey and Manage species list; any additions would occur through a renewed annual species review process, and none was added the last three times the review process took place in 2001, 2002, and 2003.

The approach of the Survey and Manage program represented a fine-filter strategy applied to hundreds of species, which created a nearly impossible administrative and financial challenge to land management agencies (Molina 2006). This approach may not be consistent with the goal of having "a few species of special concern" under the new planning rule, although the rule also calls for creating lists of "species of conservation concern." At present, we recognize that alternative strategies to applying a fine-filter approach to large numbers of species include a meso-filter approach that is based on functional groups and habitat elements (chapter 6). As levels of intensive timber management from late-successional and old-growth forests continue to be low, as has been the case in recent years (fig. 12-9), and all such forests are excluded from timber management, the original motivation for the program—logging of unreserved older forest in the matrix (Molina et al. 2006)—would seem to have weakened. Most of the logging that has occurred under the NWFP appears to have been associated with restoration in plantations in moist forests and fuel reduction activities in dry fire-excluded late-successional and old-growth forests. The situation in dry forests raises the question of how to reconcile the goals of dense-forest species with those of ecological integrity and species that use more open fire-dependent forests? Fire exclusion has dramatically altered the habitats of both types of native species in these regimes (chapter 3) (Dodson et al. 2008; Keane et al. 2002, 2009); however, effects on biodiversity have received little empirical study in the NWFP area (Lehmkuhl et al. 2007), and broader evaluations of other dimensions of biodiversity (e.g., population genetics, food webs, and ecological functions) have generally not been made.

Forest carnivores, particularly those associated with old forest conditions, were not a primary focus of the original

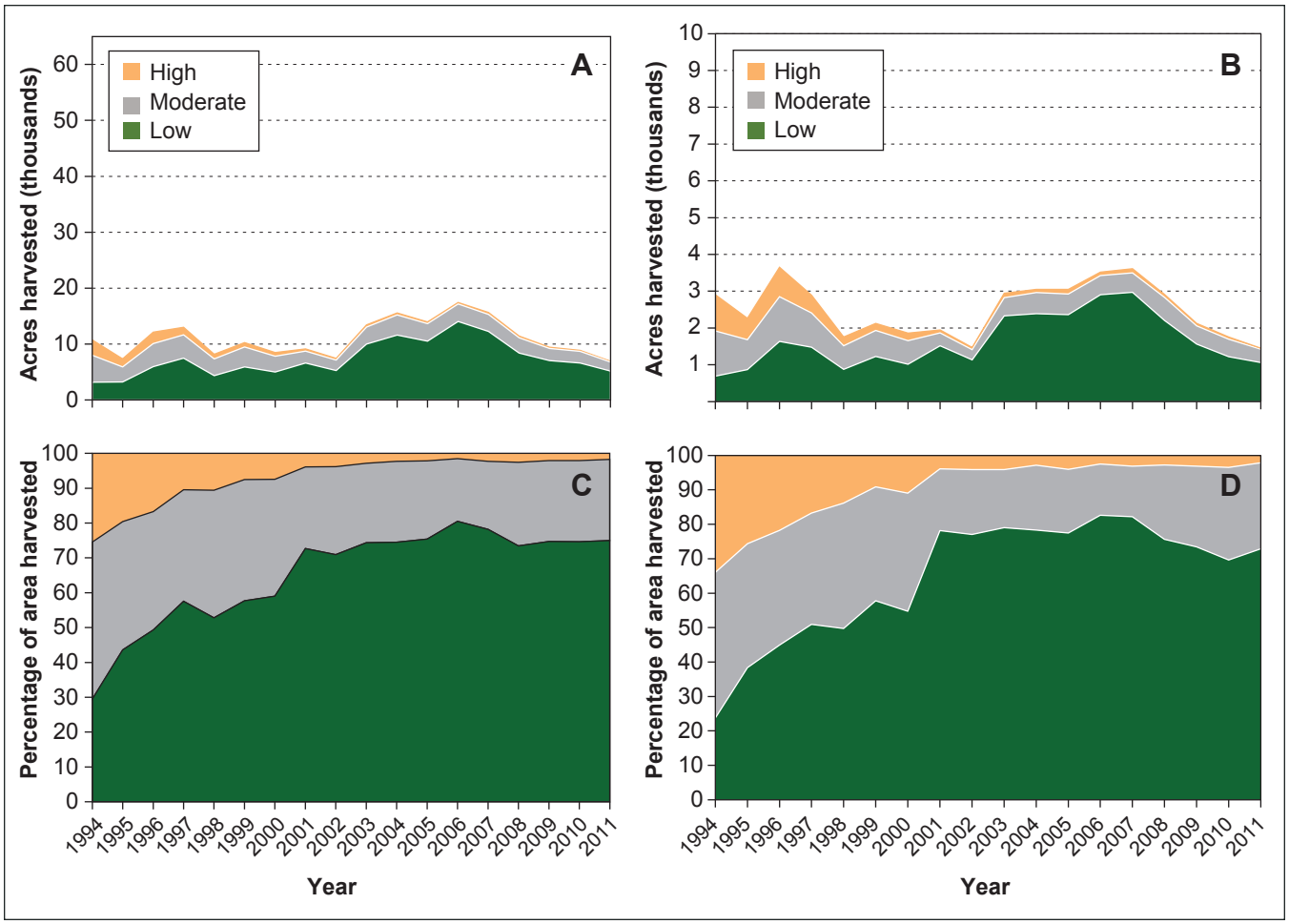


Figure 12-9—Trends in area of (A) old-growth structure index (OGSI) 80 harvested and (B) OGSI 200 harvested by intensity class (low, medium, and high) and percentage of harvest of (C) OGSI 80 and (D) OGSI 200 by intensity class on all federal lands between 1994 and 2011. OGSI is an index of stand structure based on live and dead tree characteristics that can be used to map the degree of old-growth development across a landscape as an alternative to classifications that simply define forests as old-growth or not. OGSI 80 and OGSI 200 represent the index at 80 and 200 years, respectively. Low = 0 to 33 percent loss of vegetation cover (all life forms); moderate = 33 to 66 percent loss, high = >66 percent loss. Note difference in scale between acres harvested in OGSI 80 and OGSI 200. Based on analysis of annual thematic mapper satellite imagery. Data are from Davis et al. 2015b. See Davis et al. 2015b for more information about OSGI.

NWFP. Fishers, marten, and lynx (*Lynx canadensis)* were addressed in the Forest Ecosystem Management Assessment Team report (FEMAT 1993) to a limited degree, with suggestions for conservation actions including closure to trapping of marten on federal land, evaluation of the effects of poisoning porcupines (*Erethizon dorsatum*), completion and implementation of habitat capability models for fishers and martens in California, and conducting more thorough surveys for both marten and fisher. Concern for the status of these species and for the wolverine (*Gulo gulo*) (which uses higher elevation, alpine, and subalpine habitats) has increased significantly in the past 23 years, and recent findings have identified new populations, new threats, and even new taxonomic species (see chapter 6). The Forest Service has increased measures to conserve habitat for these species, particularly in northwest California, where an extant population of fisher remains at risk. Increases in populations of carnivores would potentially have benefits to these ecosystems that cascade through trophic levels (Beschta and Ripple 2009), but the broader ecological effects of the further reduction or loss of these carnivores or their return in the NWFP area are not well understood.

Old-growth forest ecosystems—

The goal of the NWFP was to create "a functional, interactive, late-successional and old-growth ecosystem" (USDA and USDI 1994b: 6). As mentioned above, the congruence of the old-growth forest with the other conservation goals varies by location within the NWFP region, and by the definitions of old growth, and objectives. In general, the NWFP goals, which are yet to be fully achieved (e.g., in terms of area) (chapter 3) (Davis et al. 2015b), will provide a foundation for reaching many of the biodiversity goals of moist forests. But these goals are not consistent with managing for native biodiversity of dry forests and will not lead to long-term resilience of those ecosystems to wildfires and drought, or the broad diversity of successional and fuel patterns that support the natural fire regime (chapter 3) (fig. 12-7). Moreover, meeting NWFP goals has consequences for other components of forest biodiversity (e.g., early-seral species) not considered in the original NWFP (chapter 3) (Hessburg et al. 2016), especially those dependent on fire of different frequencies and severities, including aquatic ecosystems (chapter 7). In addition, new studies and increased recognition of the historical role of moderately frequent fire in drier parts of the moist forest zone, suggest that the Plan goal of conserving biodiversity associated with older forests may need to be revisited even in these relatively moist forests (chapter 3). Management for ecological integrity in this fire regime likely would seek to have a range of old-forest structural types (e.g., with and without tree age cohorts created by partial stand-replacement fires) and other successional conditions across landscapes. Fire in the moist forest zone sustains old forests and other successional stages, and contributes to hillslope processes (e.g., landslides and debris flows) that are fundamental to creating diverse and essential fish habitats (see below).

Reserves—

Late-successional forest and riparian reserves were major and controversial components of the NWFP. Based on the monitoring results and the original goals of the NWFP, the reserve strategy can be considered a success from the standpoint of halting old-growth logging (Davis et al. 2015b, 2016; Raphael et al. 2015). In addition, although late-successional and old-growth forests have continued to decline across the NWFP area owing to wildfire and logging (in the first few years of the NWFP), trends are in line with the Plan's expectation of losses (Davis et al. 2015b, 2016), but new concerns have emerged about fire and climate change. Similarly, clearcutting of riparian forests on federal lands has also come to a halt, contributing to improvements in watershed health (chapter 7).

Although trends in the amount of dense old growth are in line with expectations at a regional scale, there are reasons for concern (chapter 3). First, as mentioned above, maintaining or increasing current amounts of dense older forests in the dry forest zone is not consistent with managing for ecological integrity, as defined under the 2012 planning rule. Second, the Plan did not consider climate change effects that are already significant in dry forests (chapters 2 and 3). Managing for large areas of dense older forest (e.g., current LSR design) will not promote resilience to fire and drought, both of which are increasing under climate change. We explore these concerns in more depth below.

The standards and guidelines for the reserves specifically called out a need for active management to restore ecological diversity to plantations in both moist and dry forest types. Restoration activity has occurred in plantations in LSRs in moist forests, where innovative approaches to thinning have been developed and widely applied (chapter 3). The standards and guidelines for dry, fire-frequent forests (east of the Cascades and in the Oregon and California Klamath provinces) were different (USDA and USDI 1994b). There, the focus of management was on accelerating older forest development in younger forests and reducing risk of loss to high-severity fire in older forests. This concern was the impetus for designating some LSRs under the NWFP as "managed LSRs," in which silvicultural treatments were permitted to reduce risk of loss of stands around some northern spotted owl activity centers. However, the area of this type of LSR was small (about 102,000 ac) compared to the millions of acres of LSRs in dry forests (USDA and USDI 1994a). It is not clear how much restoration activity has actually occurred in older forests in LSR's or in riparian reserves in fire-prone forests because the implementation monitoring program was not continued. However, indications are that between

1993 and 2012 (20 years) less than 2 percent of older forest (OGSI 80) in the dry forest zone had treatments (Davis et al. 2015b) that would reduce total canopy cover, and surface and ladder fuels and risk of loss of older forest to large high-severity fires.

The issue of the need for restoration management also applies to riparian reserves, where relatively few restoration treatments have occurred (chapter 7). Primary reasons for the limited amount of restoration activity include (1) differing perspectives about the characterization of reference conditions, conservation, and management; (2) concerns about the potential effects of mechanical treatments on stream temperature and wood recruitment; (3) concerns about rare and little-known organisms (Reeves 2006); and (4) lack of trust in managers to undertake actions primarily for ecological benefits (chapter 7).

The LSR strategy of the NWFP was not designed or implemented in a way that promotes or restores ecological integrity or resilience in frequent or moderately frequent fire regimes (Spies et al. 2006, 2012). The initial identification of LSRs used a triage-based methodology that identified remaining concentrations of dense older forests after a history of fire suppression and aggressive harvesting. These areas were intended to provide habitat for northern spotted owls with adequate size and spacing of late-successional and old-growth forests to support the owl's recolonization. But this delineation was done without consideration for topographic and environmental setting and historical fire regimes of the forests. The standards and guidelines for silviculture in fire-prone forests (USDA and USDI 1994b) place many restrictions on restoration in dry forests in LSRs, and emphasize stand-level treatments to accelerate development of late-successional (i.e., dense multilayered) forests in younger forests that do not "degenerate suitable [northern spotted] owl habitat." They also suggest that treatment in older forests "may be considered" where they "will clearly result" in reduced risks. The standards and guidelines also lack a landscape perspective for fire and dry forest dynamics (e.g., see Hessburg et al. 2015, 2016; Stine et al. 2014) that is now understood to be critical to achieving a mix of ecological goals in fire-prone landscapes. The main reason for the low level of restoration in older forests in LSRs mentioned above may be lack of social license including the threat of litigation (Charnley et al. 2015), which occurs much more frequently in the Forest Service's Pacific Northwest Region (Oregon and Washington) than any other region in the country (Miner et al. 2014). Other reasons may include valuing multistoried forests, the burden of protocols under the Survey and Manage Program, lack of trust in managers (Olsen et al. 2012), the perception of some that mixed-conifer forests do not need restoration (Urgenson et al. 2017), or that reserves mean no-touch areas. Nevertheless, a review of the literature conducted for the 10-year socioeconomic monitoring report, combined with interviews held with forest managers and community members in four case-study locations across the NWFP area, found that most people (84 percent) believe that active forest management is needed to maintain forest health, as long as it does not include harvesting old-growth or clearcutting (Charnley and Donoghue 2006). Most interviewees did not believe that enough active management had occurred during the first decade of the Plan, expressing concerns about fire, insects, and disease.

If the broader goal of managers is to build resilience to fire and climate change across fire-prone landscapes, our evaluation of recent science indicates that the current NWFP conservation strategy (e.g., LSRs, matrix, survey and manage species) in fire-prone forests would not increase ecological integrity or resilience of terrestrial and aquatic ecosystems in these landscapes (chapter 3). This is because the current approaches focus on maintaining current levels or even increasing the amount of dense older forest. Although some treatments are permitted in older forests to reduce risk of loss of northern spotted owl habitat to wildfire, insects and disease, the current strategy does not appear to have a goal of landscape-level resilience to fire and climate change as indicated under the 2012 planning rule. Landscape-level strategies that restore fire as an ecological process based on topography, vegetation heterogeneity, successional dynamics, fire behavior, and other factors would be more in line with the latest scientific thinking (Cissel et al. 1999, Hessburg et al. 2015). Such an approach would also be more in line with the most recent northern spotted owl recovery plan (USFWS 2011, 2012),

which provides broad guidelines for navigating diverse ecological goals in these regions and states:

> …we recommend that dynamic, disturbance-prone forests of the eastern Cascades, California Cascades and Klamath Provinces should be actively managed in a way that reconciles the overlapping goals of spotted owl conservation, responding to climate change and restoring dry forest ecological structure, composition and processes, including wildfire and other disturbances… . Vegetation management of fire-prone forests can retain spotted owl habitat on the landscape by altering fire behavior and severity and, if carefully and strategically applied, it could be part of a larger disturbance management regime for landscapes that attempts to reintegrate the relationship between forest vegetation and disturbance regimes, while also anticipating likely shifts in future ecosystem processes due to climate… .

Modeling studies suggest that landscape approaches could reduce conflicts between restoration of fire-excluded ponderosa pine forests and conservation of the Mexican spotted owl (*Strix occidentalis lucida*) in Arizona (Prather et al. 2008); meanwhile, for the Sierra Nevada of California, Stephens et al. (2017) suggested that more comprehensive restoration treatments were needed to reduce wildfire risk to California spotted owls. Within the NWFP area, Spies et al. (2017) and Ager et al. (2017) modeled landscape scenarios in the eastern Cascade Range of Oregon and found that most of the existing area of spotted owl habitat could be maintained for 50 years despite the occurrence of wildfire (at recent rates) and restoration activities designed to create open, more resilient forests. Projected losses of owl habitat from wildfire were significantly more than from relatively limited restoration activities, but these losses were made up for by gains in habitat from growth and succession of small-diameter or relatively open forests. The value of examining both losses to fire and succession together has also been highlighted in a study by Reilly et al. (2017b), who found that in the eastern Cascades of Washington, Oregon, and California, losses of closed-canopy forests to high-severity fire between 1985 and 2010 were mostly balanced by gains from succession, though higher elevation forests showed significant declines and LSRs showed a small net decline in old, closed-canopy forests. These studies suggests that landscape-scale assessments of northern spotted owl habitat dynamics and fire need to take into account the age and structure distribution of all forests in a landscape and account for potential increases in northern owl habitat from succession. These trends may not hold in the future, however. Ager et al. (2017) found that if the rate of wildfire were to increase 2 to 3 times over current rates (e.g., moving from fire-return intervals of 250 years to 100 and 63 years, respectively), as some climate change studies suggest could happen (chapter 2), then the amount of northern spotted owl nesting and roosting habitat across the Deschutes National Forest could decrease by 25 to 40 percent in 30 years. Climate change projections also suggest decreased tree growth in the future (Restaino et al. 2016), which may affect the rate at which forest structure can regrow following fire.

The only explicit strategy that implements this vision for high-frequency fire forests is the Okanogan-Wenatchee National Forest Restoration Strategy (USDA FS 2012b). This strategy places a priority on restoring fire as an ecological process while maintaining adequate areas of spotted owl habitat that will shift across the landscape as fire and successional processes operate. Dynamic landscape approaches to reserves (as described above) or habitat conservation would have some similarities with recovery plans used for other listed bird species that find habitat in dynamic fire-prone landscapes (e.g., Kirkland's warbler and red-cockaded woodpecker). However, the habitats of these species are threatened by fire suppression rather than being promoted by it in the case of the northern spotted owl. The literature indicates that a dynamic landscape approach could still fit the broader definition of a "reserve" (e.g., exclusion of industrial level logging).

