

Section 1. Introduction

Chapter 1.1. The Northeastern California Plateaus Bioregion Science Synthesis: Background, Rationale, and Scope

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Introduction

Situated in Northeastern California, the Lassen National Forest spans 1.2 million acres (485,625 ha) and the Modoc National Forest another 1.65 million acres (667,730 ha), mainly in Lassen and Modoc Counties, but also across portions of Butte, Plumas, Shasta, Siskiyou, and Tehama counties. A unique blend of geology, topography, elevations from 2,000 to 14,000 feet (610 to 4,270 m), and climate have fostered immense biodiversity within this area. On the western edge of these national forests, the Cascade Range, characterized by steep changes in elevation and a Mediterranean climate (cool, wet winters and warm, dry summers), draws out the precipitation from Pacific storms, leaving a rain shadow to the east. The result is a rich vegetation gradient of mixed-conifer forest, dry pine forests, oak savannahs, juniper woodlands, and sagebrush steppe. In addition, fire, promoted by the Mediterranean climate, further stimulates a mosaic of vegetation across the landscape that supports a wide variety of fauna. For more detailed descriptions of this area, see Gonzales and Hoshi (2015a, b), Riegel et al. (2006), and Skinner and Taylor (2006).

The Cascade Range, characterized by basalt parent material, runs from southern British Columbia to just south of Lassen Peak in Northern California, where it transitions to the granite parent material of the Sierra Nevada (fig. 1.1.1). In Northern California, the Cascade Range receives abundant rain and snow, and supports rich, mixed-conifer forests that supply valuable forest products

and serve as the source of appreciable surface water. The forests of the Cascade Range are home to several animal species of concern, such as the northern spotted owl (*Strix occidentalis caurina*) and Pacific marten (*Martes caurina*) (Gonzales and Hoshi 2015a).

The Modoc Plateau, itself comprised of multiple plateaus such as Devil's Garden, is a broad transition zone from the basalt parent material of the Cascade Range to the sedimentary/alluvial parent materials of the Great Basin (fig. 1.1.1; Fuller et al. 2015). The Modoc Plateau began forming about a million years ago, when a long series of gentle eruptions of smooth lava began flowing across the landscape (see Peacock 1931). Because of its transitional geologic state and location in the Cascade Range rain shadow, much of the Modoc Plateau is exemplified by ecosystems typical of the Great Basin (sagebrush rangeland, shrub steppe, and juniper woodlands). These ecosystems provide important habitat for wildlife species that require sagebrush (*Artemisia* species), such as greater sage-grouse (*Centrocercus urophasianus*), pygmy rabbit



Figure 1.1.1—The Lassen and Modoc National Forests are in Northeastern California, where the Cascade Range, the Sierra Nevada, and the Modoc Plateau intersect. Here the watershed of the Pit River forms the headwaters of the Sacramento River, one of the most important waterways in the State.

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Figure 1.1.2—The wet meadows, vernal pools, and other wetlands of Northeastern California provide critical habitat for resident and migratory birds, such as these sandhill cranes visiting Pine Creek Valley on the Lassen National Forest (photo by Emmett Richards, Forest Service).

(*Brachylagus idahoensis*), pronghorn (*Antilocapra americana*), and sagebrush sparrow (*Artemisiospiza nevadensis*). Other wildlife, such as mule deer (*Odocoileus hemionus*) and elk (*Cervus canadensis*), also make use of this habitat. Vernal pools (temporary, seasonal wetlands) support rare plants and animals and the biodiversity of California’s vernal pools is noteworthy (e.g., King et al. 1996; Simovich 1998). Vernal pools help connect wetland habitat along the Pacific Flyway and are thus important for migrating birds such as sandhill cranes (*Grus canadensis*), ducks, and geese (fig. 1.1.2).

The Modoc Plateau gives rise to the 3-million-acre (1.2-million-ha) Pit River watershed that is critical to wildlife and human sustainability (fig. 1.1.1). The upper reaches of the watershed flow from the Warner Mountains, forming the headwaters of the Sacramento River that supplies about 20 percent of the water to the Sacramento Basin, which in turns irrigates about 2.1 million acres (850,000 ha) of agricultural crops (California Department of Water Resources 1998; Gonzales and Hoshi 2015a). It also supports many endemic and threatened aquatic species (Gonzales and Hoshi 2015a; Moyle et al. 2011).

The Federal Government manages about 60 percent of the Modoc Plateau, with about one-third managed by the

U.S. Department of Agriculture, Forest Service. Contained within the footprint of the Lassen and Modoc National Forests are 6 wilderness areas covering about 257,000 acres (104,000 ha). The Caribou, South Warner, and Thousand Lakes wildernesses are managed by the Forest Service, Ishi Wilderness is managed jointly by the Forest Service and the U.S. Department of the Interior, Bureau of Land Management and Lassen Volcanic Wilderness is managed by the U.S. Department of the Interior, National Park Service. Also within the footprint are the Lava Beds National Monument (46,000 acres [18,615 ha]) and Lassen National Park (106,000 acres [42,900 ha]), both managed by the National Park Service.

