Chapter 11: Tribal Ecocultural Resources and Engagement

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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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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.

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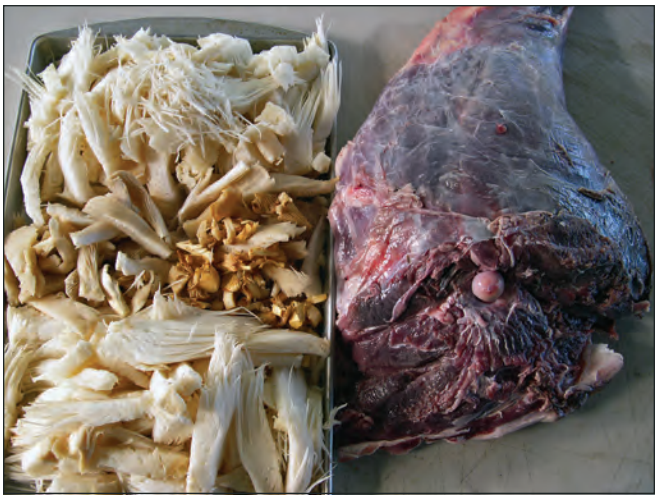
Figure 11-2—Tanoak acorns, lion's mane (*Hericium erinaceus*) mushrooms, and evergreen huckleberries collected on the Six Rivers National Forest near Orleans, California, October 2005.



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.