The current LSR-Matrix approach for dry zone forests does not appear to have or meet goals related to ecosystem integrity and management for resilience to climate change and fire. Managers may want to consider reevaluating and redesigning the NWFP conservation strategy for dry forests based on new scientific knowledge of climate change effects, knowledge of restoration strategies for dry forest landscapes (Hessburg et al. 2016), and the new 2012

planning rule, which emphasizes ecosystem approaches to conserving biodiversity. The science and experience with proposed changes to the NWFP conservation strategies indicate that design and implementation of such approaches would be facilitated by a transparent and inclusive decision-making processes (Olsen et al. 2012).

There may also be ecological benefits for alternative approaches for terrestrial and aquatic goals in dry parts of the moist zone forests (Cissel et al. 1999, Reeves et al. 1995). Management based on the historical disturbance regimes can benefit aquatic habitats (Reeves et al. 1995) in these fire regimes. For example, Cissel et al. (1999) found ecological benefits from changing the spatial distribution of reserves and standards and guidelines for LSRs and the matrix to better approximate the mixed-severity fire regime dynamics of the western Cascades of Oregon. Experiments were started in older stands to evaluate the management alternatives that included using timber harvest and prescribed fire as surrogates for partial stand-replacement fire. However, the effort was abandoned because stakeholders were skeptical of cutting older trees in the matrix lands, and they lacked trust in the agency to implement such approaches to achieve restoration goals (Olsen et al. 2012).

Thomas et al. (2006) suggested changing the NWFP allocations to protect all remaining older forest, whether located in reserves or the matrix. The U.S. Fish and Wildlife Service critical habitat designation recommends conserving spotted owl sites (recovery action 10) and protecting high-quality habitat (recovery action 32) whether it occurred in LSRs or the matrix (USFWS 2011, 2012). The science suggests that these actions will have ecological and social benefits, but there will be tradeoffs associated with timber production and needs of species that use other successional stages, although none of those species has been identified as threatened, endangered, or at risk because of conversion of their habitat to late-successional or old-growth forest conditions.

The NWFP was intended to adapt to new knowledge and changes in the environment (USDA and USDI 1994b), which is consistent with the idea that conservation should be adaptive and iterative (Carroll et. al. 2010, Walters 1986), but this goal has not been fully achieved for various reasons (see below). Although lines are drawn on maps, and standards and guidelines are developed for reserves and other land allocations, findings from conservation and ecosystem sciences suggest that these should not be seen as immutable. Ecological and social science research, adaptive management experiments at landscape scales, and monitoring are critical to learning and meeting the conservation goals of the NWFP. These tools are also critical to addressing other species and habitat concerns, along with other human values across the wide range of forest environments within the range of the northern spotted owl.

Socioeconomic goals—

The NWFP had four main socioeconomic goals (Charnley 2006b): (1) produce a predictable and sustainable level of timber and nontimber resources, (2) maintain the stability of local and regional economies on a predictable, long-term basis, (3) assist with long-term economic development and diversification in communities most affected by cutbacks in timber harvesting to minimize the adverse impacts associated with job loss (USDA and USDI 1994b), and (4) promote interagency collaboration and agency and citizen collaboration in forest management (Tuchmann et al. 1996). Regarding the first goal, 20 years of monitoring data indicate that the probable sale quantity of timber identified by the Plan was never met, meaning that timber sales have not been predictable or at the level envisioned (chapter 8). The probable sale quantity established by the Plan was based on a number of assumptions: (1) harvesting unreserved older forest in the matrix with novel silviculture would contribute roughly 90 percent of the volume during the first three to five decades of the Plan, (2) about half of the harvest during the first decade would come from forests more than 200 years old, and (3) the main harvest method would be regeneration harvest, using retention harvesting approaches (chapter 3) rather than clearcutting (Charnley 2006a). The area of regeneration harvest in OGSI 80 and OGSI 200 (fig. 12-9) was 1,000 to 2,000 ac annually in the first 5 years of the Plan, but it declined to near zero by 2000 and has stayed very low since then. Most of the harvest since 2000 has been in the form of thinning and partial canopy removal (figs. 12-9C and 12-9D), which generate less volume than intensive (regeneration) harvest. The early levels of regeneration harvest may have also included sales awarded before the Plan was implemented.

Appeals and litigation over timber sales that included large, older trees, and lack of public support for clearcutting and old-growth harvesting, were major factors preventing the agencies from cutting OGSI 80 and OGSI 200 to meet probable sale quantity (Charnley 2006a, Thomas et al. 2006). The need to protect more habitat for the northern spotted owl (given the threat from the barred owl), and the need to protect late-seral habitat for other species associated with older forest also limited harvest in mature and old-growth forests (chapter 6).

Thus, the main source of timber supply shifted from the intended ecological retention harvesting from older unreserved forests in the matrix in the first few years of the Plan to restoration thinning of smaller trees from plantations and forests less than 80 years old in LSRs and the matrix. Timber as a byproduct of thinning in plantations and restoration in dry older forests is compatible with several conservation goals as discussed above, and it is less controversial. However, such thinning in LSRs cannot be sustained, because in 10 to 20 years most of the plantations will have been thinned once, and most of them in the moist provinces will become too old (80 years) to be treated again according to the record of decision (USDA and USDI 1994b) (chapter 8). Likewise, the thinning and restoration of resilience in fire-prone older forests may not produce a sustainable supply of wood as restoration eventually shifts from mechanical removal of understory trees to using wildfire and prescribed fire to maintain resilience (Spies et al. 2007). The sale of wood products generated may not offset the costs of treatments.

One way that restoration might provide for more economically viable and longer term production of wood from federal lands is through the use of ecological forestry[8] approaches (Franklin and Johnson 2012) to create diverse early-successional habitats (chapter 3). Such habitats are created naturally by wildfires and other natural disturbance agents, but in most areas in the NWFP region these fires are suppressed to protect a variety of human and forest values (see chapter 3). Fire exclusion means that diverse early-seral conditions will develop from fire at lower rates than would have occurred historically. Restoration treatments (mechanical and prescribed fire) could be used to create diverse early-seral vegetation to help achieve biodiversity goals in contexts in which they do not conflict with goals for older forests. Such actions would typically remove some larger trees and could thereby provide timber for local economies, while helping to fund removal of small trees and biomass. Franklin and Johnson (2012) suggested that such actions be focused on existing plantations, outside of LSRs and in places where other late-successional goals are not compromised. This type of management could provide a niche for federal timber production that is something of a win-win for a diverse set of ecological and socioeconomic goals. In addition, the fact that federal timber cannot be exported could also provide a supply of timber for local mills that would not have to compete with export markets that are currently strong.

Ecological forestry principles could also be used in riparian forests to restore the diverse forest structure and composition that occurred under historical disturbance regimes. Since development of the ACS, there has been support in the scientific literature for discretion in setting site-specific activities (Kuglerová et al. 2014, Lee et al. 2004, Richardson et al. 2012), which can be economically beneficial (Tiwari et al. 2016). Greater flexibility in the management of riparian areas would depend on the "context" of the area of interest (Kondolf et al. 2006, Montgomery 2004) and the primary management objective for the specific area (Burnett and Miller 2007). However, development of such an approach has been limited because of the reliance on "off-the-shelf" and one-size-fits-all concepts and designs, rather than on an understanding of specific features and capabilities of the location of interest (Kondolf et al. 2003, Naiman et al. 2012). A mix of approaches could be undertaken, recognizing ecological and other goals such as timber harvest, especially if applied over larger spatial scales (Burnett and Miller 2007, Miller and Burnett 2008, Olson and Rugger 2007), and if consideration is given to the distribution of populations of concern and connectivity among them

[8] Ecological forestry uses silviculture based on knowledge of natural disturbance regimes and succession to manage forests for ecological goals or a mixture of ecological and socioeconomic goals. See chapter 3 for more information.

(Olson and Burnett 2009, Olson and Kluber 2014, Olson et al. 2007). Reeves et al. (2016) provided an example of such an approach and showed that small adjustments in the amount of area in which active management may occur results in substantial increases in wood production while still meeting ecological goals.

We now have a new understanding of the relations between federal forest management and community socioeconomic well-being (chapter 8) that helps us understand the ability of the NWFP to achieve goal 2 (maintain stability of local and regional economies). For example, private forests currently contribute the vast majority of logs processed by mills in the Plan area. Greater timber harvest on federal forests would increase the number of logs available to mills and likely create additional work opportunities for loggers, at least in the short term. Generally, increased federal harvest would reduce the prices paid for logs by mills, which in turn would make wood products producers better off, while making private landowners worse off because their logs will be worth less. However, there are exceptions where mills need to maintain capacity for processing but timber resources are in limited supply, including in forest regions with few mills. In these cases, increased federal harvests can help keep mills from closing, benefiting both wood products producers and private landowners.

Federal forest management can contribute to community well-being in other ways, through the production of a variety of commodities, natural amenity values, other ecosystem services, and employment opportunities, but it cannot ensure the stability of local communities and economies (chapter 8). Not only is community well-being a product of multiple influences at multiple scales; social systems, like ecological systems, are dynamic. Today a more relevant question for managers is how federal forest management can contribute to community sustainability and increase community resilience in the face of social and environmental change. Social, economic, and ecological sustainability are linked, and community resilience contributes to resilient social-ecological systems.

Regarding long-term economic development and diversification (socioeconomic goal 3), the Northwest Economic Adjustment Initiative and Jobs in the Woods programs had mixed results (see chapters 8 and 11). However, alternate formulas for payments to counties embedded in the Secure Rural Schools Act have made important economic contributions to NWFP-area counties and communities, although the future of these payments remains uncertain because the Secure Rural Schools Act expired in 2017.

As to the fourth goal—increased collaboration in forest management—the NWFP was perceived by many people who were interviewed as part of the socioeconomic monitoring program during the first decade of the Plan as moving forest management decisionmaking from the local to the regional level (Charnley 2006b). Since that time, however, the number of forest collaborative groups has grown in the Plan area (from 8 to 25), and the agencies have emphasized the importance of local-level collaboration as a way of doing business (chapter 9).

One way of reducing tradeoffs between the social and biodiversity goals of the NWFP would be to increase activities that contribute to community well-being while fostering the engagement of local communities in conservation. One clear example is to continue attempts to create quality jobs that employ local community residents in ecosystem restoration, research, monitoring, fire suppression, and other activities that contribute to forest stewardship (Charnley 2006a. Although such jobs are unlikely to replace the number of jobs lost over the past few decades in the wood products industry, and may not pay as well, they nevertheless can make a significant economic contribution in local communities and be a source of economic diversification.

Adaptive management and monitoring—
The NWFP was founded on the concept of adaptive management and learning, based on monitoring, adaptive management areas (AMAs), and other forms of reactive, active, and passive adaptive management. Adaptive management, social learning, and landscape-level experiments are key components of increasing social-ecological resilience (Tompkins and Adger 2004). Strategies to promote this type of resilience would include engagement of collaborative groups in management experiments, demonstration projects, and landscape restoration projects. Social networks

may be able to help spread adaptive forest management ideas and practices to deal with fire and climate change in the area of the NWFP (Fischer and Jasny 2017, Jacobs and Cramer 2017).

Bormann et al. (2006) provided an indepth evaluation of the adaptive management and regional monitoring program for the NWFP; here we highlight a few key findings. First, the adaptive management program as embodied in the AMAs was generally not successful, as funding for the AMAs declined after 1998, and adaptive management protocols were not widely integrated into agency missions at local scales. However, some successes in active adaptive management did occur. For example, the Central Cascades AMA was the location of efforts to develop and implement alternative landscape-scale approaches to meeting NWFP goals based on mixed-severity fire regimes (Cissel et al. 1999). Other AMAs may have implemented valuable experiments, but we could not find published or unpublished reports that document these actions. Four obstacles to adaptive management in the NWFP area were identified by Bormann et al. 2006: (1) perceived or real latitude to try different approaches on AMAs was too limited; (2) adaptive management was perceived as only a public participation process and there was a lack of consensus on implementing ideas on the ground; (3) precautionary, risk-averse approaches dominated and eventually overshadowed efforts to learn by doing, limiting the ability to increase understanding of systems; and (4) sufficient resources for management activities and the attending followup monitoring and research were not available. The lack of adaptive management activity and restoration activity in general may be a consequence of the fact that federal forest management increasingly takes place in a "vetocratic" setting in which non-Forest Service stakeholders reduce the decision space of managers and make the agency less autonomous than it was previously (Maier and Abrams 2018). According to Maier and Abrams (2018), this situation developed as a way for managers to reduce likelihood of litigation and to provide funding for nontimber objectives that is tied to collaboration.

It also should be noted that the Plan was not implemented as written, as managers responded to various social, economic, and administrative constraints. The implementation of the Plan has occurred through a more reactive or passive adaptive management approach based on resource limitations, social influences, and different interpretations at the ground level. The changes made in implementation of the NWFP include avoiding timber production from older forests in the matrix, ending of surveying for rare species, limited restoration activities in LSRs in fire-prone forests and riparian zones, and, of course, adaptive management itself. Because the NWFP has not been formally changed, it can be confusing to discuss the "Plan" without qualifying whether one is referring to the NWFP as written or as applied.

Obstacles to learning and adaptive management and maintaining an effective monitoring program are not easily overcome (Bormann et al. 2006). Some key principles for more effective adaptive management and monitoring include (1) engaging multi-agency regional executives in guiding learning, (2) involving regulatory agencies, (3) accommodating reasonable disagreement among stakeholders, (4) committing to quality, standardized record keeping by managers, (5) developing long-term funding strategies and maintaining a critical mass of agency expertise, (6) reinterpreting the burden of proof and the precautionary principle so that passive management is not the default and different management approaches can be applied, and (7) allowing for scientifically credible and relevant management experiments to take place even if they do not have total social license.

Although the adaptive management component of the NWFP fell quite short of expectations, the effectiveness monitoring program has been a relative success as evidenced by the valuable and insightful information obtained by 20 years of monitoring of old-growth forest, northern spotted owls, marbled murrelets, aquatic systems, socioeconomic conditions, and tribal relations. Monitoring moved the implementation of the Plan from opinion to evidence-based decisionmaking, helped institutionalize some adaptive management at regional scales, provided evidence of measurement error and variance in key Plan indicators, and demonstrated that agencies can work together effectively.

Plan Goals and Strategies in Relation to New Concerns

Since the development of the NWFP in the early 1990s, several new conservation concerns and issues have emerged that are directly related to meeting its original goals. Perhaps the most significant new concern is the spread of the invasive barred owl and its strong effect on populations of northern spotted owls, as noted above. Here we highlight two other major concerns: (1) the exclusion of wildfire as a keystone ecological process in many NWFP-area forest ecosystems and (2) the role of climate change in profoundly affecting species, wildfire size and severity, and reducing the resilience of dense forests that have accumulated in dry forest zones in the absence of fire.

Fire exclusion and successional diversity— We have already discussed at length the effects of fire exclusion on forest structure and composition and resilience of dry forests to fire and drought. Here we focus on a somewhat different aspect of that problem, the loss of other successional stages (which contribute to resilience) that are dependent on both low- and high-severity fire. Although not part of the original focus of conservation in the NWFP area, fire-dependent vegetation states are ecologically interdependent with dense old-growth forest in the sense that policies that promote these conditions (e.g., fire suppression) will reduce other vegetation types (Spies et al. 2006). Chapter 3 highlights the ecological significance of open, fire-dependent old-growth forests, including providing habitat for species such as the white-headed woodpecker (*Picoides albolarvatus*), a species that is on Bureau of Land Management (BLM) and Forest Service sensitive species lists for Oregon and Washington as a result of loss of open ponderosa pine forests to logging, and fire exclusion (Buchanan et al. 2003, Mellen-McLean et al. 2013).

Another fire-dependent state is early-successional vegetation (which can also arise from other disturbance agents). The lack of diverse early-successional ecosystems[9] has also become a major conservation concern (DellaSala et al. 2014, Franklin and Johnson 2012, Hessburg et al. 2016, Reilly and Spies 2015, Swanson et al. 2011). Many plant and animal species, including state-listed species, specialize in these early-successional conditions (Swanson et al. 2011, 2014). Some components of these ecosystems can persist for many decades (e.g., snags, dead wood, and open canopies) (Reilly and Spies 2015), but certain conditions within them (snag decay stages and environments for establishment of annual plants) are ephemeral, lasting just a few years. Whereas older forests can take centuries to develop, early-seral vegetation may be initiated in a few hours from a disturbance event and then further develop over many decades before tree canopy closure (chapter 3) (Raphael et al., in press). Maintaining occurrence of these episodic and dynamic ecosystems depends upon relatively frequent disturbance (of either natural or human origin) distributed across large landscapes (Reilly and Spies 2015). Clearcutting on private lands can produce open-canopy conditions that support some early-seral plant and animals species but lack dead and down wood, and active control of herbs, grasses, and shrubs to favor tree establishment and growth greatly limit the ecological diversity and function of clearcuts as surrogates for early-seral ecosystems (Spies et al. 2007, Swanson et al. 2011. Thus, early-successional stages, especially structurally and compositionally diverse ones, are important sources of biological diversity in the NWFP area, but their biodiversity has not been monitored or studied as well as later successional stages.