Planning for the Future

A land management plan or “forest plan” guides how the Forest Service manages the associated public lands and natural resources for a period of 15 to 20 years. Following mandates and provisions of the 1982 Planning Rule, the forest plan for the Modoc National Forest (hereafter, the Modoc) was completed in 1991, while the forest plan for the Lassen National Forest (hereafter, the Lassen) was completed a year later. Thus, it is time for both forests to revise their existing forest plans to meet the legal requirements of the National Forest Management Act

of 1976 and incorporate changes in law, regulation, and policy. The plan revisions will be guided by the 2012 Planning Rule (<https://www.fs.usda.gov/planningrule>), which requires public and tribal input throughout a multi-step process that embraces the fact that ecological, social, and economic objectives are interrelated. Because conditions have changed since the original forest plans were written and because new science is available, the first step is to prepare a science synthesis, guided by input from the public, tribes, and forest staffs (fig. 1.1.3). Although the Lassen and Modoc will each prepare an independent forest plan, these neighboring forests have worked together on this science synthesis because they share management of unique geology and ecosystems.

What Is a Science Synthesis?

Scientists are continually learning and gaining new understanding of the natural processes that affect ecosystems, how humans influence ecosystems, and the ways that society values what ecosystems provide. Since the last forest plans for the Lassen and Modoc were written, much new information has been discovered. Combining these discoveries into a single document, commonly referred to as a “synthesis,” requires reviewing the best available scientific information. The goal of the science synthesis is to combine the findings from the full body of relevant science within a topic area (defined and refined by input from the public, tribes, and forest staffs) into a current, concise, comprehensive, and coherent



Figure 1.1.3—Forest plans are revised through a multi-step process that encourages public participation. The first step is Pre-Assessment, which includes development of a science synthesis.

overview that can be more readily interpreted and used by forest staffs and stakeholders during the forest plan process. In turn, the science synthesis will be followed by additional opportunities for public input as the forest plans develop (fig. 1.1.3). While science syntheses focus mainly on broad, widely accepted and applicable concepts, this synthesis also sought to incorporate research specifically conducted on or near the Lassen and Modoc.

Best Available Scientific Information

In *A Citizens' Guide to National Forest Planning*, the Forest Service explains its definition of best available scientific information (see textbox 1.1.1). In evaluating science for inclusion in the synthesis, the Science Team (comprised of seven Forest Service scientists representing the Rocky Mountain and Pacific Southwest Research Stations) that prepared this synthesis followed an assessment hierarchy similar to that used in recent science syntheses prepared in support of forest planning in California, Oregon, and Washington (Long et al. 2014; Spies et al. 2018). Peer-reviewed (refereed) journal publications were the primary sources of information because these publications are critically scrutinized by independent reviewers (referees), usually anonymously, to ensure that the study methods were well-developed, appropriate, and with reasonable assumptions; data were correctly analyzed; results were valid; the discussion and conclusions were logical and supported by the data collected, any information gaps and/or inconsistencies were addressed, and the work is placed in the proper context within the body of knowledge; and that the references included the most recent, relevant, refereed work as well as older, foundational studies. The Science Team also examined publications having undergone peer review but published in other formats, such as government publications (e.g., Forest Service General Technical Reports), conference proceedings, proceedings from professional organizations, and university theses and dissertations. Occasionally, unpublished government reports were included too. During the initial public forum and comment period (December 2016), participants suggested nearly 60 publications to be considered in addition to publications identified using Internet search tools, such as Google Scholar and Web of Science, and the Forest Service database, Treesearch (<https://treesearch.fs.fed.us>). More than 1,100 publications were reviewed in the process.

Textbox 1.1.1—"The 2012 Planning Rule requires the use of the best available scientific information to inform planning and plan decisions. Science is a dynamic process that builds knowledge and reduces uncertainty by testing predictions; scientific information can be considered the expanding body of knowledge developed through the scientific process. Scientific information comes in many forms, including social, economic, and ecological information. Scientific information comes from many sources—for example, from peer-reviewed articles, scientific assessments, expert opinion, and data in the form of monitoring results. It also comes from information gathered during public involvement efforts and traditional ecological knowledge. What is the 'best available scientific information'? Generally, it is high-quality information that results from well-developed and appropriate methods, draws logical conclusions based on reasonable assumptions, explains information gaps and inconsistencies, has been appropriately peer-reviewed, is placed in the proper context within the body of knowledge, and cites references. Not all information, however, needs to meet all of these characteristics to be considered best available scientific information. At a minimum, scientific information needs to be available, accurate, reliable, and relevant. 'Available' means that the Forest Service does not need to create new scientific information and conduct new research, but simply should use information that currently exists. Finally, one of the fundamentals to effective use of scientific information is transparency in how it is used. The 2012 Planning Rule requires the Forest Service to document and summarize how the universe of best available scientific information was identified and how it informed the planning process."