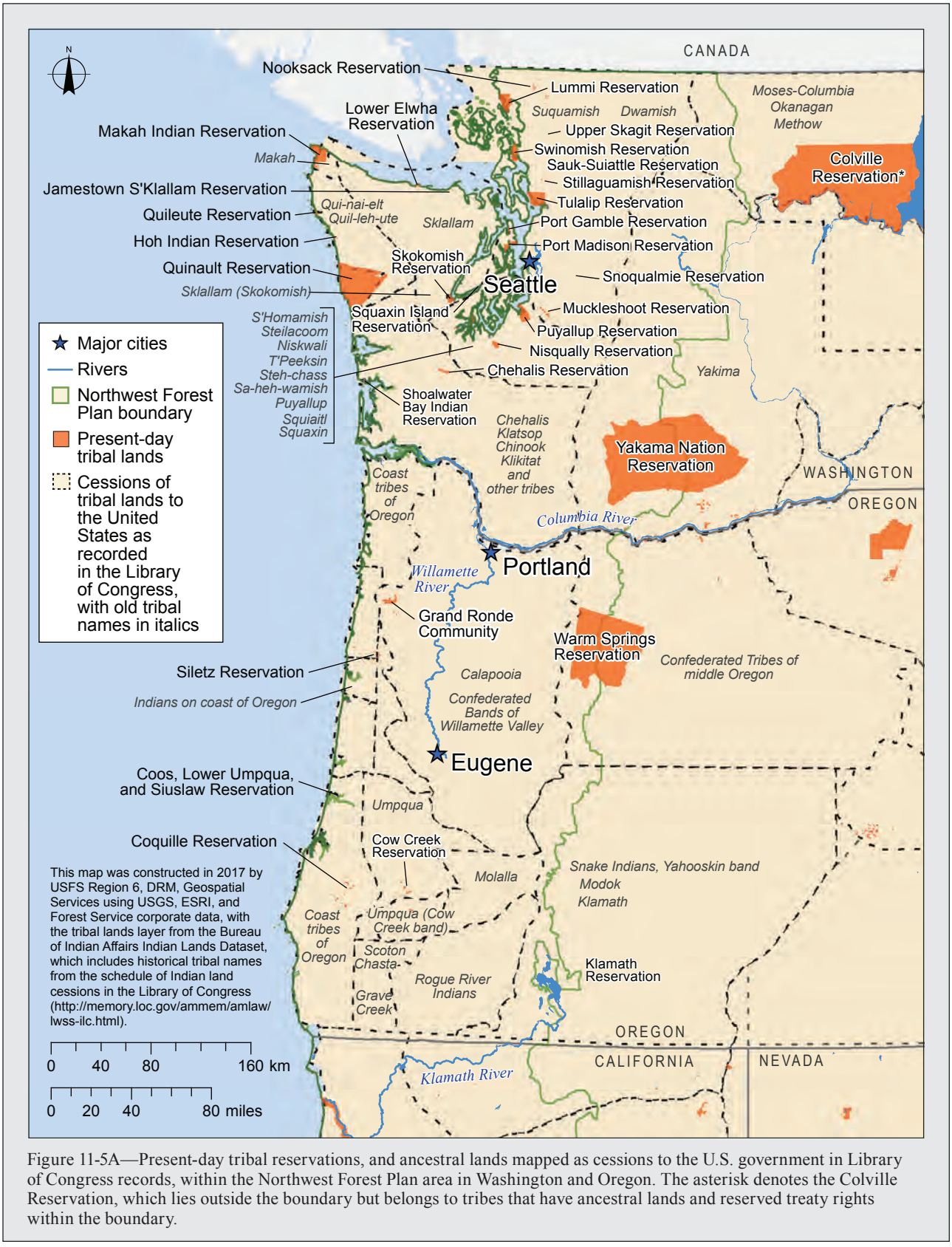


Figure 11-5A—Present-day tribal reservations, and ancestral lands mapped as cessions to the U.S. government in Library of Congress records, within the Northwest Forest Plan area in Washington and Oregon. The asterisk denotes the Colville Reservation, which lies outside the boundary but belongs to tribes that have ancestral lands and reserved treaty rights within the boundary.