Despite increasing wildfire activity over the past 25 years, the occurrence of high-severity fire across all NWFP fire regimes has been low: rotations of 1,628 to 2,398 years in moist forest fire regimes and 333 to 690 years in dry forest fire regimes (chapter 3). Although area burned has increased with drought in the past 25 years in the area of the NWFP (chapter 2) (Reilly et al. 2017a), the amount of high-severity fire in moist forest may still be within the full historical range (over the past few thousand years) given the large amount of historical climate and fire variability in the region (chapter 3) (Reilly et al. 2017a, Walsh et al. 2015). However, when climate is taken into account, the recent (past 25 years) amount of high-severity fire and early-seral vegetation

[9] These are ecosystems dominated by shrubs, herbs, and grasses that have little or no tree canopy. They develop after stand-replacing disturbances (see chapter 3) and often contain dead legacies of the previous forest. Site conditions are such that they have the potential to develop into closed-canopy forests that can eventually develop into old-growth forests.

in moist forest regimes is probably low given that we are currently experiencing a warming climate. In addition, we know that more than 6,000 lightning-caused fires have been suppressed in moist forests during the past 20 years (chapter 3) within the Plan area. Thus, it is likely that the amount of early-seral post-wildfire vegetation within moist forest regimes is deficient relative to the historical range of variation, especially for the drier parts of the moist forests. In the historical very frequent fire regimes of the dry forests, large patches of high-severity fire that create early-successional vegetation would not have been common, and early-seral conditions would have occurred as a fine-grained mosaic within a matrix of open older forest (fig. 12-2).

Although early-seral post-wildfire vegetation on sites capable of growing forests appeared to be historically uncommon in most areas of high-frequency, low-severity fire (chapter 3), large patches of nonforest areas, such as savannas, grasslands, shrublands, and even some wetlands would have been relatively common and maintained by fire (chapter 3). These nonforest environments, which have been decreasing in many dry forest landscapes (Hessburg et al. 2007, Skinner 1995), are known to support unique biodiversity based on global-scale studies (Veldman et al. 2015) and may be more reduced than dense old-growth forests in the Pacific Northwest region. However, relatively little attention has been paid to the conservation needs of these nonforest and low-tree-density vegetation types in the literature from the NWFP region.

Climate change—

The effects of climate change have become a major concern and focus of research since the NWFP was developed and implemented (chapter 2). The effects and magnitude of climate change are still uncertain and will differ among species, ecosystem processes, and geographic area. In general, climate change adaptation goals can be congruent or compatible with many of the original goals and strategies of the NWFP, including large reserves in which commodity management and roads are excluded or minimized (Spies et al. 2010a). However, the degree of congruence varies with geography and spatial and temporal scale. For example, efforts to reduce tree density within forest stands and to increase resilience to drought conflict with development of dense, multilayer forest habitat at stand or patch scales (e.g., less than 100 ac). Early-seral vegetation created by wildfire or through restoration management could provide opportunity to plant or naturally establish more drought-resistant genotypes of native tree species (Spies et al. 2010a).

Addressing fish responses to climate change will be especially challenging because of the prominent role of ocean conditions and the importance of nonfederal lands for fish that move through large watersheds (chapter 7). The conservation and restoration strategies of the NWFP can benefit native fish, but there are inherent limits given the complex life histories of anadromous fish and ownership patterns. Populations of introduced or reintroduced fish species may expand under a warming climate and affect native species. Terrestrial and aquatic species responses to climate change will be variable, as mentioned above, or essentially unknown, as with most of the lichens, bryophytes, and invertebrates. We lack scientific assessments of which and how many species may respond negatively to climate change and how management strategies, including protection of climate refugia, silviculture to promote forest resilience, and possibly even managed relocation of organisms might benefit at-risk species (Schwartz et. al. 2012).

Mitigation efforts to limit releases of greenhouse gases and increase carbon storage can be compatible with many NWFP goals. For example, protecting and developing old-growth forests will contribute toward carbon sequestration in forest stands and landscapes (chapter 2). On the other hand, maximizing carbon sequestration will not be compatible with habitat creation for early-successional species (Kline et al. 2016), and may not be consistent with reducing stand density in dry forests to increase resilience to drought, fire, and insects. The tradeoffs between carbon emissions related to thinning and the carbon emissions that are avoided because forests are more resilient to fire- or climate-induced mortality (after thinning) will vary with scale of observation of fire, and forest type (McKinley et al. 2011, Ryan et al. 2010) (chapter 2). Carbon calculators are now available for exploring how different forest management and fire regimes might affect carbon sequestration in the forest ecosystem and in forest products (Zald et al. 2016).

Fire and climate change will also have an impact on some of the NWFP socioeconomic goals. For example, the ability of federal agencies to produce a predictable and sustainable supply of timber, recreation opportunities, nontimber resources such as mushrooms, and fish and game will be challenged as climate change alters weather, ecosystem productivity, and species distributions. Winter recreation associated with snow is already being affected by warmer winters, particularly at lower elevations. And, high-severity fire affects timber stocks and availability of nontimber forest products. As mentioned above, local job creation associated with forest restoration to increase resilience to wildfire, and for fire suppression, can support the Plan goal of contributing to economic development and diversification in communities (chapter 8).

Regional-Scale Issues and Challenges

The regional-scale concerns related to the NWFP goals include (1) the limited ability of federal forest lands to meet some conservation objectives, (2) the need for coordination among management units (e.g., national forests) to provide for population conservation goals and develop standards and guidelines that take regional ecological variability into account, (3) the connectivity and distribution of federal lands as they relate to the capacity of organisms to respond to changing climate and vegetation dynamics, and (4) coordination among ownerships to deal with cross-boundary and regional-scale issues such as wildfire and smoke, watershed processes, populations of sensitive species, and road systems.

The limits of federal lands to meet conservation goals for species and ecosystems were recognized at the time the NWFP was developed. These limits are particularly relevant to the marbled murrelet and the ACS. The marbled murrelet (as well as the northern spotted owl) occur in coastal forests in southwestern Washington, Oregon, and northern California, where the proportion of nonfederal forest land is relatively high (chapter 5). In these areas, continuing loss of marbled murrelet nesting habitat may eventually lead to a large gap in distribution of nesting habitat and thus a potential gap in the marbled murrelet distribution, leading to genetic isolation of northern and southern populations (Raphael et al. 2016). Habitat for six salmonid species is not well provided solely on federal lands because these species find high-quality habitat in lower reaches where most habitat is on private lands (chapter 7). With divergence of forest management intensity between federal and private forest lands, the landscapes may become more "black and white" with old forest on public lands and plantation forests on private lands (Spies et al. 2007). The implications of this landscape change in terms of edge effects and lack of diverse early- and mid-successional stages in the landscape as a whole are not well understood but may result in a reduction in regional biodiversity.

The need for coordination among management units (e.g., national forests, districts) for conservation of populations of listed species and recognition of variability in ecosystems and disturbance regimes was recognized in the development of the NWFP (USDA and USDI 1994b). The need for a regional-scale strategy still exists for the listed species (chapters 5, 4, and 7) (USFWS 2008). Recent science indicates that the regional-scale stratification of disturbance regimes into just two regimes (wet and dry) for purposes of standards and guidelines for management under the NWFP (USDA and USDI 1994b) was too simplistic because it lumped drier, more fire-frequent ecosystems in parts of western Oregon and Washington into one infrequent fire regime, and drier types into a single frequent regime with low- to moderate-severity fire (chapter 3).

Another limitation of the regional perspective that underlies the strategy and implementation of the NWFP is the lack of characterization of regional variability in socioeconomic conditions and aggregation of local-level variability at the human community scale, including community types and their contexts (e.g., proximity to and dependence on federal lands). For example, it might be possible to map regional or local variation in the availability of ecosystem services and well-being of communities (chapter 8) and community dependence on ecosystem services from federal lands. That information could be used to set priorities for meeting socioeconomic objectives and finding areas where restoration needs and socioeconomic needs line up.

The importance of regional connectivity of federal forest lands to provide for movements of plants and animals in response to climate change has been recognized (chapter 3) (Carroll et al. 2010, McRae et al. 2016, Spies et al. 2010a). The distribution of federal lands and reserves appears generally favorable for species that will likely need to move upslope and northward (DellaSala et al. 2016, Spies et al. 2010a). In general, areas occupied by federal lands have a relatively high topo-climatic diversity. Their permeability to movement of vagile vertebrates may be relatively high based on general land cover and use types (fig. 12-10), but it is not known how the distribution and condition of federal lands affects more sessile terrestrial organisms or benefits aquatic organisms.

Quantitative analysis of the effectiveness of the NWFP reserves and federal lands in providing for most species ecological processes, and other aspects of biodiversity under climate change, has been very limited. Carroll et al. (2010) found that "the current reserve system will face challenges conserving its current suite of species under future climates." They suggested that to address climate change for all species revisions to reserve networks designs may be needed. More research is needed to address this issue using updated models of climate, vegetation dynamics, species habitats, population dynamics, and landscape genetics.

The NWFP had a federal lands focus, but it is increasingly acknowledged that an all-lands or a multi-ownership perspective would be beneficial in dealing with issues such as fire, climate change, watersheds, and recovery of listed and at-risk species (chapters 4 and 7) (Bone et al. 2016; Charnley et al. 2017; Spies et al. 2007, 2010b). All-lands approaches can be promoted in several ways including prioritizing actions on federal lands based on conditions (context) in nearby nonfederal lands; providing funding mechanisms to support restoration on public, private, and tribal lands within shared landscapes; and coordinating management actions within watersheds and landscapes, where social and administrative processes enable such actions (Charnley et al. 2017, Knight and Landres 1998).

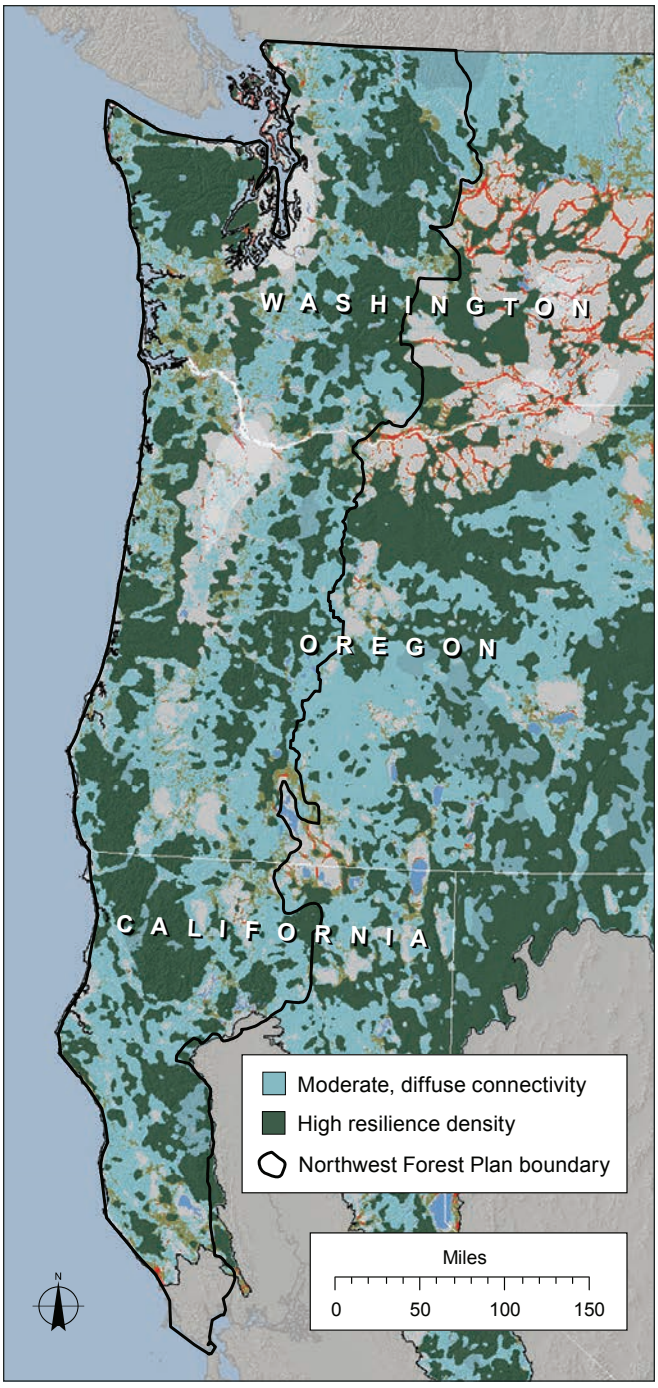


Figure 12-10—Regional connectivity and terrestrial resilience to climate change effects based on land cover types (connectivity) and topoclimatic conditions (resilience). Illustration adapted from McRae et al. 2016. Blue represents moderate levels of diffuse connectivity (movement is largely unrestricted); dark green represents areas of high resilience density (topoclimatic diversity).

Tradeoffs Associated With Restoration

Because the ecological goals of the NWFP are not necessarily consistent with addressing new conservation issues (e.g., the tension between managing for dense old-forest species versus open old-forest or early-seral species), it should not be a surprise that forest management activities for specific restoration goals would have variable effects across a spectrum of ecological and socioeconomic goals. We have touched on some of these in the previous section; here we summarize these in more detail in terms of specific management actions and how they might affect different management goals (table 12-1). Most of these effects are discussed in greater detail in other chapters of this report.

Variable-density thinning in plantations in moist and dry forests—
Variable-density thinning in plantations in uplands and riparian areas to immediately increase vegetation diversity and accelerate future development of large tree boles and crowns has a variety of effects across all fire regimes, as noted elsewhere in this document (chapters 3, 4, 5, and 7). Thinning can have immediate positive effects on several species; e.g., some lichens and bryophytes (chapter 6), and can accelerate growth of larger trees, but it reduces dead wood amounts compared to the unthinned state unless some thinned trees are left on the site. Studies of effects of variable-density thinning on invertebrates in western Washington indicate that the effects can be positive, especially in the short term, or negative depending on time since thinning, forest structure, and environment (Schowalter et al. 2003). Increasing spatial heterogeneity of the tree layer in plantations creates discontinuous fuel beds, increases structural and compositional diversity, and restores some of the heterogeneity that would have occurred in young post-wildfire stands. Similarly, thinning in riparian plantations can accelerate growth of large trees that occurred in variable densities near streams. Dense, uniform plantations are an altered ecosystem that may not serve as a good reference for management in riparian zones, many of which were historically a mosaic of older conifers, hardwoods, and shrub patches, especially near larger streams (chapter 7) (fig. 12-10). Thinning in plantations in riparian areas can also increase spatial heterogeneity of trees and shrubs and increase overall biotic community diversity, but reduce shading, which can increase stream temperatures (chapter 7). The role of thinning in increasing resilience of forests climate change has received only limited empirical study globally (chapter 2) (D'Amato et al. 2013, Elkin et al. 2015, Seidl et al. 2017).

Restoration of fire-excluded forests—
Thinning and prescribed fire to restore structure, composition, and resilience to older forests that historically experienced frequent fire can have numerous site- and landscape-level benefits (chapter 3; table 12-1) (Hessburg et al. 2016) that are both ecological and social. Restoration for ecological integrity and conservation of listed species can improve resilience to climate change and fire, and habitat for open old-growth species. Reducing fuel loads and increasing the heterogeneity of amounts and types of fuel can also reduce the potential extent of large patches of high-severity fire that result in losses of denser forest habitat. This practice can have adverse effects on northern spotted owls (but see North et al. [2017] for a different perspective) and some species such as fisher and marten that use dead wood as sites for foraging, resting, and denning. Little published science exists about blending the goals of conservation of northern spotted owl habitat and restoration of fire-dependent forest ecosystems at landscape scales. As experience with the Blue River plan (Cissel et al. 1999) indicates, this is both an ecological and socioeconomic problem that requires more research and evaluation through adaptive management and collaborative landscape efforts that try new approaches to the problem.

Restoration of fire-excluded forests also has social and economic benefits, particularly by reducing the risk of loss of property, structures, and lives to high-severity wildfire in the wildland-urban interface; by producing wood products and biomass that can be utilized; and by creating jobs. Tradeoffs include the impacts of smoke from prescribed fire treatments, the risk of escaped prescribed fire, and the cost of restoration treatments in areas where there are insufficient larger trees to provide revenue to offset restoration costs

Early-seral vegetation in moist forests—
Given that fire suppression has reduced the occurrence of early-seral vegetation, innovative silviculture including prescribed fire (such as ecological forestry) (Franklin et al. 2007), could be used to create large enough patches of early-seral conditions that are minimally influenced (e.g., by shade and belowground effects) from adjacent forest areas. To reduce impacts on existing older forests, such actions would be best focused on existing plantations, especially in matrix areas. Such activities would allow for establishment and persistence of early-successional species, including shrubs, and would contain large-diameter dead and some live trees that would be characteristic of higher severity post-wildfire environments (Franklin and Johnson 2012, Franklin et al. 2007) and that would serve as "legacy" elements of the previous stand conditions. The amount of retention of live trees would be variable to match variation in fire effects and site capacity at patch and landscape scales. Prescribed fire could be used in conjunction with this action to approximate some of effects of wildfire, especially on soil surface layers and understory plant and animal communities. This type of silviculture could meet diverse ecological and socioeconomic goals in both regimes of the moist forests and could target stands of any age because wildfire would occur across the full range of successional stages. However, when applied in older forests in the matrix, there are some tradeoffs (table 12-1). Large early-seral and nonforest patches do not provide habitat for late-successional species unless those species use early-successional and edge environments for some facet of their life history requirements. Cutting larger or older trees to create early-seral patches can provide larger volumes of wood for local mills, but it may not be socially acceptable because the focus and expectations of the Plan are currently to protect all remaining older forests from logging, and such harvest may conflict with the need to protect owl habitat given the threat of the barred owl. Recognizing these concerns, Franklin and Johnson (2012) have proposed that this type of habitat creation focus on stands less than 80 years old in the matrix. When applied in older plantations, this activity could produce significant amounts of wood and be a potential win-win for biodiversity and socioeconomic values. It should be noted, however, that there is little research and management experience in this type of restoration. In addition, using mechanical treatments to create early-successional habitat in younger forests and plantations will not provide large dead trees and other vegetation structures of late-successional and old-growth forests, nor some of the fire effects of naturally created early-successional vegetation (e.g., very large patches of early-seral ecosystems).