From: *A citizens' guide to national forest planning*. Prepared by the Federal Advisory Committee on Implementation of the 2012 Land Management Planning Rule. Version 1.0. Washington, DC: U.S. Department of Agriculture, Forest Service, Washington Office. September 2016. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd520670.pdf.

Northeastern California Plateaus Bioregion Science Synthesis

The goal of the *Northeastern California Plateaus Bioregion Science Synthesis* (hereafter, Plateaus Science Synthesis) is to address the unique niches of the Lassen and Modoc not addressed, or fully addressed, by two previously completed science syntheses that have relevance to the Lassen and

Modoc. The first relevant synthesis is the *Science Synthesis to Support Socioecological Resilience in the Sierra Nevada and Southern Cascade Range* (hereafter, Sierra Nevada Science Synthesis) published by Long et al. (2014), which covered the nine national forests in California associated with the Sierra Nevada, including the Lassen and Modoc (see textbox 1.1.2). This comprehensive, two-volume publication addressed the “forested mountains” (p. iv), primarily the “conifer-dominated forest ecosystems” (p. 4) of the Sierra Nevada, the Southern Cascades, and the Modoc Plateau. The second is the *Synthesis of Science to Inform Land Management within the Northwest Forest Plan Area* (hereafter, simply Northwest Forest Plan Science Synthesis; Spies et al. 2018). Portions of this synthesis are applicable because the Lassen and Modoc, according to the 2018 data used in the Pacific Southwest Region of the Forest Service for planning, have approximately 45,000 and 51,000 acres (18,210 and 20,640 ha; 3 and 3.8 percent of the total landbase), respectively, included in the Northwest Forest Plan Area. Moreover, the ecoregions (see textbox 1.1.3) associated with these designated acres (Level III Ecoregion 4) cover a much larger area of the Lassen (a total of 585,000 acres [236,740 ha]).

Why Is Another Science Synthesis Needed?

Most commonly, national forests are supported in their efforts to revise forest plans by a single science synthesis. Because of their unique location on the landscape, portions of the Lassen and Modoc were already addressed by the Northwest Forest Plan and Sierra Nevada science syntheses. Thus, during the initial stages of development, the Plateaus Science Synthesis was referred to as the “Great Basin Science Synthesis,” reflecting the known need to address sagebrush rangeland (characteristic of the Great Basin) not covered by the Northwest Forest Plan and Sierra Nevada science syntheses. Early input from forest staffs, tribes, local governments, and the general public showed, however, that some forest landscapes that fell within the defined scopes of the earlier syntheses were insufficiently addressed and amply unique to require special attention, thus pushing the scope of this effort beyond the Great Basin definition (see *Scope* below). Some other topics not included in the previous syntheses but deemed necessary in order for the Lassen and Modoc to revise their forest plans included juniper forestland, wild horses, greater sage-grouse, and the effects of prison populations on local demographics. Because plateaus are common landscape features of the Lassen and Modoc, this effort was renamed the *Northeastern California Plateaus Bioregion Science*

Textbox 1.1.2—The ecological portion of Sierra Nevada Science Synthesis drew heavily from Forest Service General Technical Reports PSW-GTR-220 (North et al. 2009) and PSW-GTR-237 (North 2012) that included substantial discussion about forest types occurring in the Southern Cascades and the Sierra Nevada and their fauna (e.g., fisher, Pacific marten, northern spotted owl). The Sierra Nevada Science Synthesis also made a substantial effort to address social issues. The effects of grazing on wet meadows and their restoration was the focus of Chapter 6.3 (Long and Pope 2014), and grazing on national forests in California was described in Chapter 9.5 (Charnley and Long 2014).

Textbox 1.1.3—Ecoregions are areas where ecosystems (a biological community of interacting organisms and their physical environment) are relatively similar. This synthesis uses ecoregions, developed by Omernik (1987) and widely used by many Federal agencies, to provide a common point of reference because maps and descriptions for California ecoregions (Griffith et al. 2016) are readily available on the Internet (<https://www.epa.gov/eco-research/ecoregion-download-files-state-region-9#pane-04> or <https://dx.doi.org/10.3133/ofr20161021>). Whereas Level 1 Ecoregions are the broadest, most general descriptions of the landscape, Level IV Ecoregions provide the most detailed descriptions of particular portions of the landscape. See Appendix 1.1 for descriptions of Level IV Ecoregions used in this synthesis.

Synthesis to more uniquely describe the land base covered. Therefore, the Lassen and Modoc will each establish their revised forest plans drawing from all three science syntheses as necessary and appropriate for different portions of their landscapes (fig. 1.1.4).

Scope

To integrate all three syntheses and note where the Plateaus Science Synthesis provides novel information beyond the Northwest Forest Plan and Sierra Nevada science syntheses, this synthesis divides the Lassen and Modoc into four, necessarily broad, vegetation zones: (1) Southern Cascades Forestland; (2) Sierra Nevada Forestland; (3) Dry Pine Forestland; and (4) Juniper Forestland, Sagebrush Rangeland, and Shrubland (fig. 1.1.5).