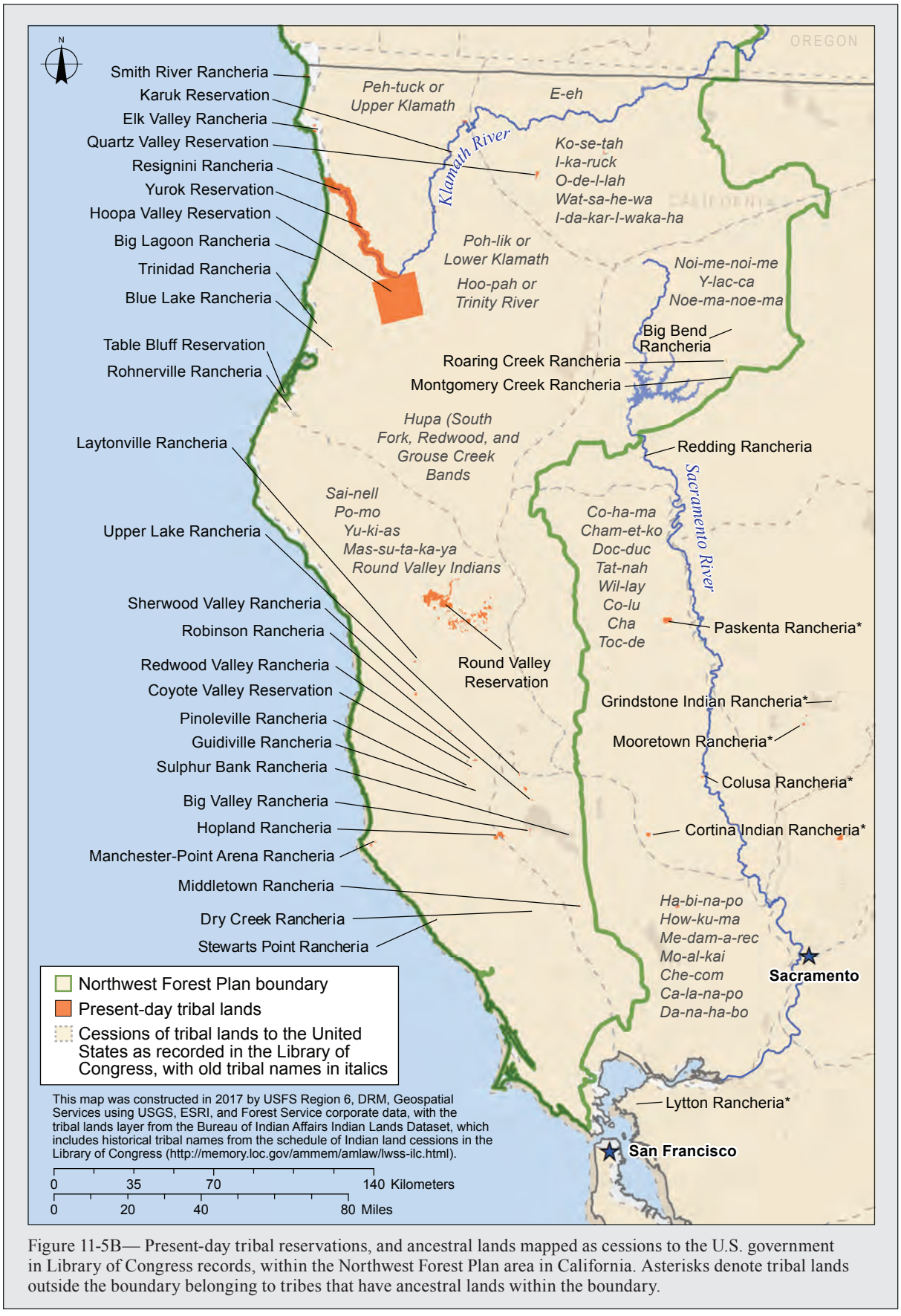


Figure 11-5B— Present-day tribal reservations, and ancestral lands mapped as cessions to the U.S. government in Library of Congress records, within the Northwest Forest Plan area in California. Asterisks denote tribal lands outside the boundary belonging to tribes that have ancestral lands within the 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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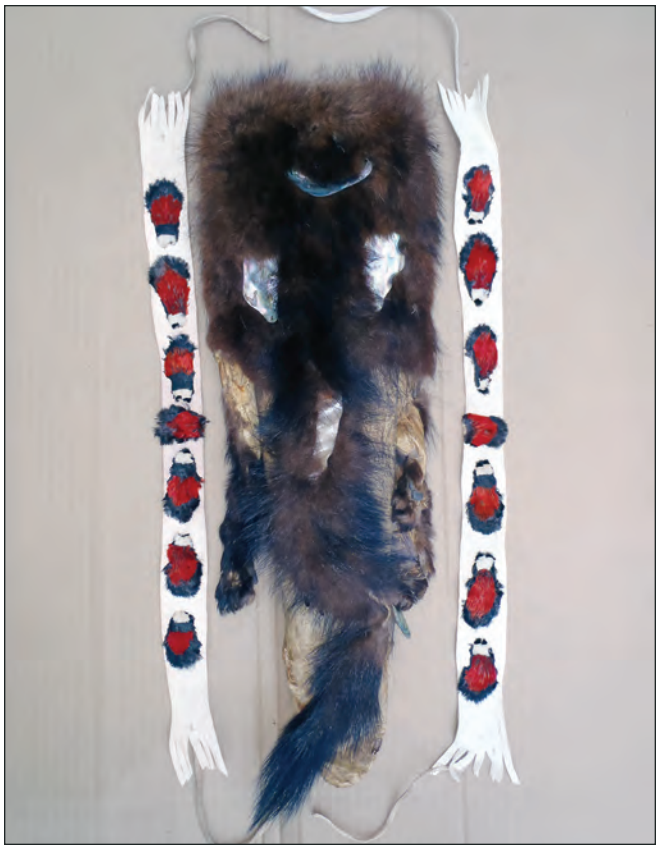

Figure 11-7—Lake family regalia photographed August 2016, including a quiver made from fisher adorned with red abalone shells surrounded by men's ceremonial headbands composed of acorn woodpecker scalps sewn on tanned deer hide.