Post-wildfire management—
Post-wildfire management typically includes both salvage logging and planting of trees, which may or may not occur together in management. The ecological effects of postfire salvage logging can differ depending on treatment, fire severity, and biophysical setting (Peterson et al. 2009), but, in general, much existing research indicates that salvage logging does not have beneficial ecological effects on terrestrial or aquatic ecosystems (chapter 3) (table 12-3). However, there may be some exceptions to this rule. Peterson et al. (2015) and Hessburg et al. (2016) identified situations, e.g., concerns about lack of seed sources or reburns that maintain undesirable shrub fields, in which postfire wood removal might meet ecological goals. These include (1) fuel reduction treatments that reducs levels of large woody fuels derived from shade-tolerant species that may have accumulated under fire suppression and may pose a risk to soil fertility were the area to reburn; and (2) fuel treatments to reduce potential for high-severity reburns, and planting of trees to speed rate of forest succession where the potential for large semistable patches of shrubs is high and regeneration is lacking (Coppoletta et al. 2016, Dodson and Root 2013, Lauvaux et al. 2016, Meng et al. 2015); and (3) to reduce surface fuels that may impede establishment of trees. Sudden oak death also is likely contributing to ecologically novel configurations of dead trees and high fuels that may warrant interventions to reduce the potential for undesirable effects of reburn on soils.

Where timber salvage is conducted, reserving dense patches of snags adjacent to salvaged stands, rather than uniformly retaining small numbers of snags across a landscape, may be essential for sustaining populations of

Table 12-3—Summary of socioecological impacts of postfire management (salvage or planting)

Issue	Cons	Pros
Carbon	Carbon in dead trees may be slowly released as wood decays, and some may enter long-term pools in soils or in streams	Burned trees can be used as harvested wood products or can offset energy from more carbon-intensive energy sources when burned in biomass facilities; replanting of trees has potential to accelerate long-term carbon storage in areas where natural regeneration is poor
Wildlife habitat	Negative impacts on wildlife communities of removing biological "legacies" such as standing and down wood, particularly "early-successional" species that depend on standing snags	Planting of trees can accelerate forest development and reestablishment of late-successional habitat
Erosion	Mechanical activity can pose risks of increased erosion and runoff	Residual materials can be used as source of ground cover
Wood loading to streams	Removal can interrupt important process for storing sediments and reforming aquatic habitats	Reducing excessive wood loading could lessen risk of debris jams and downstream culvert/bridge failures
Fuel loading/fire hazard	Salvage can increase loading of fine fuels, leading to increased fire severity upon reburn; planted stands are highly vulnerable to fire for decades	Removal of excessive fuel load can moderate future fire severity and fire behavior in some contexts; can reduce risk to firefighters
Forest development	Salvage has potential to affect natural revegetation by trees and shrubs	Salvage plus replanting can accelerate return to forest conditions in areas
Economic returns	Investments in planted stands may be lost, especially as climatic conditions become less favorable to tree establishment and more favorable to frequent reburns, and they may also complicate use of fire at landscape scales	Timber from burned areas has high economic value, and returns can be used to offset costs of hazard reduction and long-term restoration; replanting can accelerate regrowth of timber-producing forests

early-successional species such as black-backed woodpecker (*Picoides arcticus*) (White et al. 2016b). Within riparian areas, more research is needed to understand variation in wood loading and whether there are loads that are detrimental to stream function, as well as the effects of riparian snag patches of different densities and sizes. As with terrestrial systems, retaining large snags that are likely to remain standing longer, and which are more likely to form persistent elements of aquatic ecosystems, could help to extend and moderate the input of large wood. Fuel hazard reduction might be achieved in part by removing smaller dead trees for biomass utilization or masticating them into ground cover where soils are severely burned and lack protective cover.

Roads—

The ecological effects of roads have been extensively reviewed in the literature (chapter 7) (Fahrig and Rytwinski 2009, Jones et al. 2000, Trombulak and Frissell 2000). The ecological effects of roads affect both terrestrial and aquatic ecosystems but are especially pronounced for aquatic ecosystems and species as the following list of impacts (chapter 7) indicates:

1. Accelerating erosion and increasing sediment loading.
2. Imposing barriers to the migration of aquatic organisms, including access to floodplains and off-channel habitats.
3. Increasing stream temperatures.
4. Causing changes in channel morphology.

5. Introducing exotic species.
6. Increasing harvest and poaching pressure.
7. Changing hillslope hydrology and resulting peak flows.

In the case of hydrological processes, the majority of roads have negligible effects, suggesting the need for a landscape approach to identity problem roads and prioritize road decommissioning. Hydrologically problematic roads constrain floodplains or have direct hydrologic connectivity with fish-bearing streams, but most streams in a network are not fish bearing.

On the other hand, roads are needed for forest restoration management, recreation, access to tribal resources and nontimber forest products, timber harvesting, and fire suppression. Roads are the primary way for people to access public lands, including private inholdings and historical tribal use areas. Decommissioning roads can help both reduce ecological impacts and reduce maintenance costs, which can be significant, but some road systems area still needed to meet other objectives. For example, roads provide access to forests and wilderness areas and are the pathways to special places to which people form strong attachments through repeated use. Roads also provide access to areas of the forest that generate incomes and provide jobs, as well as access to food and forage used by the public for everyday sustenance and survival. The costs associated with road decommissioning, which involves regrading, removing culverts, and revegetation, often make this option impractical. Roads that may be decommissioned by default through neglect may become safety hazards and sources of public conflict. Roads and road decommissioning are a prime example of tradeoffs associated with meeting competing goals for federal forests, including ecological restoration.

Uncertainty and Risk in Forest Planning and Management

Uncertainty and risk have long been a part of forest management and planning. However, as management objectives have shifted from commodity production to a broader range of ecological and social values from complex ecological and social systems (Moore and Conroy 2006, Rose and Chapman 2003), it has become even more crucial to consider ways of dealing with uncertainty, risk, and tradeoffs (Spies et al. 2010a). In addition, the threats from climate change, undesirable fire effects, invasive species, and social change introduce new drivers of forest ecosystems and management goals that are difficult to predict, control, and have variable effects on ecosystems and forest values. Uncertainty is defined as lack of information that falls on a continuum between absolute determinism and total ignorance (Walker et al. 2003). Risk can be defined as the probability (often not well known) of some, often undesirable, occurrence.

Uncertainty and risk pervade our understanding of the species, ecosystems, and social systems of the NWFP area. We know a great deal, of course, as the chapters of this synthesis demonstrate, but we also know that our knowledge in some key areas (e.g., persistence of the northern spotted owl and climate change effects, suitability of conditions other than old growth being favorable for fish and other aquatic organisms) is uncertain, and that the ability of management to achieve particular outcomes can be quite unsure. We also know that many forest values are at risk from influences that are both internal and external to the NWFP area and outside the control of forest managers (e.g., climate change and markets for wood products). Although concepts of uncertainty and risk are well known from the forest planning literature, the practical applications of this theory in decision support models and management are rare (Pasalodos-Tato et al. 2013). Managers and scientists may not be comfortable in admitting to the public that they are unsure of outcomes of proposed actions, but ignoring or not acknowledging uncertainties, risks, and tradeoffs can lead to poor decisions and bad planning alternatives (Pasalodos-Tato (2013). Although uncertainty is pervasive, it should not necessarily be seen as a reason for inaction (Dessai and Hulme 2004).

Several strategies exist for incorporating uncertainty and risk in forest management or biodiversity conservation. For example, Lindenmayer et al. (2000) suggested four approaches: (1) establish biodiversity priority areas (e.g., reserves) managed primarily for the conservation of biological diversity; (2) within production forests, apply

structure-based indicators including structural complexity, connectivity, and heterogeneity; (3) use multiple conservation strategies at multiple spatial scales, spreading out risk in wood-production forests; and (4) adopt an adaptive management approach to test the validity of structure-based indices of biological diversity by treating management practices as experiments. Lindenmayer et al. (2000) also noted that "a biodiversity priority area should not imply a lack of need for active management regimes inside that area…such as the restoration of burning regimes that may be required by taxa dependent on particular seral stages or vegetation mosaics." Others have also called for risk spreading by creating heterogeneous systems at stand and landscape scales (Hessburg et al. 2016, O'Hara and Ramage 2013). In general, adaptive management (including monitoring) is considered one of the most important strategies for dealing with uncertainty (e.g., acknowledging it and reducing it) in forest planning and management (Keenan 2015, Moore and Conroy 2006, USDA FS 2012). Although more passive learning approaches can be successful, active and intentional adaptive management is much more likely to reduce uncertainty (McCarthy and Possingham 2007). It should be reiterated that active adaptive management is expensive and time consuming, however, how often have scientists and managers looked back 10 years and lamented lack of action to pursue such work?

Other approaches for dealing with uncertainty, risk and tradeoffs involve governance systems and interactions with stakeholders in plan development and implementation. The goals here are not so much to reduce uncertainty but to incorporate it into decisionmaking and communications with the public to provide more flexibility to change plans and management approaches to meet new challenges. Strategies include communication by managers with communities (in the case of natural hazards like fire), collaboratives, partnerships with nongovernmental organizations and planning boards (Calkin et al. 2011), and engaging stakeholders to improve plans and decisionmaking (Bizikova and Krcmar 2015, Keenan 2015).

Scenario analysis can help deal with and communicate to stakeholders the reality that social-ecological system complexity and stochasticity preclude prediction and certainty about management effects. Scenario analysis was used to inform forest management and policy across 13 states in the Southeastern United States (Wear and Greis 2012). In scenario analysis, a range of plausible futures is identified, and the consequences of different management strategies are evaluated with models (e.g., discussion/decision support tools) or expert opinion. This approach can help identify management alternatives that are likely to fail under certain futures and other alternatives that may provide some level of desired outcomes across a range of possible futures. Such efforts may help communicate sources of uncertainty and the idea that plans need to be flexible and adaptive to respond to unexpected and undesirable future outcomes and tradeoffs. However, this approach is also very labor intensive, involving much up-front work before engaging with stakeholders to develop and evaluate scenarios (Bizikova and Krcmar 2015). The challenges are many, including designing the social process of stakeholder engagement and interactions of stakeholders with data and models.

Policy research indicates that in our current biophysical and socioeconomic environment, forest plans must not only meet ecological and socioeconomic goals but also be robust and adaptable over time (Walker et al. 2013). Walker et al. (2013) listed three key principles to guide development of robust forest plans:

- Explore a wide variety of relevant uncertainties including natural variability, external changes, and policy responses.
- Connect short-term targets with long-term goals.
- Commit to short-term actions that keep options open for the future.

The NWFP was designed to be adaptable (e.g., through research, monitoring, and adaptive management), but as we described above, the adaptive management component of the Plan and some of the monitoring components did not survive for various social and economic reasons. Nevertheless, the idea that forest plans should be adaptable and underpinned by adaptive management is still considered the best way forward in a dynamic and uncertain world.

Information Gaps, Research Needs, and Limitations

Monitoring—
We lack information about the amount, pattern, and type of restoration activities that have occurred in upland and riparian forests. Implementation monitoring has not occurred to a degree that we can know the rate, pattern, and type of restoration actions across the NWFP area. Effectiveness monitoring has provided useful information (e.g., about the northern spotted owl and marbled murrelet), but disinvestment in some aspects of NWFP monitoring over time (e.g., socioeconomic, implementation, Survey and Manage species) has limited the amount and usefulness of the monitoring information produced. Research is needed to determine how well the current set of monitoring metrics (e.g., old-growth index) address issues related to fire exclusion (e.g., metrics for open canopy, old-growth forests) and climate change, and how effectiveness monitoring can be better linked with validation monitoring and research. Research is also needed to better understand what is causing the monitoring trends observed and how to address undesirable trends.

Climate change—
Uncertainties about the effects of climate change on ecosystems, including fire activity, remain large owing to regional variability, complex interactions, and the coarse spatial scale of projections. Having large areas dedicated to promoting biodiversity and resilience to climate change is a foundational strategy, but we lack quantitative analyses of how different management approaches to biodiversity conservation affect vulnerability to climate change. Silviculture, including innovative tree planting strategies, may help improve resilience of forests to climate change impacts (e.g., large patches of high-severity fire). However, we lack information on how future vegetation communities might form and adapt to different climate scenarios to fully understand the interactions and tradeoffs. We also are challenged to estimate how vegetation might change across time and landscapes under different climate scenarios and the degree to which various measures of and objectives for "forest resilience" may be met. This lack of information also tempers our confidence in climate change adaptation strategies for human communities. Landscape-scale models and tools are needed to analyze scenarios and the effects of alternative landscape designs on species, ecosystems, and human communities. New monitoring field studies and assessment tools are needed to evaluate stress and mortality in forests at landscape scales and to test hypotheses from landscape simulation models that are a major source of information about possible future climate change effects.

Species and ecosystems—
We have virtually no published information about how northern spotted owls respond to wildfires, including increased frequency and severity of fire. We also need to improve our understanding about interactions between northern spotted owls and barred owls and their niche separations to help identify key areas for northern spotted owl conservation.

Effects of fire suppression (e.g., increased forest density and increased proportion of shade-tolerant trees) on ecosystem processes and population responses of plants and animals are not well understood in the area of the NWFP. More research has been conducted on how changes in stand structure and composition affect fire behavior than on how those altered forest conditions affect resilience to drought, biodiversity and ecosystem function, and successional trajectories.

Conservation and restoration strategies—
The limits (ecological and social) to restoring forest ecological integrity (per the 2012 planning rule) and resilience with fire (both prescribed and wildfire managed to achieve resource objectives) across diverse landscapes are not well understood. More fundamentally, we need research to help develop definitions and metrics of integrity and resilience so that managers can operationalize them at different scales. It is unclear if we have passed tipping points (e.g., crossed ecological and socioecological thresholds that make it difficult to restore desired conditions) in some landscapes that have been transformed by the cumulative effects of altered disturbance regimes and climate change. In addition, the ecological and social impacts of using surrogates (e.g., mechanical fuels treatments) for fire are also not well understood across the fire regimes of the NWFP area, especially

for biodiversity (most work has focused on forest structure and composition change, and fire behavior); previous work suggested that such surrogates may not serve well if they do not pay attention to biological legacies (Franklin et al. 2000). For example, research is needed to help us understand how well mechanical methods and prescribed fire create diverse early-successional habitat and functions, especially when applied to forest plantations. Although theory supports the hypothesis that biodiversity and ecosystem function associated with post-clearcutting environments and young plantations (e.g., on private lands) are different from post-wildfire or post-windthrow environments, no empirical research has been conducted.

Relatively little published research has focused on how well the regional NWFP strategy of reserves and associated management guidelines will meet biodiversity goals under changing climate and fire regimes. Research is needed to understand the ecological tradeoffs associated with alternative conservation land allocations and designs based on different ecological priorities (e.g., single species versus multiple species and processes).

Tradeoffs associated with alternative management strategies—
Although we have some knowledge of the tradeoffs associated with restoration and conservation strategies to meet ecological and socioeconomic goals, we generally lack knowledge of how those tradeoffs and interactions differ across the region, with scale, and over time. Reliance on precautionary approaches that avoid interventions may produce unintended outcomes because no action (e.g., not thinning a plantation or not using fire) may have undesirable effects (e.g., less biotic community diversity). In such cases, rigorous adaptive management approaches (e.g., learning by doing) are considered the best way to address uncertainty and complexity (Walters 1986). Research is needed for understanding the long-term and landscape-scale effects of restoration on terrestrial and aquatic species, biodiversity elements, and ecosystems and how these actions interact with social systems.

Scientific literature has been fairly clear in indicating that the benefits from salvage logging are generally economic, in the form of wood products, rather than ecological. However, we lack information on the long-term effects of salvage logging in burned forests whose density and composition have been heavily altered by fire exclusion before the fire. As the likelihood of reburn in immature forests increases with climate change, the rationale for such interventions may grow. In addition, we lack information on when and where planting might be needed and what kind of salvage might be appropriate, if at all, to facilitate recovery of desired forest conditions following large high-severity wildfire events. Finally, where salvage logging is conducted for economic objectives, we lack studies that quantify the ecological effects of salvage logging when managers seek to meet both ecological and economic goals through carefully planned approaches to post-wildfire management.

Social-ecological interactions and collaboration—
Although ecosystem services are now widely recognized as a framework for characterizing the range of values on federal forests, relatively little quantification and application have occurred on federal lands. Some ecosystem services, particularly cultural services such as support for spirituality or solitude, are important to many, but difficult to quantify or monetize. In addition, the potential for tradeoffs among ecosystem services (e.g., carbon sequestration, habitat for some species of wildlife, water supply, and regulation of fire), particularly across long periods and large areas, is not well understood. Research is needed to determine the best methods for quantifying ecosystem services, understanding tradeoffs, and using qualitative approaches in planning and management when quantification of ecosystem services does not exist. In addition, research is needed to determine the costs and benefits (e.g., providing more public support for investment in public lands) of using an ecosystem management framework compared to alternative ways of valuing and communicating the benefits that public lands provide.