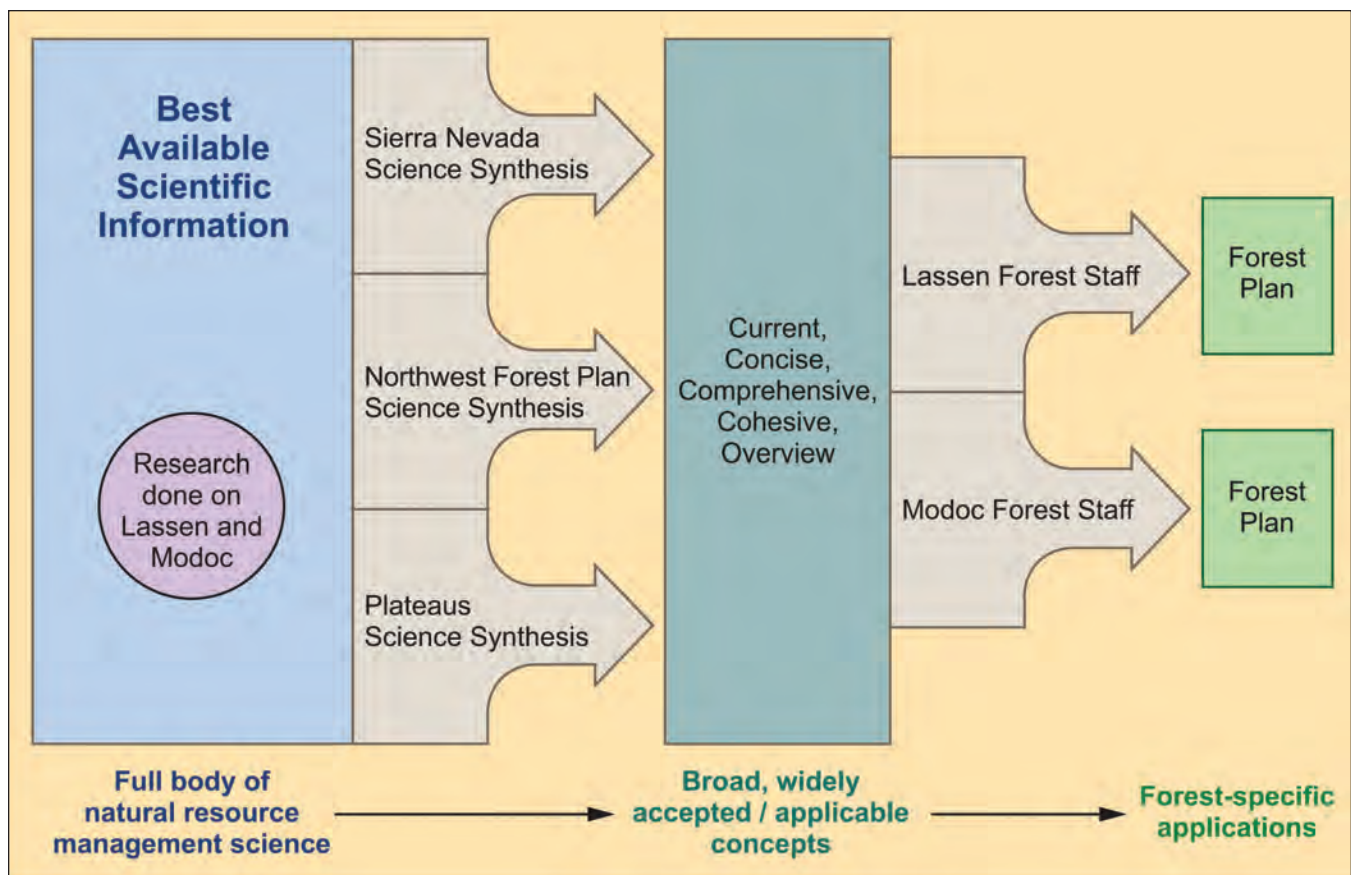


Figure 1.1.4—A science synthesis searches the best available scientific information and condenses it into a current, concise, comprehensive, coherent overview that staffs of national forests can then use to develop forest plans for their respective forests. For this synthesis, the science team reviewed the best available scientific information for topics identified by staffs of the Lassen and Modoc, tribes, local governments, and the general public, with specific focus on finding any relevant research conducted on or near the Lassen and the Modoc. This synthesis, along with the other two science syntheses that have relevance to the Lassen and Modoc (the Sierra Nevada and Northwest Forest Plan science syntheses), primarily deliver the broad, widely accepted and applied concepts that provide a solid science-based foundation that the forest staffs can use as a starting point in the process to revise their specific forest plans. The forest plans are more focused on the pragmatic specifics of the Lassen and the Modoc.