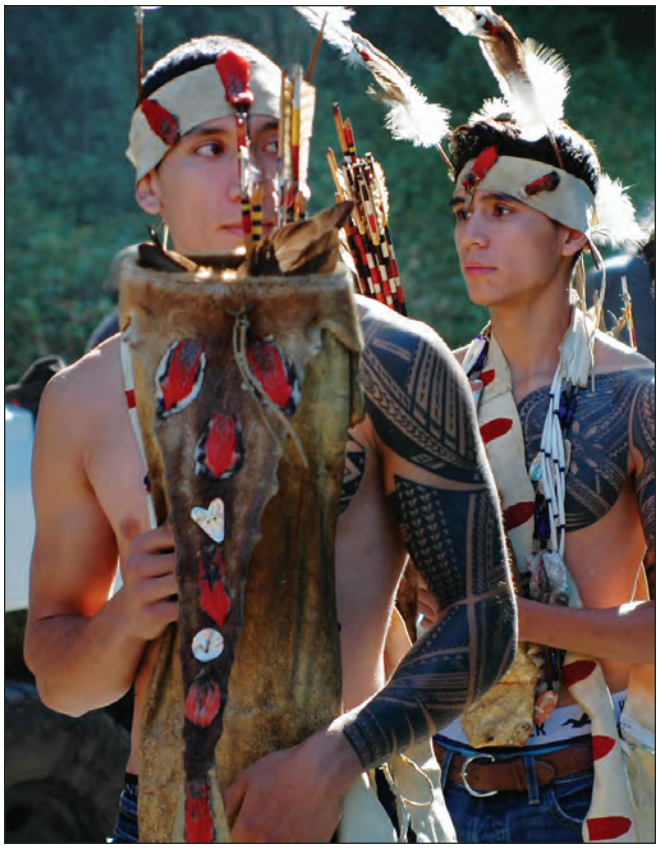

Figure 11-8—Hupa men dressed in brush dance regalia in 2015, adorned with pileated woodpecker scalps along with a variety of other products derived from forest and ocean wildlife.

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.

Frank K. Lake

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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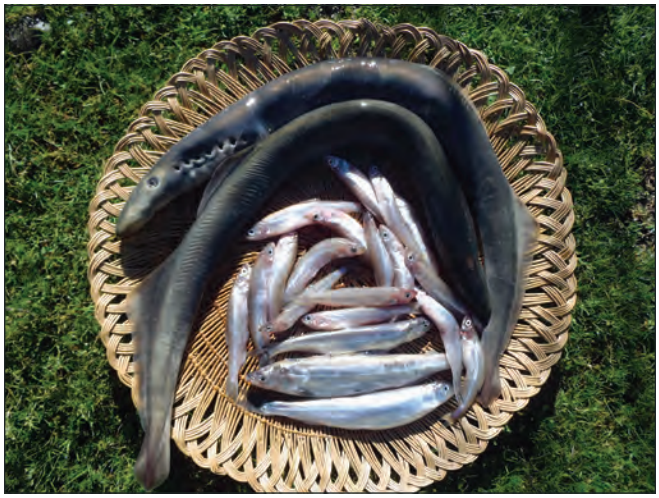

Figure 11-11—Lamprey (top), candlefish (bottom), and night smelt (*Spirinchus starksi*) (center) harvested by Yurok Tribal members on a basket tray made from sandbar willow (*Salix exigua*), March 2014.