Low income and minority populations protected by the 1994 Executive Order on Environmental Justice have increased throughout the NWFP area over the past two decades. This trend increases the need for ongoing research into how these populations relate to federal forests and are affected by their management. There is a fairly substantive literature about how minority populations relate to national forests in terms of work (e.g., forestry

services work, commercial NTFP harvesting). However, apart from recreation, little information is available about noneconomic relations between federal forests and low-income or minority populations (other than American Indians). Furthermore, research is only beginning to fill the gap in knowledge about the environmental justice implications of Forest Service management actions. For example, there remains a lack of information about how fire—managed, prescribed, or wild—and associated smoke affect low income and minority populations in the Plan area. There is also little information about how management activities that influence forest structure and composition affect uses and values of associated species that are valued by these populations.

The ability to undertake active management to achieve diverse ecological and socioeconomic goals is constrained by many factors, but limited public trust in federal managers is among the most critical, especially when it comes to working in forests with larger or older trees in frequent and moderately frequent fire regimes. Forest landscape collaboratives provide socioecological laboratories for studying how interactions among stakeholders and federal managers affect the ability to achieve restoration and resilience to fire and climate change. These collaboratives are relatively new, and study results are still unfolding. However, findings thus far suggest that collaboratives have not been a cure-all for resolving conflicts about public values and minimizing litigation, but in some cases participants have suggested that progress has been made on those measures (Schultz et al. 2012, Urgenson et al. 2017). A contributing factor to those trends has been social learning by agency staff in managing their roles (Butler 2013), adopting new approaches such as multiparty monitoring and use of stewardship contracts, as well as picking collaborative projects that have a high likelihood of success. More information is needed about public responses to restoration management efforts, especially in complex contexts such as mixed-severity fire regimes (Urgenson et al. 2017), and addressing socioecological objectives including timber production while applying nonindustrial, ecological forestry methods.

We lack understanding of how trust at different organizational scales (individual, district, forest, national) affects public understanding of and support for various types of active forest management strategies. Finally, although research suggests that the efforts required for collaboration can be taxing on both agency staff and community stakeholders (Urgenson et al. 2017), we lack information on appropriate forms and levels of support to bolster the capacity of both for long-term engagement in collaborative processes.

Conclusions and Management Considerations

The goals of the NWFP for federal forests occur within a diverse, dynamic, and complex social-ecological system that has changed in significant ways since the Plan was implemented. For example, the capacity of the agency and of the forest industry to conduct restoration efforts across landscapes has declined significantly; budgets for managing resources are greatly diminished, and wildfire suppression programs and budgets overshadow most other work. The contributions of public forest lands to ecosystem services (e.g., carbon sequestration and water supply) are now more widely recognized than ever, but the ecosystem services framework has only just begun to be implemented at forest and project scales and not been applied yet in assessments and forest plan revision (Deal et al. 2017b). A major change in biodiversity conservation policy has also occurred for the Forest Service in the form of the 2012 planning rule, which emphasizes whole ecosystem approaches to conservation in contrast to previous planning rules, which emphasized population viability of individual species, and which the agency considered "procedurally burdensome to implement" (Schultz et al. 2013). NWFP monitoring indicates that progress is being made toward meeting several of the original long-term goals, namely maintenance of vegetation conditions that support northern spotted owls and marbled murrelets, protecting dense old-growth forests, providing habitat for aquatic and riparian-associated organisms, and reducing the loss of mature and old forests to logging, (Bormann et al. 2006, DellaSala et al. 2015). Other goals, such as providing for a predictable timber harvest to support rural communities, road decommissioning, adaptation, learning through adaptive management (Bormann et al. 2006, Burns et al. 2011) (chapter 8), and effectiveness and

validation monitoring of old-forest species and biodiversity (chapter 6) have not been realized. Finally, Congressional legislation that provided alternative formulas for payments to counties most affected by the Plan to mitigate the financial impacts of reduced timber harvesting were realized in the short to mid term, but their long-term viability remains uncertain (Phillips 2006). In addition, new concerns have emerged that were not part of the original Plan, including a major threat to populations of the northern spotted owl from the native invasive barred owl, widespread loss of fire-dependent ecosystems including open old-growth, early-seral forests, nonforest communities, increased influence of exotic invasive species, and climate change.

Over the past 150 years, timber harvest, fire exclusion, and the loss of American Indian burning have profoundly changed both moist and dry forests of the NWFP area. Although the motivation for the Plan arose from halting 20th century clearcutting of old growth, moist forests and the associated loss of habitat for the spotted owl habitat and other old-growth forest species, the dry forests, which occupy about 43 percent of the Plan area, probably have experienced much more pervasive ecological changes as a result of human activity (chapter 3). Key changes in dry forests are loss of large, typically open grown, fire-resistant trees to logging; large increases in surface and canopy fuels and their connectivity; widespread shifts in seral-stage dominance; and changes in the patch size distributions of those seral stages. These changes have affected all species and processes; some in favorable ways (e.g., more habitat for dense, young multistory forest associates) and others in unfavorable ways (e.g., loss of open old-growth and early-seral forests, and associated resilience to fire and drought). Changes in moist forests are also significant, but they have been affected differently by logging and fire exclusion. Here, intensive timber harvest has been the primary impact on biodiversity by dramatically fragmenting and reducing the amount of closed-canopy old-growth forests, and habitats for the associated species. Fire exclusion in moist forests has also had important effects as well; historical fires created a highly diverse seral-stage patchwork with many patches of early- and mid-seral-aged forest. This patchwork is now highly altered.

Strategies are available to move these ecosystems, forests, landscapes, and species toward conditions that appear better aligned with policy direction (e.g., ecological integrity under the 2012 planning rule) and with current social values, both utilitarian (e.g., clean water, sustainable production of wood and special forest products, recreation) and intrinsic (nature for its own sake). The challenge will be to determine how to prioritize restoration goals and distribution actions across landscapes. Ecological history can be a valuable guide for restoration, but land managers, in reality, cannot restore ecosystems to any particular historical period or condition, or meet all management objectives in one area of land. However, they can learn from the historical conditions about the kinds of patterns and patch size distributions that offered the best hedging strategies against large wildfires and climate warming. Managers can take actions that increase the likelihood of retaining desired ecosystem services, species, intrinsic values of forests, and resilience to climate change and disturbances, even if their actions produce forest conditions that are altered relative to the pre-Euro-American period. Ecological and social history demonstrates that change is inherent in these forests, and we appear to be entering a new period of rapid change with uncertain outcomes.

Species and ecosystems—

The current outlook for widespread persistence of the northern spotted owls is not good. It appears unlikely that the northern spotted owl can persist without significant reduction in barred owl populations. However, without the implementation of the NWFP (e.g., if the pace of old-growth logging from the 1970s and 1980s had continued for 23 years), northern spotted owl populations would likely have already become moribund. Forests capable of supporting interconnected populations of northern spotted owls have increased or stayed relatively stable at the Plan scale. However, the rapid pace of climate and fire regime change suggests that recent trends may not continue. Continued success at conservation of northern spotted owls under the NWFP rests on understanding how to minimize the impacts of barred owls and on how to manage dry and moist zone forests in ways that increase rather than reduce future resilience to wildfire and climate change effects.

Under the original NWFP goals, an emphasis on multilayered old-growth forest conservation was critical given its relationship to owl habitat occurrence and its reduced abundance through harvesting. However, the 2012 planning rule emphasizes ecological integrity and resilience (ecosystem goals that were not part of the NWFP goals), and deemphasizes species viability approaches, a policy change that could significantly affect the conservation goals for biodiversity in the NWFP area. Managing to maintain current levels and patterns of multilayered old forests in dry forest zones (the NWFP goal) will not promote resilience of those dry forests to climate change, fire, and other stressors, and it will not restore more natural ecosystem dynamics. The new rule also has implications for supporting human communities, including tribes with protected treaty rights. Finally, the using ecological integrity as a guide means that conserving biodiversity in this region is more than just conserving dense old-growth forests—other stages are valuable, including open old growth, diverse early- and mid-successional post-wildfire vegetation, wetlands, oak-dominated forest patches and woodlands, and shrublands and grasslands.

Conservation and restoration—
The contribution of federal lands to the conservation and recovery of ESA-listed fish, northern spotted owl, and marbled murrelet populations continues to be essential, but it is likely insufficient to reach the comprehensive goals of the NWFP, or the newer goals of the 2012 planning rule. Contributions from streams and forests on nonfederal lands are important to achieving NWFP conservation goals, especially under climate change, which may shift species distributions. Transboundary collaborative efforts can help to address challenges such as restoration of fire regimes, and can enhance conservation efforts, especially when supported with innovative arrangements to share funding, resources, information, or liability, such as the Fire Learning Network and Training Exchange (TREX) program to support prescribed burning (fig. 12-11) (Goldstein and Butler 2010). These efforts have supported collaborations that have engaged tribes, including the Western Klamath Restoration Partnership (see chapter 11). Such approaches combined with other incentives can help to increase conservation on nonfederal lands, but further research to evaluate the impact of particular approaches within the NWFP context is needed.

Under current goals, a restoration strategy would likely combine efforts to ameliorate anthropogenic impacts, such as culverts that are likely to fail in priority watershed areas, as well as some dams and diversions used for irrigation water withdrawal, while also directing active management interventions, such as intensive thinning and use of fire, to restore degraded systems or at least increase their resilience to climate change and fire. Such active management may be particularly valuable in areas where both fire regimes and forest structure have been dramatically altered, because it can increase the likelihood that wildfires will help promote rather than erode resilience.

With congressional reserves, LSRs and riparian reserves, and administratively withdrawn areas occupying more than 80 percent of the Forest Service and BLM land base in the NWFP area, rates of additional fragmentation of older forests outside of reserves from management activities on federal lands will be very low. Landscape-level change will be dominated by succession of young and mid-seral forests, with increasing area of disturbance from wildfire. Concerns over connectivity among old-growth forests and LSRs have shifted to climate change effects and access to climate refugia, although the effects of past logging on connectivity remain. The widespread effects of roads on species and ecosystem processes also remain a conservation concern, especially those that constrain full floodplain functioning or contribute high sediment loads.

The small amount of logging within nonreserved northern spotted owl habitat or mature and old-growth forests over the past 15 years of NWFP implementation does not reflect the original provisions of the Plan as written, but it does mean that the major historical threat to biodiversity (commercial logging of old-growth forests) has been greatly reduced on federal lands. This outcome may have been largely a result of the Survey and Manage program and changes in the social acceptability of cutting old growth in the matrix. The lack of harvesting of older forests outside the reserves means that a major motivation for adding hundreds of species to the Survey and Manage lists no longer



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Figure 12-11—2015 Klamath River Training Exchange prescribed fire at night.

exists (i.e., the older forest habitat needs of the northern spotted owl do not necessarily cover the needs of other late-successional species). The Survey and Manage program was abolished under its economic weight and because fewer older forests were being logged than originally projected.

Fire suppression in some parts of the moist forest region has reduced the amount of structurally diverse early-seral vegetation over the past several decades. It also has likely reduced the diversity of older forest structural and composition conditions and landscape diversity in the drier parts of the moist forest zone. Managers could explore opportunities to restore fire effects in these systems through combinations of thinning, prescribed burning, and managing wildfires. In theory, such restoration actions could occur in the matrix in forests with old trees (e.g., greater than 80 years old), but the ecological and social acceptability of this activity are unknown. The issue is well suited for adaptive management studies. Possible win-win (wood production and biodiversity) alternatives are to create early-seral vegetation in plantations in the matrix or to do more active management in plantations in riparian reserves using principles of ecological forestry or restoration silviculture.

A major challenge to management for resilience to fire and climate change exists in landscapes that historically experienced frequent fire in northern California, southern Oregon, and the eastern Cascade Range of Oregon and Washington. Fires in these areas have been much less frequent in recent decades than historically. However, some recent fires have created larger patches of high-severity fire compared to the historical regime, likely as a result of fuel continuity. The denser forests and more shade-tolerant tree species have increased the area of northern spotted owl habitat despite losses to fire in recent years (chapter 3). Landscapes that include northern spotted owl habitat reserves, in

which little or no restoration or management to restore fire and successional dynamics occurs, likely will not provide for resilient forest ecosystems in the face of climate change and increasing fire. Prioritizing conservation of dense forest habitats that have increased in area with fire exclusion is not congruent with managing forests for ecological integrity or resilience to fire and climate change. Management strategies that promote resilience in fire-prone forest landscapes include restoring fire and the patchwork of open and closed-canopy forests, and tailoring these conditions to topography. Landscape-level strategies are needed to provide for dense forest conditions, where they would typically occur, and would be more likely to persist in the face of coming wildfires and a steadily warming climate. Finding and implementing these strategies is both a technical and social problem that is perhaps the most difficult challenge that land managers will face in the near term.

Scientists are becoming more aware that active management within reserves or redesign of reserves may be needed to conserve biodiversity in fire-frequent landscapes, where human activities have excluded fire and decreased resilience of forests to fire, insects, disease, and drought. Invasive species such as the barred owl and the sudden oak death pathogen are also motivators for interventions within reserves. Many studies suggest that conservation strategies (and reserve design) should periodically be reevaluated to determine how well they are meeting original and any new goals, and to make possible changes to standards and guidelines and reserve or habitat conservation area boundaries. This may include expanding reserves, increasing connectivity of reserves, shifting locations of reserves (e.g., for small reserves), or using dynamic landscape approaches based on historical disturbance regimes to guide management. Ideally, meeting ecosystem goals for reserves would require areas that are large enough to support fire and other key natural disturbance processes. Meeting both fine- and coarse-filter objectives in these dry forests requires landscape-scale approaches that can integrate potentially competing ecological goals over large areas and long time frames. Using disturbance-based management approaches to conservation is likely to require robust social engagement to increase transparency, public understanding, and trust in managers.

Social-ecological interactions—
For much of the 20th century, timber production was the central way in which federal forests in the NWFP area contributed to community socioeconomic well-being. Although timber production remains important today in some Plan-area communities, the economies of many communities have shifted or diversified their focus over the past two decades. Rural communities are not all alike, forest management policies affect different communities differently, and the social and economic bases of many traditionally forest-dependent communities have changed. Better understanding and consideration of the economic development trajectories of different communities will help to identify forest management activities that best contribute to their well-being. Providing for a diverse set of community benefits from public lands may be the best way to support communities in their efforts to diversify economically, and contribute to building community resilience to future changes in federal forest management and policy.

The forests of the NWFP area provide many ecosystems services to people of the region, in addition to wood. Carbon sequestration, water supply, and recreation are among some of the most valuable of these services. Several policies (table 12-2) direct the agency to use ecosystem management frameworks in planning. However, efforts to quantify and communicate ecosystem services and characterize the associated tradeoffs have yet to be applied in forest plan revision, and there is much to be learned about the most effective ways to use ecosystem services at project and forest scales, though some examples are beginning to appear.

The ability to sustain ecosystem services, conserve species, and promote ecosystem resilience to climate change and fire is highly dependent on socioeconomic factors. Declines in wood processing infrastructure throughout the Plan area have made vegetation management less economical and thus created a financial barrier to fully accomplishing forest restoration. With declining agency capacity, it will be difficult to impossible to maximize all of these objectives, and prioritization likely would be necessary for making progress or goals. Nongovernmental organizations (NGOs) and other government agencies may help manag-

ers meet their social and ecological goals. As outlined in chapter 11, an emphasis on engaging with tribes to promote tribal ecocultural resources, in part as a means of upholding the federal trust responsibility, would likely also align with other objectives for ecological restoration, while also providing additional tools and resources for accomplishing those objectives. Approaches such as disturbance-based management or "ecological forestry" may provide a way for federal forests to contribute to local timber-based economies, while providing early-successional habitat and vegetation dependent on fire that has been excluded by fire suppression to meet other management objectives.

Collaborative groups may be part of the solution to increasing trust and social license for forest management. However, collaborative processes are a relatively recent phenomenon and continued learning and adaptive management will be needed to determine the best way forward into an uncertain future. In addition, efforts to collaborate with neighboring landowners in planning and implementing management activities for landscape-level treatments can contribute to increasing forest resilience to climate change, invasive species, and wildfire, and to provide desired ecosystem services (e.g., owl and fish habitat) in mixed-ownership landscapes. Any strategies to promote resilience will need to recognize complex ecological and social system dynamics operating across land ownerships, as well as tensions that arise among competing goals, by adopting long-term and landscape-scale perspectives that include transparent accountability for all involved.

Major disturbances such as large wildfires can promote desired conditions and reestablish key ecosystem processes and species over larger areas of land than can be accomplished through prescribed fire or mechanical treatments. Institutional and social systems may need to evolve to take advantage of such opportunities; for example, by designing postfire management interventions based upon long-term restoration goals as well as more short-term considerations such as safety and timber salvage. Institutional capacity to take advantage of these opportunities is severely limited by an agency-wide decline in staffing, a decades-long history of budget cuts in non-wildfire areas, limited or absent infrastructure for wood processing of forest products, and monetary resource shifts toward fighting wildfires rather than restoring forests. Currently, nearly 55 to 60 percent of the total Forest Service budget each year goes to fighting fires, up from 17 percent 25 years ago.

The challenges ahead for public lands may well require new staffing and partnerships to get work done and new approaches to the problem of restoration. For example, managing natural ignitions for resource benefit may be a particularly cost-effective means of treating landscapes, but prior, large-scale, and widespread fire use planning is likely needed to make these methods effective.

Nevertheless, these opportunities for managing wildfire for resource benefit will pose difficult challenges for managers. Careful assessment of risk to life and property is paramount.