Southern Cascades Forestland

Both the Northwest Forest Plan Science Synthesis and the Sierra Nevada Science Synthesis discuss the forested landscapes of the “Southern Cascades.” The Southern Cascades occur within the Level III Ecoregion 4 (Cascades) and are mainly represented by four Level IV Ecoregions (see textboxes 1.1.3, 1.1.4, 1.1.5 and Appendix 1.1 for descriptions of Level IV Ecoregions used in this synthesis). The Southern Cascades forest communities move downslope from alpine zones through high-elevation zones of mountain hemlock, lodgepole pine, white fir, and Shasta red fir to mid-elevation forests of western hemlock, western redcedar, incense cedar, white fir, Shasta red fir, and Jeffrey pine to lower-elevation forests of either ponderosa and Jeffrey pines, or ponderosa pine

and Douglas-fir mingled with California black and canyon live oaks. Because of extensive coverage in the previous syntheses, these forests are not discussed in the Plateaus Science Synthesis. The exception is Level IV Ecoregion 4g (California Cascades Eastside Conifer Forest), which is included in the Dry Pine Forestland category in the Plateaus Science Synthesis (figs. 1.1.5 and 1.1.6).

Sierra Nevada Forestland

The Sierra Nevada Science Synthesis generally placed the forests of the Lassen and Modoc in two categories: Sierra Nevada forests and the forests of the Modoc Plateau. The Sierra Nevada forests are represented by Level III Ecoregion 5 (Sierra Nevada) with four Level IV Ecoregions (see textbox 1.1.5) that generally pertain

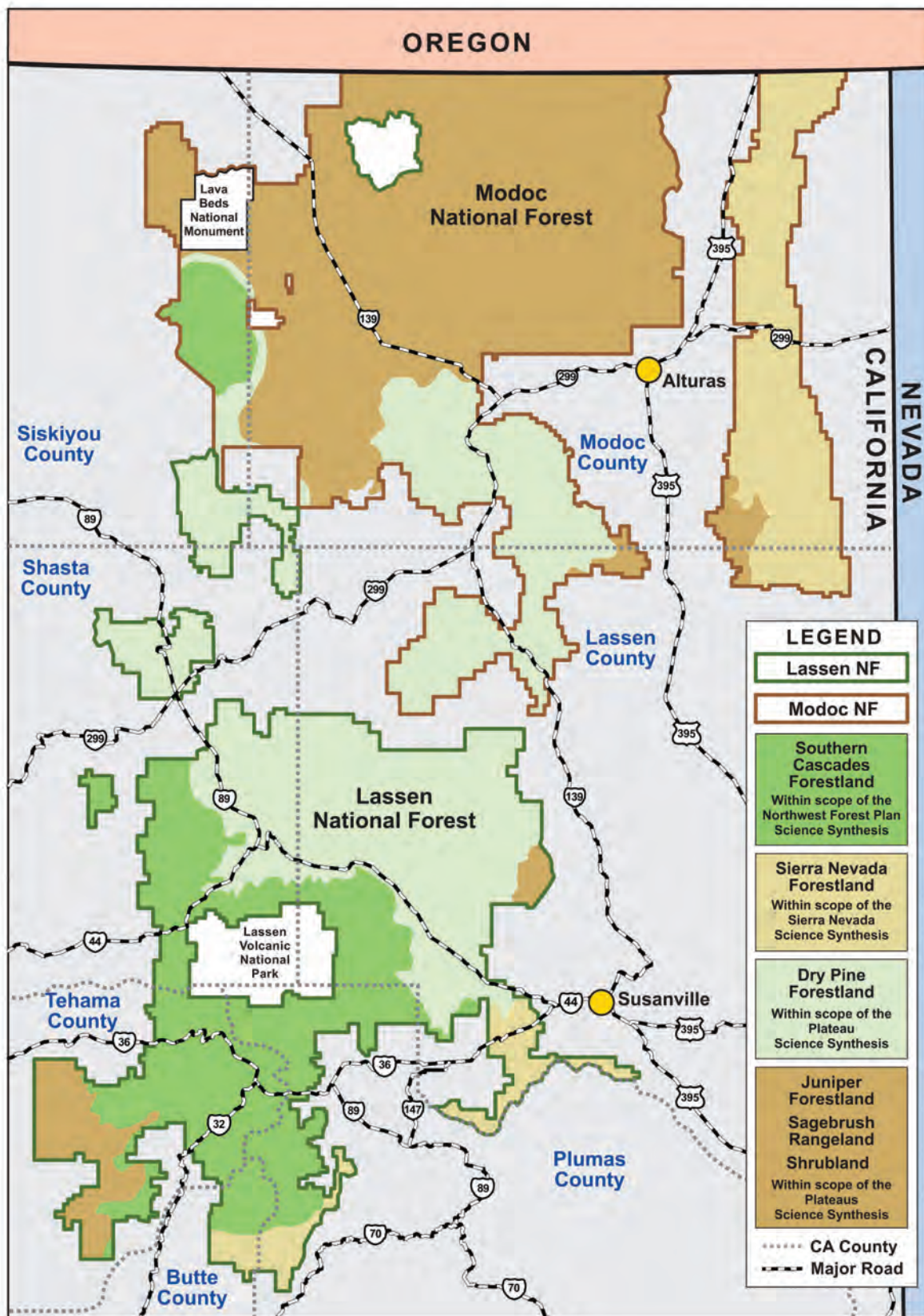


Figure 1.1.5—The Plateaus Science Synthesis delineates the Lassen and Modoc into four broad vegetation zones: (1) Southern Cascades Forestland; (2) Sierra Nevada Forestland; (3) Dry Pine Forestland; and (4) Juniper Forestland, Sagebrush Rangeland, and Shrubland. The Southern Cascades Forestland and the Sierra Nevada Forestland were covered in previous syntheses; thus, the focus of the Plateaus Science Synthesis is on Dry Pine Forestland and Juniper Forestland, Sagebrush Rangeland, and Shrubland.