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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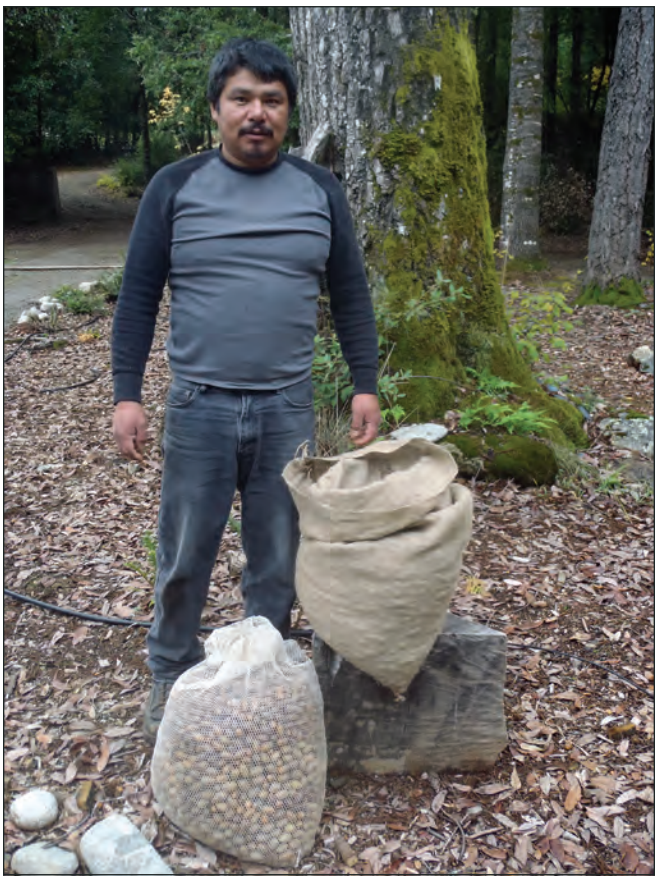

Figure 11-12—Chris Peters harvesting acorns, near Orleans, California, November 2012.

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.

Frank K. Lake

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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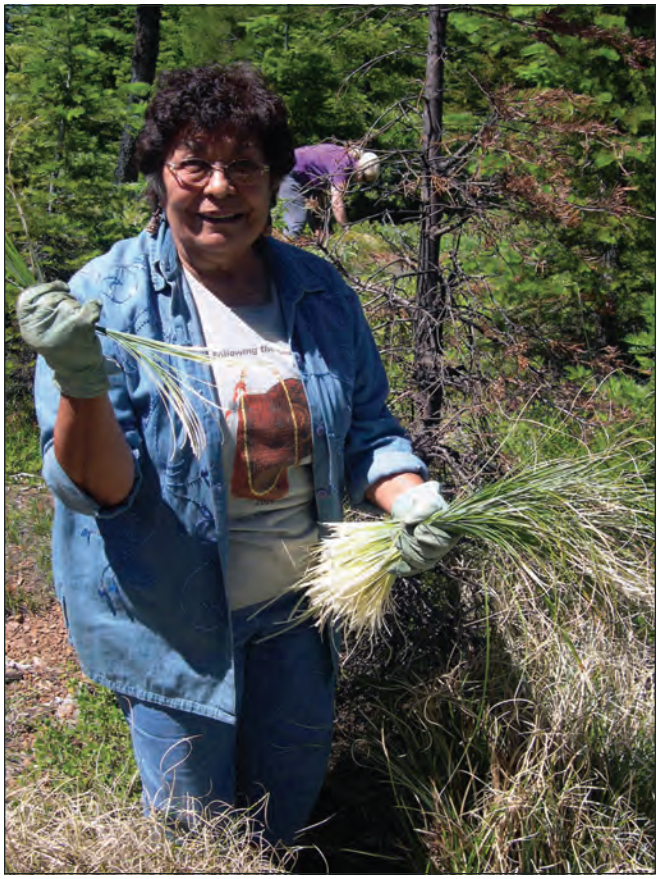

Figure 11-16—LaVerne Glaze holding harvested beargrass (*Xerophyllum tenax*), July 2005.

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).

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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).

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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.