Tradeoffs associated with management—
All management choices involve some social and ecological tradeoffs among the goals of the NWFP. For example,

1. Variable-density thinning can accelerate the development of large live trees and habitat diversity that will benefit northern spotted owls and other species in the future, and produce wood products for the market. However, within the range of the murrelet, these actions may have a short-term negative impact on habitat quality, by creating diverse understory species that benefit murrelet predators, and can reduce amounts of dead wood that are habitat of other species.
2. Thinning and restoring fire to fire-dependent forests will increase habitat for species that use more open older forests and increase forest resilience to fire and drought while creating restoration jobs and reducing wildfire risk in the wildland-urban interface, but these actions can reduce habitat quality for species that use dense older forests.
3. Maintaining road systems to conduct landscape-scale restoration and support recreation will negatively affect some species and ecosystem processes. Many of the potential negative impacts can be ameliorated through landscape-scale planning and using best practices for decisionmaking.

In the long run, thinning in plantations less than 80 years old in LSRs to promote old-growth forest development will not sustain wood production for local communities (chapter 8). Future wood production depends on management in the matrix, where the NWFP allows timber harvest even from older forests. There is no new science that specifically indicates that timber management using retention silviculture in forests over 80 years old in the matrix is inconsistent with the original goals of the NWFP. In addition, partial stand-replacement fires were part of the historical dynamics of some older forests of the moist zone, and the ecological effects of excluding this type of disturbance are not well understood but might convey some resilience to climate and future fire. Given the social pressure to avoid logging of older trees, management in existing plantations for wood in the matrix would appear to be the most socially acceptable way to provide economic returns to support local communities while promoting biodiversity associated with early-seral ecosystems. In addition, it will be valuable to demonstrate how other ecosystems services (e.g., water, recreation) contribute to the mix of values of federal forests, and how effectively active management can meet ecological and social goals.

Monitoring and adaptive management— The long-term NWFP monitoring program and complementary research efforts of countless agency, university, tribal, and NGO scientists have provided managers, researchers, and stakeholders with an enormous amount of information on how species, ecosystems, and social systems in the NWFP area interact, and have changed over the past 23 years. There will be a need for sustained technical and scientific capacity in the management agencies to keep up with and help translate the large volumes of rapidly expanding scientific knowledge and tools into guidance for planning and management. However, the capacity of agencies to generate new knowledge has precipitously declined, threatening their ability to sustain the flow of information that can lead to more effective management and policies. Scientific uncertainties and debates will continue. Although they may be frustrating to managers, scientists, and the public, the debates also spur research that can lead to new understanding and discovery of knowledge that challenges assumptions, and improve our ability to set and meet attainable goals for forests and aquatic and riparian ecosystems. Further, areas of scientific uncertainty, highlighted by risk analysis, can be clearly articulated to managers and decisionmakers who engage in risk management. Development, evaluation, and testing of new, highly integrated conservation strategies are encouraged to deal with changing knowledge, new perspectives on fire regimes, climate change, invasive species, and recognition of tradeoffs in pursuing biodiversity goals (e.g., coarse filter and fine filter), and other ecological and social dimensions of forest ecosystem management. These forest and social systems will undoubtedly change in the next 23 years. Continuation of monitoring, research, public engagement, and adaptive management will help managers and society adapt to these changes and to meet old and new goals.

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Scientific and common names of plant species identified in this report

Scientific name	Common name
Abies amabilis (Douglas ex Loudon) Douglas ex Forbes	Pacific silver fir
Abies concolor (Gord. & Glend.) Lindl. ex Hildebr.	White fir
Abies grandis (Douglas ex D. Don) Lindl.	Grand fir
Abies lasiocarpa (Hook.) Nutt.	Subalpine pine
Abies magnifica A. Murray bis	California red fir
Abies procera Rehder	Noble fir
Acer circinatum Pursh	Vine maple
Acer macrophyllum Pursh	Bigleaf maple
Achlys triphylla (Sm.) DC.	Sweet after death
Adenocaulon bicolor Hook.	American trailplant
Alliaria petiolata (M. Bieb.) Cavara & Grande	Garlic mustard
Alnus rubra Bong.	Red alder
Amelanchier alnifolia (Nutt.) Nutt. ex M. Roem.	Saskatoon serviceberry
Anemone oregana A. Gray	Blue windflower
Apocynum cannabinum L.	Dogbane
Arbutus menziesii Pursh)	Madrone
Arceuthobium M. Bieb.	Dwarf mistletoe
Arceuthobium occidentale Engelm.	Gray pine dwarf mistletoe
Arceuthobium tsugense Rosendahl	Hemlock dwarf mistletoe
Arctostaphylos nevadensis A. Gray	Pinemat manzanita
Brachypodium sylvaticum (Huds.) P. Beauv.	False brome
Brodiaea coronaria (Salisb.) Engl.	Cluster-lilies
Callitropsis nootkatensis (D. Don) Oerst. ex D.P. Little	Alaska yellow-cedar
Calocedrus decurrens (Torr.) Florin	Incense cedar
Cannabis L.	Marijuana
Carex barbarae Dewey and *C. obnupta* L.H. Bailey	Sedges
Centaurea solstitialis L.	Yellow starthistle
Chamaecyparis lawsoniana (A. Murray bis) Parl.	Port Orford cedar
Chimaphila menziesii (R. Br. ex D. Don) Spreng.	Little prince's pine
Chimaphila umbellata (L.) W.P.C. Barton	Pipsissewa
Clematis vitalba L.	Old man's beard
Clintonia uniflora Menzies ex Schult. & Schult. f.) Kunth	Bride's bonnet
Coptis laciniata A. Gray	Oregon goldthread
Corylus cornuta Marshall var. *californica* (A. DC.) Sharp	California hazel
Cornus canadensis L.	Bunchberry dogwood
Cytisus scoparius (L.) Link	Scotch broom
Disporum hookeri (Torr.) G. Nicholson var. *hookeri*	Drops-of-gold
Fallopia japonica (Houtt.) Ronse Decr. var. *japonica*	Japanese knotweed
Gaultheria ovatifolia A. Gray	Western teaberry
Gaultheria shallon Pursh	Salal

Scientific name	Common name
Gentiana douglasiana Bong.	Swamp gentian
Geranium lucidum L.	Shining geranium
Geranium robertianum L.	Robert geranium
Goodyera oblongifolia Raf.	Western rattlesnake plantain
Hedera helix L.	English ivy
Heracleum mantegazzianum Sommier & Levier	Giant hogweed
Hesperocyparis sargentii (Jeps.) Bartel	Sargent's cypress
Hieracium aurantiacum L.	Orange hawkweed
Ilex aquifolium L.	English holly
Iris pseudacorus L.	Paleyellow iris
Juniperus occidentalis Hook.	Western juniper
Lamiastrum galeobdolon (L.) Ehrend. & Polatschek	Yellow archangel
Lilium occidentale Purdy	Western lily
Linnaea borealis L.	Twinflower
Lithocarpus densiflorus (Hook. & Arn.) Rehder	Tanoak
Lonicera hispidula Pursh	Honeysuckle
Lupinus albicaulis Douglas	Sickle-keeled lupine
Lycopodium clavatum L.	Running clubmoss
Lythrum salicaria L.	Purple loosestrife
Mahonia nervosa (Pursh) Nutt.	Cascade barberry
Malus fusca (Raf.) C.K. Schneid.	Pacific crabapple
Notholithocarpus densiflorus (Hook. & Arn.) P.S. Manos, C.H. Cannon, & S.H. Oh	Tanoak
Notholithocarpus densiflorus (Hook. & Arn.) P.S. Manos, C.H. Cannon, & S.H. Oh var. *echinoides* (R.Br. ter) P.S. Manos, C.H. Cannon & S.H. Oh	Shrub form of tanoak
Nuphar polysepala (Engelm.)	Yellow pond lily
Nymphoides peltata (S.G. Gmel.) Kuntze	Yellow floating heart
Osmorhiza chilensis Hook. & Arn.	Sweetcicely
Phalaris arundinacea L.	Reed canarygrass
Picea engelmannii Parry ex Engelm.	Engelmann spruce
Picea sitchensis (Bong.) Carrière	Sitka spruce
Pinus albicaulis Engelm.	Whitebark pine
Pinus attenuata Lemmon	Knobcone pine
Pinus contorta Douglas ex Loudon	Lodgepole pine
Pinus contorta Douglas ex Loudon var. *contorta*	Beach pine, shore pine
Pinus jeffreyi Balf.	Jeffrey pine
Pinus lambertiana Douglas	Sugar pine
Pinus monticola Douglas ex D. Don)	Western white pine
Pinus ponderosa Lawson & C. Lawson	Ponderosa pine
Populus trichocarpa L. ssp. *trichocarpa* (Torr. & A. Gray ex Hook) Brayshaw	Black cottonwood
Potamogeton crispus L.	Curly pondweed
Potentilla recta L.	Sulphur cinquefoil

Scientific name	Common name
Prunus emarginata (Douglas ex Hook. D. Dietr.)	Bitter cherry
Pseudotsuga menziesii (Mirb.) Franco	Douglas-fir
Pteridium aquilinum (L. Kuhn)	Brackenfern
Pueraria montana (Lour.) Merr. var. *lobata* (Willd.) Maesen & S.M. Almeida ex Sanjappa & Predeep	Kudzu
Pyrola asarifolia Sweet	American wintergreen
Quercus agrifolia Née var. *oxyadenia* (Torr.) J.T. Howell	Coastal live oak
Quercus berberidifolia Liebm.	Scrub oak
Quercus chrysolepis Liebm.	Canyon live oak
Quercus douglasii Hook. & Arn.	Blue oak
Quercus garryana Douglas ex hook.	Oregon white oak
Quercus kelloggi Newberry	California black oak
Quercus lobata Née	Valley oak
Rhamnus purshiana (DC.) A. Gray	Cascara
Rhododendron groenlandicum Oeder	Bog Labrador tea
Rhododendron macrophyllum D. Don ex G. Don	Pacific rhododendron
Ribes lacustre (Pers.) Poir.	Prickly currant
Rubus armeniacus Focke	Himalayan blackberry
Salix exigua Nutt.	Sandbar willow
Senecio bolanderi A. Gray	Bolander's ragwort
Sequoia sempervirens (Lamb. ex D. Don) Endl.	Redwood
Smilacina stellata (L.) Desf.	Starry false Solomon's seal
Synthyris reniformis (Douglas ex Benth.) Benth.	Snowqueen
Taxus brevifolia Nutt.	Pacific yew
Thuja plicata Donn ex D. Don	Western redcedar
Tiarella trifoliate L.	Threeleaf foamflower
Trapa natans L.	Water chestnut
Trillium ovatum Pursh	Pacific trillium
Tsuga heterophylla (Raf.) Sarg.	Western hemlock
Tsuga mertensiana (Bong.) Carrière	Mountain hemlock
Typha latifolia L.	Cattails
Umbellularia californica (Hook. & Arn.) Nutt.	California bay laurel
Vaccinium alaskaense Howell	Alaska blueberry
Vaccinium membranaceum Douglas ex Torr.	Thinleaf huckleberry, big huckleberry
Vaccinium ovatum Pursh	Evergreen huckleberry
Vaccinium oxycoccos L.	Small cranberry
Vaccinium parvifolium Sm.	Red huckleberry
Vancouveria hexandra (Hook.) C. Morren & Decne.	White insideout flower
Xerophyllum tenax (Pursh) Nutt.	Beargrass

Glossary

This glossary is provided to help readers understand various terms used in the Northwest Forest Plan (NWFP) science synthesis. Sources include the Forest Service Handbook (FSH), the Code of Federal Regulations (CFR), executive orders, the Federal Register (FR), and various scientific publications (see "Glossary Literature Cited"). The authors have added working definitions of terms used in the synthesis and its source materials, especially when formal definitions may be lacking or when they differ across sources.

active management—Direct interventions to achieve desired outcomes, which may include harvesting and planting of vegetation and the intentional use of fire, among other activities (Carey 2003).

adaptive capacity—The ability of ecosystems and social systems to respond to, cope with, or adapt to disturbances and stressors, including environmental change, to maintain options for future generations (FSH 1909.12.5).

adaptive management—A structured, cyclical process for planning and decisionmaking in the face of uncertainty and changing conditions with feedback from monitoring, which includes using the planning process to actively test assumptions, track relevant conditions over time, and measure management effectiveness (FSH 1909.12.5). Additionally, adaptive management includes iterative decisionmaking, through which results are evaluated and actions are adjusted based on what has been learned.

adaptive management area (AMA)—A portion of the federal land area within the NWFP area that was specifically allocated for scientific monitoring and research to explore new forestry methods and other activities related to meeting the goals and objectives of the Plan. Ten AMAs were established in the NWFP area, covering about 1.5 million ac (600 000 ha), or 6 percent of the planning area (Stankey et al. 2003).

alien species—Any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to a particular ecosystem (Executive Order 13112). The term is synonymous with exotic species, nonindigenous, and nonnative species (see also "invasive species").

allochthonous inputs—Material, specifically food resources, that originates from outside a stream, typically in the form of leaf litter.

amenity communities—Communities located near lands with high amenity values.

amenity migration—Movement of people based on the draw of natural or cultural amenities (Gosnell and Abrams 2011).

amenity value—A noncommodity or "unpriced" value of a place or environment, typically encompassing aesthetic, social, cultural, and recreational values.

ancestral lands (of American Indian tribes)—Lands that historically were inhabited by the ancestors of American Indian tribes.

annual species review—A procedure established under the NWFP in which panels of managers and biologists evaluate new scientific and monitoring information on species to potentially support the recommendation of changes in their conservation status.

Anthropocene—The current period (or geological epoch) in which humans have become a dominant influence on the Earth's climate and environment, generally dating from the period of rapid growth in industrialization, population, and global trade and transportation in the early 1800s (Steffen et al. 2007).

Aquatic Conservation Strategy (ACS) —A regional strategy applied to aquatic and riparian ecosystems across the area covered by the NWFP) (Espy and Babbit 1994) (see chapter 7 for more details).

at-risk species—Federally recognized threatened, endangered, proposed, and candidate species and species of conservation concern. These species are considered at risk of low viability as a result of changing environmental conditions or human-caused stressors.

best management practices (BMPs) (for water quality)—Methods, measures, or practices used to reduce or eliminate the introduction of pollutants and other detrimental impacts to water quality, including but not limited to structural and nonstructural controls and to operation and maintenance procedures.

biodiversity—In general, the variety of life forms and their processes and ecological functions, at all levels of biological organization from genes to populations, species, assemblages, communities, and ecosystems.

breeding inhibition—Prevention of reproduction in healthy adult individuals.

bryophytes—Mosses and liverworts.

canopy cover—The downward vertical projection from the outside profile of the canopy (crown) of a plant measured in percentage of land area covered.

carrying capacity—The maximum population size a specific environment can sustain.

ceded areas—Lands that particular tribes ceded to the United States government by treaties, which have been catalogued in the Library of Congress.

climate adaptation—Management actions to reduce vulnerabilities to climate change and related disturbances.

climate change—Changes in average weather conditions (including temperature, precipitation, and risk of certain types of severe weather events) that persist over multiple decades or longer, and that result from both natural factors and human activities such as increased emissions of greenhouse gases (U.S. Global Change Research Program 2017).

coarse filter—A conservation approach that focuses on conserving ecosystems, in contrast to a "fine filter" approach that focuses on conserving specific species. These two approaches are generally viewed as complementary, with fine-filtered strategies tailored to fit particular species that "fall through the pores" of the coarse filter (Hunter 2005). See also "mesofilter."

co-management—Two or more entities, each having legally established management responsibilities, working collaboratively to achieve mutually agreed upon, compatible objectives to protect, conserve, use, enhance, or restore natural and cultural resources (81 FR 4638).

collaborative management—Two or more entities working together to actively protect, conserve, use, enhance, or restore natural and cultural resources (81 FR 4638).

collaboration or collaborative process—A structured manner in which a collection of people with diverse interests share knowledge, ideas, and resources, while working together in an inclusive and cooperative manner toward a common purpose (FSH 1909.12.05).

community (plant and animal)—A naturally occurring assemblage of plant and animal species living within a defined area or habitat (36 CFR 219.19).

community forest—A general definition is forest land that is managed by local communities to provide local benefits (Teitelbaum et al. 2006). The federal government has specifically defined community forest as "forest land owned in fee simple by an eligible entity [local government, nonprofit organization, or federally recognized tribe] that provides public access and is managed to provide community benefits pursuant to a community forest plan" (36 CFR 230.2).

community of place or place-based community—A group of people who are bound together because of where they reside, work, visit, or otherwise spend a continuous portion of their time.

community resilience—The capacity of a community to return to its initial function and structure when initially altered under disturbance.

community resistance—The capacity of a community to withstand a disturbance without changing its function and structure.

composition—The biological elements within the various levels of biological organization, from genes and species to communities and ecosystems (FSM 2020).

congeneric—Organisms that belong to the same taxonomic genus, usually belonging to different species.

connectivity (of habitats)—Environmental conditions that exist at several spatial and temporal scales that provide landscape linkages that permit (a) the exchange of flow, sediments, and nutrients; (b) genetic interchange of genes among individuals between populations; and (c) the long-distance range shifts of species, such as in response to climate change (36 CFR 219.19).

consultation (tribal)—A formal government-to-government process that enables American Indian tribes and Alaska Native Corporations to provide meaningful, timely input, and, as appropriate, exchange views, information, and recommendations on proposed policies or actions that may affect their rights or interests prior to a decision. Consultation is a unique form of communication characterized by trust and respect (FSM 1509.05).