Textbox 1.1.4—Southern Cascades forest landscapes included in the Northwest Forest Plan and Sierra Nevada Science Synthesis generally represent these ecoregions:

Level III Ecoregion 4—Cascades

Level IV Ecoregions:

4e: High Southern Cascades Montane Forest

4f: Low Southern Cascades Mixed Conifer Forest Service

4g: California Cascades Eastside Conifer Forest Service

4h: Southern Cascades Foothills

See Appendix 1.1 for descriptions of these Level IV Ecoregions.

Textbox 1.1.5—Sierra Nevada forest landscapes included in the Sierra Nevada Science Synthesis generally represent these ecoregions:

Level III Ecoregion 5—Sierra Nevada

Level IV Ecoregions:

5c: Northern Sierra Upper Montane Forests

5d: Northern Sierra Mid-Montane Forests

5e: Northern Sierra Lower Montane Forests

5f: Northern Sierra Mixed Conifer-Pine Forests

Level III Ecoregion 9—Eastern Cascades Slopes and Foothills

Level IV Ecoregions:

9m: Warner Mountains

9n: High-Elevation Warner Mountains

9q: Adin/Horsehead Mountains Forest and Woodland

See Appendix 1.1 for descriptions of these Level IV Ecoregions.

to higher-elevation forests of Shasta red and white fir, Jeffrey and sugar pines, incense cedar and quaking aspen; mid-elevation forests of white fir, Douglas-fir, Jeffrey pine, black oak, and tanoak; and lower-elevation forests of Douglas-fir, ponderosa pine, canyon live, interior live, and black oaks, and tanoak. Because of extensive coverage in the previous syntheses, these forests are not discussed in the Plateaus Science Synthesis. The Sierra Nevada Science Synthesis also discusses forests on the Modoc Plateau; these forests are included in Level III Ecoregion 9 (Eastern Cascades Slopes and Foothills) and are mostly represented by the higher-elevation forests of the Warner Mountains (Level IV Ecoregions 9m, 9n) and the lower elevation conifer forests (predominantly Level IV Ecoregion 9q). These forests are chiefly lower-elevation communities of ponderosa and Jeffrey pines and white fir transitioning to forests of ponderosa, Jeffrey, and Washoe pines, quaking aspen, and white fir on the Warner Mountains. Although the forest staffs believed that the forests of the Warner Mountains (Ecoregions 9m and 9n) were sufficiently addressed by the Sierra Nevada Science Synthesis, they also believed that the ponderosa and Jeffrey pine forests on the remainder of the Modoc Plateau (Ecoregion 9q) should be included as part of the dry pine forestland covered in the Plateaus Science Synthesis (figs. 1.1.5 and 1.1.6).

Dry Pine Forestland

In this synthesis, dry pine forestland is defined as the drier portions of the Southern Cascades and the forested portions of the Modoc Plateau excluding juniper-dominated stands (figs. 1.1.5 and 1.1.6). This forestland is mainly ponderosa and Jeffrey pines.

Juniper Forestland, Sagebrush Rangeland, Shrubland

This broad vegetation zone embraces those ecosystems more often associated with the Great Basin and not covered by the Northwest Forest Plan and Sierra Nevada science syntheses (figs. 1.1.5 and 1.1.6). Western juniper is the predominant conifer, with rare occurrence of singleleaf piñon.

Organization of the Plateaus Science Synthesis

The Plateaus Science Synthesis is organized into six sections (each with one or more chapters) corresponding to major topic areas defined through the initial public workshop. The first section is this **Introduction**. The second section, **Forestland**, has a single chapter (Chapter 2.1, Moser, this synthesis, *Understanding and Managing*