corticosterone—A steroid hormone produced by many species of animals, often as the result of stress.

cryptogam—An organism that reproduces by spores and that does not produce true flowers and seeds; includes fungi, algae, lichens, mosses, liverworts, and ferns.

cultural keystone species—A species that significantly shapes the cultural identity of a people, as reflected in diet, materials, medicine, or spiritual practice (Garibaldi and Turner 2004).

cultural services—A type of ecosystem service that includes the nonmaterial benefits that people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences (Sarukhán and Whyte 2005).

desired conditions—A description of specific social, economic, or ecological characteristics toward which management of the land and resources should be directed.

disturbance regime—A description of the characteristic types of disturbance on a given landscape; the frequency, severity, and size distribution of these characteristic disturbance types and their interactions (36 CFR 219.19).

disturbance—Any relatively discrete event in time that disrupts ecosystem, watershed, community, or species population structure or function, and that changes resources, substrate availability, or the physical environment (36 CFR 219.19).

dynamic reserves—A conservation approach in which protected areas are relocated following changes in environmental conditions, especially owing to disturbance.

early-seral vegetation—Vegetation conditions in the early stages of succession following an event that removes the forest canopy (e.g., timber harvest, wildfire, windstorm), on sites that are capable of developing a closed canopy (Swanson et al. 2014). A nonforest or "pre-forest" condition occurs first, followed by an "early-seral forest" as young shade-intolerant trees form a closed canopy.

ecocultural resources—Valued elements of the biophysical environment, including plants, fungi, wildlife, water, and places, and the social and cultural relationships of people with those elements.

ecological conditions—The biological and physical environment that can affect the diversity of plant and animal communities, the persistence of native species, invasibility, and productive capacity of ecological systems. Ecological conditions include habitat and other influences on species and the environment. Examples of ecological conditions include the abundance and distribution of aquatic and terrestrial habitats, connectivity, roads and other structural developments, human uses, and occurrence of other species (36 CFR 219.19).

ecological forestry—A ecosystem management approach designed to achieve multiple objectives that may include conservation goals and sustainable forest management and which emphasizes disturbance-based management and retention of "legacy" elements such as old trees and dead wood (Franklin et al. 2007).

ecological integrity—The quality or condition of an ecosystem when its dominant ecological characteristics (e.g., composition, structure, function, connectivity, and species composition and diversity) occur within the natural range of

variation and can withstand and recover from most perturbations imposed by natural environmental dynamics or human influence (36 CFR 219.19).

ecological keystone species—A species whose ecological functions have extensive and disproportionately large effects on ecosystems relative to its abundance (Power et al. 1996).

ecological sustainability—The capability of ecosystems to maintain ecological integrity (36 CFR 219.19).

economic sustainability—The capability of society to produce and consume or otherwise benefit from goods and services, including contributions to jobs and market and nonmarket benefits (36 CFR 219.19).

ecoregion—A geographic area containing distinctive ecological assemblages, topographic and climatic gradients, and historical land uses.

ecosystem—A spatially explicit, relatively homogeneous unit of the Earth that includes all interacting organisms and elements of the abiotic environment within its boundaries (36 CFR 219.19).

ecosystem diversity—The variety and relative extent of ecosystems (36 CFR 219.19).

ecosystem integrity—See "ecological integrity."

ecosystem management—Management across broad spatial and long temporal scales for a suite of goals, including maintaining populations of multiple species and ecosystem services.

ecosystem services—Benefits that people obtain from ecosystems (see also "provisioning services," "regulating services," "supporting services," and "cultural services").

ectomycorrhizal fungi—Fungal species that form symbiotic relationships with vascular plants through roots, typically aiding their uptake of nutrients. Although other mycorrhizal fungi penetrate their host's cell walls, ectomycorrhizal fungi do not.

endangered species—Any species or subspecies that the Secretary of the Interior or the Secretary of Commerce has deemed in danger of extinction throughout all or a significant portion of its range (16 U.S.C. Section 1532).

endemic—Native and restricted to a specific geographical area.

El Niño Southern Oscillation (ENSO)—A band of anomalously warm ocean water temperatures that occasionally develops off the western coast of South America and can cause climatic changes across the Pacific Ocean. The extremes of this climate pattern's oscillations cause extreme weather (such as floods and droughts) in many regions of the world.

environmental DNA (eDNA)—Genetic material (DNA) contained within small biological and tissue fragments that can be collected from aquatic, terrestrial, and even atmospheric environments, linked to an individual species, and used to indicate the presence of that species.

environmental justice populations—Groups of people who have low incomes or who identify themselves as African American, Asian or Pacific Islander, American Indian or Alaskan Native, or of Hispanic origin.

ephemeral stream—A stream that flows only in direct response to precipitation in the immediate locality (watershed or catchment basin), and whose channel is at all other times above the zone of saturation.

epicormic—Literally, "of a shoot or branch," this term implies growth from a previously dormant bud on the trunk or a limb of a tree.

epiphyte—A plant or plant ally (including mosses and lichens) that grows on the surface of another plant such as a tree, but is not a parasite.

even-aged stand—A stand of trees composed of a single age class (36 CFR 219.19).

fecundity—The reproductive rate of an organism or population.

federally recognized Indian tribe—An Indian tribe or Alaska Native Corporation, band, nation, pueblo, village, or community that the Secretary of the Interior acknowledges

to exist as an Indian tribe under the Federally Recognized Indian Tribe List Act of 1994, 25 U.S.C. 479a (36 CFR 219.19).

fine filter—A conservation approach that focuses on conserving individual species in contrast to a "coarse filter" approach that focuses on conserving ecosystems; these approaches are generally viewed as complementary with fine-filtered strategies tailored to fit particular species that "fall through the pores" of the coarse filter (Hunter 2005). See also "mesofilter."

fire-dependent vegetation types—A vegetative community that evolved with fire as a necessary contributor to its vitality and to the renewal of habitat for its member species.

fire exclusion—Curtailment of wildland fire because of deliberate suppression of ignitions, as well as unintentional effects of human activities such as intensive grazing that removes grasses and other fuels that carry fire (Keane et al. 2002).

fire intensity—The amount of energy or heat release during fire.

fire regime—A characterization of long-term patterns of fire in a given ecosystem over a specified and relatively long period of time, based on multiple attributes, including frequency, severity, extent, spatial complexity, and seasonality of fire occurrence.

fire regime, low frequency, high severity—A fire regime with long return intervals (>200 years) and high levels of vegetation mortality (e.g., ~70 percent basal area mortality in forested ecosystems), often occurring in large patches (>10,000 ac [4047 ha]) (see chapter 3 for more details).

fire regime, moderate frequency, mixed severity—A fire regime with moderate return intervals between 50 and 200 years and mixtures of low, moderate, and high severity; high-severity patches would have been common and frequently large (>1,000 ac [>405 ha]) (see chapter 3 for more details).

fire regime, very frequent, low severity—A fire regime with short return intervals (5 to 25 years) dominated by surface fires that result in low levels of vegetation mortality (e.g., <20 percent basal area mortality in forested ecosystems), with high-severity fire generally limited to small patches (<2.5 ac [1 ha]) (see chapter 3 for more details).

fire regime, frequent, mixed severity—A fire regime with return intervals between 15 and 50 years that burns with a mosaic of low-, moderate-, and high-severity patches (Perry et al. 2011) (see chapter 3 for more details).

fire rotation—Length of time expected for a specific amount of land to burn (some parts might burn more than once or some not at all) based upon the study of past fire records in a large landscape (Turner and Romme 1994).

fire severity—The magnitude of the effects of fire on ecosystem components, including vegetation or soils.

fire suppression—The human act of extinguishing wildfires (Keane et al. 2002).

floodplain restoration—Ecological restoration of a stream or river's floodplain, which may involve setback or removal of levees or other structural constraints.

focal species—A small set of species whose status is assumed to infer the integrity of the larger ecological system to which it belongs, and thus to provide meaningful information regarding the effectiveness of a resource management plan in maintaining or restoring the ecological conditions to maintain the broader diversity of plant and animal communities in the NWPF area. Focal species would be commonly selected on the basis of their functional role in ecosystems (36 CFR 219.19).

food web—Interconnecting chains between organisms in an ecological community based upon what they consume.

Forest Ecosystem Management Assessment Team (FEMAT)—An interdisciplinary team that included expert ecological and social scientists, analysts, and managers assembled in 1993 by President Bill Clinton to develop options for ecosystem management of federal forests within the range of the northern spotted owl (FEMAT 1993).

forest fragmentation—The patterns of dispersion and connectivity of nonhomogeneous forest cover (Riitters et al. 2002). See also "landscape fragmentation" and "habitat fragmentation" for specific meanings related to habitat loss and isolation.

frequency distribution—A depiction, often appearing in the form of a curve or graph, of the abundance of possible values of a variable. In this synthesis report, we speak of the frequency of wildfire patches of various sizes.

fuels (wildland)—Combustible material in wildland areas, including live and dead plant biomass such as trees, shrub, grass, leaves, litter, snags, and logs.

fuels management—Manipulation of wildland fuels through mechanical, chemical, biological, or manual means, or by fire, in support of land management objectives to control or mitigate the effects of future wildland fire.

function (ecological)—Ecological processes, such as energy flow; nutrient cycling and retention; soil development and retention; predation and herbivory; and natural disturbances such as wind, fire, and floods that sustain composition and structure (FSM 2020). See also "key ecological function."

future range of variation (FRV)—The natural fluctuation of pattern components of healthy ecosystems that might occur in the future, primarily affected by climate change, human infrastructure, invasive species, and other anticipated disturbances.

gaps (forest)—Small openings in a forest canopy that are naturally formed when one or a few canopy trees die (Yamamoto 2000).

genotype—The genetic makeup of an individual organism.

glucocorticoid—A class of steroid hormones produced by many species of animals, often as the result of stress.

goals (in land management plans)—Broad statements of intent, other than desired conditions, that do not include expected completion dates (36 CFR part 219.7(e)(2)).

guideline—A constraint on project and activity decision-making that allows for departure from its terms, so long as the purpose of the guideline is met (36 CFR section 219.15(d)(3)). Guidelines are established to help achieve or maintain a desired condition or conditions, to avoid or mitigate undesirable effects, or to meet applicable legal requirements.

habitat—An area with the environmental conditions and resources that are necessary for occupancy by a species and for individuals of that species to survive and reproduce.

habitat fragmentation—Discontinuity in the spatial distribution of resources and conditions present in an area at a given scale that affects occupancy, reproduction, and survival in a particular species (see "landscape fragmentation").

heterogeneity (forest)—Diversity, often applied to variation in forest structure within stands in two dimensions: horizontal (e.g., single trees, clumps of trees, and gaps of no trees), and vertical (e.g., vegetation at different heights from the forest floor to the top of the forest canopy), or across large landscapes (North et al. 2009).

hierarchy theory—A theory that describes ecosystems at multiple levels of organization (e.g., organisms, populations, and communities) in a nested hierarchy.

high-severity burn patch—A contiguous area of high-severity or stand-replacing fire.

historical range of variation (HRV)—Past fluctuation or range of conditions in the pattern of components of ecosystems over a specified period of time.

hybrid ecosystem—An ecosystem that has been modified from a historical state such that it has novel attributes while retaining some original characteristics (see "novel ecosystem").

hybrid—Offspring resulting from the breeding of two different species.

inbreeding depression—Reduced fitness in a population that occurs as the result of breeding between related individuals, leading to increased homogeneity and simplification of the gene pool.

in-channel restoration—Ecological restoration of the channel of a stream or river, often through placement of materials (rocks and wood) or other structural modifications.

individuals, clumps, and openings (ICO) method—A method that incorporates reference spatial pattern targets based upon individual trees, clumps of trees, and canopy openings into silvicultural prescriptions and tree-marking guidelines (Churchill et al. 2013).

Interagency Special Status and Sensitive Species Program (ISSSSP)—A federal agency program, established under the U.S. Forest Service Pacific Northwest Region and Bureau of Land Management Oregon/Washington state office. The ISSSSP superseded the Survey and Manage standards and guidelines under the NWFP and also addresses other species of conservation focus, coordinates development and revision of management recommendations and survey protocols, coordinates data management between the agencies, develops summaries of species biology, and conducts other tasks.

intermittent stream—A stream or reach of stream channel that flows, in its natural condition, only during certain times of the year or in several years, and is characterized by interspersed, permanent surface water areas containing aquatic flora and fauna adapted to the relatively harsh environmental conditions found in these types of environments.

invasive species—An alien species (or subspecies) whose deliberate, accidental, or self-introduction is likely to cause economic or environmental harm or harm to human health (Executive Order 13112).

key ecological function—The main behaviors performed by an organism that can influence environmental conditions or habitats of other species.

key watersheds—Watersheds that are expected to serve as refugia for aquatic organisms, particularly in the short term, for at-risk fish populations that have the greatest potential for restoration, or to provide sources of high-quality water.

land and resource management plan (Forest Service)—A document or set of documents that provides management direction for an administrative unit of the National Forest System (FSH 1909.12.5).

landform—A specific geomorphic feature on the surface of the Earth, such as a mountain, plateau, canyon, or valley.

landscape—A defined area irrespective of ownership or other artificial boundaries, such as a spatial mosaic of terrestrial and aquatic ecosystems, landforms, and plant communities, repeated in similar form throughout such a defined area (36 CFR 219.19).

landscape fragmentation—Breaking up of continuous habitats into patches as a result of human land use and thereby generating habitat loss, isolation, and edge effects (see "habitat fragmentation").

landscape genetics—An interdisciplinary field of study that combines population genetics and landscape ecology to explore how genetic relatedness among individuals and subpopulations of a species is influenced by landscape-level conditions.

landscape hierarchy—Organization of land areas based upon a hierarchy of nested geographic (i.e., different-sized) units, which provides a guide for defining the functional components of a system and how components at different scales are related to one another.

late-successional forest—Forests that have developed after long periods of time (typically at least 100 to 200 years) following major disturbances, and that contain a major component of shade-tolerant tree species that can regenerate beneath a canopy and eventually grow into the canopy in which small canopy gaps occur (see chapter 3 for more details). Note that FEMAT (1993) and the NWFP also applied this term to older (at least 80 years) forest types, including both old-growth and mature forests, regardless of the shade tolerance of the dominant tree species (e.g., 90-year-old forests dominated by Douglas-fir were termed late successional).

leading edge—The boundary of a species' range at which the population is geographically expanding through colonization of new sites.

legacy trees—Individual trees that survive a major disturbance and persist as components of early-seral stands (Franklin 1990).

legacies (biological)—Live trees, seed and seedling banks, remnant populations and individuals, snags, large soil aggregates, hyphal mats, logs, uprooted trees, and other biotic features that survive a major disturbance and persist as components of early-seral stands (Franklin 1990, Franklin et al. 2002).

lentic—Still-water environments, including lakes, ponds, and wet meadows.

longitudinal studies—Studies that include repeated observations on the same response variable over time.

lotic—Freshwater environments with running water, including rivers, streams, and springs.

low-income population—A community or a group of individuals living in geographic proximity to one another, or a set of individuals, such as migrant workers or American Indians, who meet the standards for low income and experience common conditions of environmental exposure or effect (CEQ 1997).

managing wildfire for resource objectives—Managing wildfires to promote multiple objectives such as reducing fire danger or restoring forest health and ecological processes rather than attempting full suppression. The terms "managed wildfire" or "resource objective wildfire" have also been used to describe such events (Long et al. 2017). However, fire managers note that many unplanned ignitions are managed using a combination of tactics, including direct suppression, indirect containment, monitoring of fire spread, and even accelerating fire spread, across their perimeters and over their full duration. Therefore, terms that separate "managed" wildfires from fully "suppressed" wildfires do not convey that complexity. (See "Use of wildland fire," which also includes prescribed burning).

matrix—Federal and other lands outside of specifically designated reserve areas, particularly the late-successional reserves under the NWFP, that are managed for timber production and other objectives.

mature forest—An older forest stage (>80 years) prior to old-growth in which trees begin attaining maximum heights and developing some characteristic, for example, 80 to 200 years in the case of old-growth Douglas-fir/western hemlock forests, often (but not always) including big trees (>50 cm diameter at breast height), establishment of late-seral species (i.e., shade-tolerant trees), and initiation of decadence in early species (i.e., shade-intolerant trees).

mesofilter—A conservation approach that "focuses on conserving critical elements of ecosystems that are important to many species, especially those likely to be overlooked by fine-filter approaches, such as invertebrates, fungi, and nonvascular plants" (Hunter 2005).

meta-analysis—A study that combines the results of multiple studies**.**

minority population—A readily identifiable group of people living in geographic proximity with a population that is at least 50 percent minority; or, an identifiable group that has a meaningfully greater minority population than the adjacent geographic areas, or may also be a geographically dispersed/transient set of individuals such as migrant workers or Americans Indians (CEQ 1997).

mitigation (climate change)—Efforts to reduce anthropogenic alteration of climate, in particular by increasing carbon sequestration.

monitoring—A systematic process of collecting information to track implementation (implementation monitoring), to evaluate effects of actions or changes in conditions or relationships (effectiveness monitoring), or to test underlying assumptions (validation monitoring) (see 36 CFR 219.19).

mosaic—The contiguous spatial arrangement of elements within an area. In regions, this is typically the upland vegetation patches, large urban areas, large bodies of water, and large areas of barren ground or rock. However, regional mosaics can also be described in terms of land ownership, habitat

patches, land use patches, or other elements. For landscapes, this is typically the spatial arrangement of landscape elements.