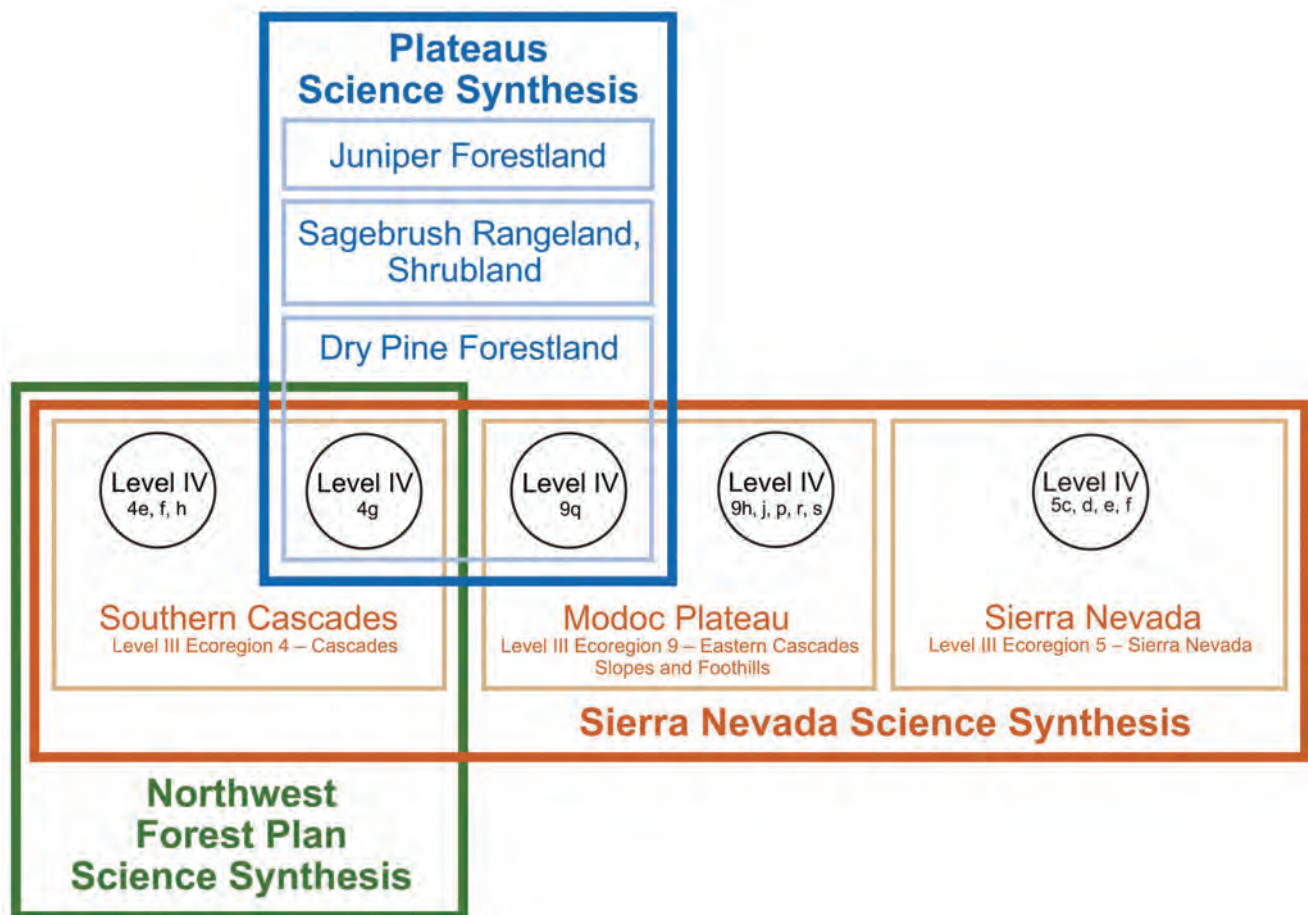


Figure 1.1.6—This Venn diagram shows the scope of three science syntheses as they pertain to the Lassen and Modoc National Forests. The Southern Cascades, which occur in both the Lassen and the Modoc, were part of the discussion within the Northwest Forest Plan Science Synthesis. The Sierra Nevada Science Synthesis also discussed the Southern Cascades as well as forests of the Sierra Nevada and the non-juniper-dominated forests of the Modoc Plateau. The Dry Pine Forestland discussion in the Plateaus Science Synthesis augments discussion about the Southern Cascades in the Northwest Forest Plan and Sierra Nevada science syntheses, particularly that of the California Cascades Eastside Conifer Forest (Level IV Ecoregion 4g). The Dry Pine Forestland also includes discussion about forested landscapes on the Modoc Plateau discussed in the Sierra Nevada Science Synthesis, notably those dominated by Jeffrey and ponderosa pines with some white fir (Level IV Ecoregion 9q; see textbox 1.1.6 for scientific names of tree species used in this chapter). Because neither of the previous syntheses focused on either juniper-dominated landscapes or sagebrush rangelands, these ecosystems are a focus of the Plateaus Science Synthesis.

the Dry Conifer Forests of Northeastern California) devoted to understanding and managing the dry conifer forests of the Lassen and Modoc. This chapter begins with a broad discussion about the potential impacts of drought on Western forestlands, and then focuses in more depth on different forest management tenets. The chapter discusses ponderosa and Jeffrey pine ecology, history, and how those forests can benefit from silviculture, and concludes with discussion about the ecology and management of juniper-dominated forestlands.

The third section, **Rangeland**, consists of four chapters. The first chapter (Chapter 3.1, Warren, this synthesis, *Perceptions and History of Rangeland*) briefly describes how rangeland management has been perceived in the Western United States. The second chapter focuses on the interactions of climate change, grazing, and carbon storage on rangelands; the response of native plant communities, especially those dominated by annual invasive grasses, to grazing; meeting rangeland management objectives; and restoring sagebrush ecosystems (Chapter 3.2, Dumroese, this synthesis, *Rangeland in Northeastern California*).