multiaged stands—Forest stands having two or more age classes of trees; this includes stands resulting from variable-retention silvicultural systems or other traditionally even-aged systems that leave residual or reserve (legacy) trees.

multiple use—The management of all the various renewable surface resources of the National Forest System so that they are used in the combination that will best meet the needs of the American people; making the most judicious use of the land for some or all of these resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in use to conform to changing needs and conditions; that some land will be used for less than all of the resources; and harmonious and coordinated management of the various resources, each with the other, without impairment of the productivity of the land, with consideration being given to the relative values of the various resources, and not necessarily the combination of uses that will give the greatest dollar return or the greatest unit output, consistent with the Multiple-Use Sustained-Yield Act of 1960 (16 U.S.C. 528–531) (36 CFR 219.19).

natal site—Location of birth.

native knowledge—A way of knowing or understanding the world, including traditional ecological, and social knowledge of the environment derived from multiple generations of indigenous peoples' interactions, observations, and experiences with their ecological systems. This knowledge is accumulated over successive generations and is expressed through oral traditions, ceremonies, stories, dances, songs, art, and other means within a cultural context (36 CFR 219.19).

native species—A species historically or currently present in a particular ecosystem as a result of natural migratory or evolutionary processes and not as a result of an accidental or deliberate introduction or invasion into that ecosystem (see 36 CFR 219.19).

natural range of variation (NRV)—The variation of ecological characteristics and processes over specified scales of time and space that are appropriate for a given management application (FSH 1909.12.5).

nested hierarchy—The name given to the hierarchical structure of groups within groups used to classify organisms.

nontimber forest products (also known as "special forest products")—Various products from forests that do not include logs from trees but do include bark, berries, boughs, bryophytes, bulbs, burls, Christmas trees, cones, ferns, firewood, forbs, fungi (including mushrooms), grasses, mosses, nuts, pine straw, roots, sedges, seeds, transplants, tree sap, wildflowers, fence material, mine props, posts and poles, shingle and shake bolts, and rails (36 CFR part 223 Subpart G).

novel ecosystem—An ecosystem that has experienced large and potentially irreversibly modifications to abiotic conditions or biotic composition in ways that result in a composition of species, ecological communities, and functions that have never before existed, and that depart from historical analogs (Hobbs et al. 2009). See "hybrid ecosystem" for comparison.

old-growth forest—A forest distinguished by old trees (>200 years) and related structural attributes that often (but not always) include large trees, high biomass of dead wood (i.e., snags, down coarse wood), multiple canopy layers, distinctive species composition and functions, and vertical and horizontal diversity in the tree canopy (see chapter 3). In dry, fire-frequent forests, old growth is characterized by large, old fire-resistant trees and relatively open stands without canopy layering.

palustrine—Inland, nontidal wetlands that may be permanently or temporarily flooded and are characterized by the presence of emergent vegetation such as swamps, marshes, vernal pools, and lakeshores.

passive management—A management approach in which natural processes are allowed to occur without human intervention to reach desired outcomes.

patch—A relatively small area with similar environmental conditions, such as vegetative structure and composition. Sometimes used interchangeably with vegetation or forest stand.

Pacific Decadal Oscillation (PDO)—A recurring (approximately decadal-scale) pattern of ocean-atmosphere

—a stream or reach of a channel that flows continuously or nearly so throughout the year and whose upper surface is generally lower than the top of the zone of saturation in areas adjacent to the stream.

perennial stream—A stream or reach of a channel that flows continuously or nearly so throughout the year and whose upper surface is generally lower than the top of the zone of saturation in areas adjacent to the stream.

phenotype—Physical manifestation of the genetic makeup of an individual and its interaction with the environment.

place attachment—The "positive bond that develops between groups or individuals and their environment" (Jorgensen and Stedman 2001: 234).

place dependence— "The strength of an individual's subjective attachment to specific places" (Stokols and Shumaker 1982: 157).

place identity—Dimensions of self that define an individual's [or group's] identity in relation to the physical environment through ideas, beliefs, preferences, feelings, values, goals, and behavioral tendencies and skills (Proshansky 1978).

place-based planning—"A process used to involve stakeholders by encouraging them to come together to collectively define place meanings and attachments" (Lowery and Morse 2013: 1423).

plant association—A fine level of classification in a hierarchy of potential vegetation that is defined in terms of a climax-dominant overstory tree species and typical understory herb or shrub species.

population bottleneck—An abrupt decline in the size of a population from an event, which often results in deleterious effects such as reduced genetic diversity and increased probability of local or global extirpation.

potential vegetation type (PVT)—Native, late-successional (or "climax") plant community that reflects the regional climate, and dominant plant species that would occur on a site in absence of disturbances (Pfister and Arno 1980).

poverty rate—A measure of financial income below a threshold that differs by family size and composition.

precautionary principle—A principle that if an action, policy, or decision has a suspected risk of causing harm to the public or to the environment, and there is no scientific consensus that it is not harmful, then the burden of proof that it is not harmful falls on those making that decision. Particular definitions of the principle differ, and some applications use the less formal term, "precautionary approach." Important qualifications associated with many definitions include (1) the perceived harm is likely to be serious, (2) some scientific analysis suggests a significant but uncertain potential for harm, and (3) applications of the principle emphasize generally constraining an activity to mitigate it rather than "resisting" it entirely (Doremus 2007).

prescribed fire—A wildland fire originating from a planned ignition to meet specific objectives identified in a written and approved prescribed fire plan for which National Environmental Policy Act requirements (where applicable) have been met prior to ignition (synonymous with controlled burn).

primary recreation activity—A single activity that caused a recreation visit to a national forest.

probable sale quantity—An estimate of the average amount of timber likely to be awarded for sale for a given area (such as the NWFP area) during a specified period.

provisioning services—A type of ecosystem service that includes clean air and fresh water, energy, food, fuel, forage, wood products or fiber, and minerals.

public participation geographic information system (PPGIS)—Using spatial decisionmaking and mapping tools to produce local knowledge with the goal of including and empowering marginalized populations (Brown and Reed 2009).

public values—Amenity values (scenery, quality of life); environmental quality (clean air, soil, and water); ecological

values (biodiversity); public use values (outdoor recreation, education, subsistence use); and spiritual or religious values (cultural ties, tribal history).

record of decision (ROD)—The final decision document that amended the planning documents of 19 national forests and seven Bureau of Land Management districts within the range of the northern spotted owl (the NWFP area) in April 1994 (Espy and Babbit 1994).

recreation opportunity—An opportunity to participate in a specific recreation activity in a particular recreation setting to enjoy desired recreation experiences and other benefits that accrue. Recreation opportunities include nonmotorized, motorized, developed, and dispersed recreation on land, water, and in the air (36 CFR 219.19).

redundancy—The presence of multiple occurrences of ecological conditions, including key ecological functions (functional redundancy), such that not all occurrences may be eliminated by a catastrophic event.

refugia—An area that remains less altered by climatic and environmental change (including disturbances such as wind and fire) affecting surrounding regions and that therefore forms a haven for relict fauna and flora.

regalia—Dress and special elements made from a variety of items, including various plant and animal materials, and worn for tribal dances and ceremonies.

regulating services—A type of ecosystem service that includes long-term storage of carbon; climate regulation; water filtration, purification, and storage; soil stabilization; flood and drought control; and disease regulation.

representativeness—The presence of a full array of ecosystem types and successional states, based on the physical environment and characteristic disturbance processes.

reserve—An area of land designated and managed for a special purpose, often to conserve or protect ecosystems, species, or other natural and cultural resources from particular human activities that are detrimental to achieving the goals of the area.

resilience—The capacity of a system to absorb disturbance and reorganize (or return to its previous organization) so as to still retain essentially the same function, structure, identity, and feedbacks (see FSM Chapter 2020 and see also "socioecological resilience"). Definitions emphasize the capacity of a system or its constituent entities to respond or regrow after mortality induced by a disturbance event, although broad definitions of resilience may also encompass "resistance" (see below), under which such mortality may be averted.

resistance—The capacity of a system or an entity to withstand a disturbance event without much change.

restoration economy—Diverse economic activities associated with the restoration of structure or function to terrestrial and aquatic ecosystems (Nielsen-Pincus and Moseley 2013).

restoration, ecological—The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. Ecological restoration focuses on reestablishing the composition, structure, pattern, and ecological processes necessary to facilitate terrestrial and aquatic ecosystems sustainability, resilience, and health under current and future conditions (36 CFR 219.19).

restoration, functional—Restoration of dynamic abiotic and biotic processes in degraded ecosystems, without necessarily a focus on structural condition and composition.

riparian areas—Three-dimensional ecotones (the transition zone between two adjoining communities) of interaction that include terrestrial and aquatic ecosystems that extend down into the groundwater, up above the canopy, outward across the floodplain, up the near slopes that drain to the water, laterally into the terrestrial ecosystem, and along the water course at variable widths (36 CFR 219.19).

riparian management zone—Portions of a watershed in which riparian-dependent resources receive primary emphasis, and for which plans include Plan components to maintain or restore riparian functions and ecological functions (36 CFR 219.19).

riparian reserves—Reserves established along streams and rivers to protect riparian ecological functions and processes

necessary to create and maintain habitat for aquatic and riparian-dependent organisms over time and ensure connectivity within and between watersheds. The Aquatic Conservation Strategy in the NWFP record of decision included standards and guidelines that delineated riparian reserves.

risk—A combination of the probability that a negative outcome will occur and the severity of the subsequent negative consequences (36 CFR 219.19).

rural restructuring—Changes in demographic and economic conditions owing to declines in natural resource production and agriculture (Nelson 2001).

scale—In ecological terms, the extent and resolution in spatial and temporal terms of a phenomenon or analysis, which differs from the definition in cartography regarding the ratio of map distance to Earth surface distance (Jenerette and Wu 2000).

scenic character—A combination of the physical, biological, and cultural images that gives an area its scenic identity and contributes to its sense of place. Scenic character provides a frame of reference from which to determine scenic attractiveness and to measure scenic integrity (36 CFR 219.19).

science synthesis—A narrative review of scientific information from a defined pool of sources that compiles and integrates and interprets findings and describes uncertainty, including the boundaries of what is known and what is not known.

sense of place—The collection of meanings, beliefs, symbols, values, and feelings that individuals or groups associate with a particular locality (Williams and Stewart 1998).

sensitive species—Plant or animal species that receive special conservation attention because of threats to their populations or habitats, but which do not have special status as listed or candidates for listing under the Endangered Species Act.

sensitivity—In ecological contexts, the propensity of communities or populations to change when subject to disturbance, or the opposite of resistance (see "community resistance").

sink population—A population in which reproductive rates are lower than mortality rates but that is maintained by immigration of individuals from outside of that population (see also "source population").

social sustainability—"The capability of society to support the network of relationships, traditions, culture, and activities that connect people to the land and to one another, and support vibrant communities" (36 CFR 219.19). The term is commonly invoked as one of the three parts of a "triple-bottom line" alongside environmental and economic considerations. The concept is an umbrella term for various topics such as quality of life, security, social capital, rights, sense of place, environmental justice, and community resilience, among others discussed in this synthesis.

socioecological resilience—The capacity of socioecological systems (see "socioecological system") to cope with, adapt to, and influence change; to persist and develop in the face of change; and to innovate and transform into new, more desirable configurations in response to disturbance.

socioecological system (or social-ecological system)—A coherent system of biophysical and social factors defined at several spatial, temporal, and organizational scales that regularly interact, continuously adapt, and regulate critical natural, socioeconomic, and cultural resources (Redman et al. 2004); also described as a coupled-human and natural system (Liu et al. 2007).

source population—A population in which reproductive rates exceed those of mortality rates so that the population has the capacity to increase in size. The term is also often used to denote when such a population contributes emigrants (dispersing individuals) that move outside the population, particularly when feeding a sink population.

special forest products—See "nontimber forest products."

special status species—Species that have been listed or proposed for listing as threatened or endangered under the Endangered Species Act.

species of conservation concern—A species, other than federally recognized as a threatened, endangered, proposed,

or candidate species, that is known to occur in the NWFP area and for which the regional forester has determined that the best available scientific information indicates substantial concern about the species' capability to persist over the long term in the Plan area (36 CFR 219.9(c)).

stand—A descriptor of a land management unit consisting of a contiguous group of trees sufficiently uniform in age-class distribution, composition, and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit.

standard—A mandatory constraint on project and activity decisionmaking, established to help achieve or maintain the desired condition or conditions, to avoid or mitigate undesirable effects, or to meet applicable legal requirements.

stationarity—In statistics, a process that, while randomly determined, is not experiencing a change in the probability of outcomes.

stewardship contract—A contract designed to achieve land management goals while meeting local and rural community needs, including contributing to the sustainability of rural communities and providing a continuing source of local income and employment.

strategic surveys—One type of field survey, specified under the NWFP, designed to fill key information gaps on species distributions and ecologies by which to determine if species should be included under the Plan's Survey and Manage species list.

stressors—Factors that may directly or indirectly degrade or impair ecosystem composition, structure, or ecological process in a manner that may impair its ecological integrity, such as an invasive species, loss of connectivity, or the disruption of a natural disturbance regime (36 CFR 219.19).

structure (ecosystem)—The organization and physical arrangement of biological elements such as snags and down woody debris, vertical and horizontal distribution of vegetation, stream habitat complexity, landscape pattern, and connectivity (FSM 2020).

supporting services—A type of ecosystem service that includes pollination, seed dispersal, soil formation, and nutrient cycling.

Survey and Manage program—A formal part of the NWFP that established protocols for conducting various types of species surveys, identified old-forest-associated species warranting additional consideration for monitoring and protection (see "Survey and Manage species"), and instituted an annual species review procedure that evaluated new scientific and monitoring information on species for potentially recommending changes in their conservation status, including potential removal from the Survey and Manage species list.

Survey and Manage species—A list of species, compiled under the Survey and Manage program of the NWFP, that were deemed to warrant particular attention for monitoring and protection beyond the guidelines for establishing late-successional forest reserves.

sustainability—The capability to meet the needs of the present generation without compromising the ability of future generations to meet their needs (36 CFR 219.19).

sustainable recreation—The set of recreation settings and opportunities in the National Forest System that is ecologically, economically, and socially sustainable for present and future generations (36 CFR 219.19).

sympatric—Two species or populations that share a common geographic range and coexist.

threatened species—Any species that the Secretary of the Interior or the Secretary of Commerce has determined is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Threatened species are listed at 50 CFR sections 17.11, 17.12, and 223.102.

timber harvest—The removal of trees for wood fiber use and other multiple-use purposes (36 CFR 219.19).

timber production—The purposeful growing, tending, harvesting, and regeneration of regulated crops of trees to be cut into logs, bolts, or other round sections for industrial or consumer use (36 CFR 219.19).

topo-edaphic—Related to or caused by particular soil conditions, as of texture or drainage, rather than by physiographic or climatic factors within a defined region or area.

traditional ecological knowledge—"A cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (Berkes et al. 2000: 1252). See also "native knowledge."

trailing edge—When describing the range of a species, the boundary at which the species' population is geographically contracting through local extinction at occupied sites.

trophic cascade—Changes in the relative populations of producers, herbivores, and carnivores following the addition or removal of top predators and the resulting disruption of the food web.

uncertainty—Amount or degree of confidence as a result of imperfect or incomplete information.

understory—Vegetation growing below the tree canopy in a forest, including shrubs and herbs that grow on the forest floor.

use of wildland fire—Management of either wildfire or prescribed fire to meet resource objectives specified in land or resource management plans (see "Managing wildfire for resource objectives" and "Prescribed fire").

variable-density thinning—The method of thinning some areas within a stand to a different density (including leaving dense, unthinned areas) than other parts of the stand, which is typically done to promote ecological diversity in a relatively uniform stand.

vegetation series (plant community)—The highest level of the fine-scale component (plant associations) of potential vegetation hierarchy based on the dominant plant species that would occur in late-successional conditions in the absence of disturbance.

vegetation type—A general term for a combination or community of plants (including grasses, forbs, shrubs, or trees), typically applied to existing vegetation rather than potential vegetation.

viable population—A group of breeding individuals of a species capable of perpetuating itself over a given time scale.

vital rates—Statistics describing population dynamics such as reproduction, mortality, survival, and recruitment.

watershed—A region or land area drained by a single stream, river, or drainage network; a drainage basin (36 CFR 219.19).

watershed analysis—An analytical process that characterizes watersheds and identifies potential actions for addressing problems and concerns, along with possible management options. It assembles information necessary to determine the ecological characteristics and behavior of the watershed and to develop options to guide management in the watershed, including adjusting riparian reserve boundaries.

watershed condition assessment—A national approach used by the U.S. Forest Service to evaluate condition of hydrologic units based on 12 indicators, each composed of various attributes (USDA FS 2011).

watershed condition—The state of a watershed based on physical and biogeochemical characteristics and processes (36 CFR 219.19).

watershed restoration—Restoration activities that focus on restoring the key ecological processes required to create and maintain favorable environmental conditions for aquatic and riparian-dependent organisms.

well-being—The condition of an individual or group in social, economic, psychological, spiritual, or medical terms.

wilderness—Any area of land designated by Congress as part of the National Wilderness Preservation System that was established by the Wilderness Act of 1964 (16 U.S.C. 1131–1136) (36 CFR 219.19).

wildlife—Undomesticated animal species, including amphibians, reptiles, birds, mammals, fish, and invertebrates or even all biota, that live wild in an area without being introduced by humans.

wildfire—Unplanned ignition of a wildland fire (such as a fire caused by lightning, volcanoes, unauthorized and accidental human-caused fires), and escaped prescribed fires.

wildland-urban interface (WUI)—The line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetation fuels.

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