Textbox 1.1.6—Tree species mentioned in this chapter.

California black oak—*Quercus kelloggii*
Canyon live oak—*Quercus chrysolepis*
Douglas-fir—*Pseudotsuga menziesii*
Incense cedar—*Calocedrus decurrens*
Interior live oak—*Quercus wislizeni*
Jeffrey pine—*Pinus jeffreyi*
Lodgepole pine—*Pinus contorta*
Mountain hemlock—*Tsuga mertensiana*
Ponderosa pine—*Pinus ponderosa*
Quaking aspen—*Populus tremuloides*
Shasta red fir—*Abies magnifica*
Singleleaf piñon—*Pinus monophylla*
Sugar pine—*Pinus lambertiana*
Tanoak—*Notholithocarpus densiflorus*
Washoe pine—*Pinus ponderosa* var. *washoensis*
Western hemlock—*Tsuga heterophylla*
Western juniper—*Juniperus occidentalis*
Western redcedar—*Thuja occidentalis*
White fir—*Abies concolor*

The third chapter (Chapter 3.3, Padgett, this synthesis, *Weeds, Wheels, Fire, and Juniper: Threats to Sagebrush Steppe*) reviews threats (and management responses) to the sagebrush ecosystem, including invasive weeds, vehicles, fire, and conifer encroachment. Chapter 3.4 (Warren, this synthesis, *Biological Soil Crusts*) examines the ecology, threats, and restoration of the microorganisms associated with biological soil crusts.

The fourth section, **Habitat and Wildlife**, consists of three chapters. The first chapter (Chapter 4.1, Hanberry and Dumroese, this synthesis, *Biodiversity and Representative Species in Dry Pine Forests*) examines the biodiversity of dry pine forests, from fungi to herbaceous plants to invertebrates to three representative species of this habitat: black-backed woodpecker (*Picoides arcticus*), flammulated owl (*Psilosops flammeolus*), and gray wolf (*Canis lupus*). Chapter 4.2 (Padgett, this synthesis, *Aquatic Ecosystems, Vernal Pools, and Other Unique Wetlands*) focuses on the role and importance of

aquatic ecosystems, including lakes, vernal pools, fens, and swales to biodiversity, especially native trout and rare plants. The final chapter (Chapter 4.3, Dumroese, this synthesis, *Sagebrush Rangelands and Greater Sage-grouse in Northeastern California*) begins with a broad look at sagebrush rangelands and then focus on greater sage-grouse because some view the health of this species as an indicator of overall sagebrush ecosystem health.

Society is the topic of the fifth section. Given that the major focal point of new forests plans is management of National Forest System lands so that they are ecologically sustainable and contribute to social and economic sustainability, this section addresses the subject in five chapters. The first chapter provides an overview of the section (Chapter 5.1, Flores, this synthesis, *An Introduction to Social, Economic, and Ecological Factors in Natural Resource Management of Northeastern California Public Lands*). The second chapter (Chapter 5.2, Flores and Russell, this synthesis, *Demographic Trends in Northeastern California*) focuses on current rural demographics in Lassen and Modoc Counties and their expected changes, the impacts of prisons on local communities, and the decisionmaking process managing natural resources. The third chapter (Chapter 5.3, Flores and Haire, this synthesis, *Ecosystem Services and Public Land Management*) examines the social benefits provided by ecosystems, the economic benefits of these services, and societal inputs into resource management. Community engagement is the focus of the fourth chapter (Chapter 5.4, Flores and Stone, this synthesis, *Community Engagement in the Decisionmaking Process for Public Land Management in Northeastern California*), and hones in on how communities can participate in natural resource management and use that engagement to resolve conflict. How tribes value place, interact with managers, and use fire management is the theme of the fifth chapter (Chapter 5.5, Flores and Russell, this synthesis, *Integrating Tribes and Culture Into Public Land Management*).

Responding to Disturbances is the final section. Its single chapter (Chapter 6.1, Wright, this synthesis, *Ecological Disturbance in the Context of a Changing Climate: Implications for Land Management in Northeastern California*) takes a broad look at various factors that are currently, or may in the future, affect these ecosystems, how a changing climate interacts with those disturbances, and what possible management techniques could be considered to mitigate disturbances.

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Appendix 1.1—Descriptions (Griffith et al. 2016) of the Main Level IV Ecoregions Found Within the Broader Level III Ecoregions Occurring Within the Lassen and Modoc National Forests.

Level III Ecoregion 4—Cascades

4e The **High Southern Cascades Montane Forest Ecoregion** is an undulating, volcanic plateau containing isolated buttes, cones, and peaks. Some parts of the region are glaciated. The terrain often is less dissected than that of Ecoregion 4f. Elevations of Ecoregion 4e are generally intermediate to elevations in the Low Southern Cascades Mixed Conifer Forest (4f) and the Cascade Subalpine/Alpine (4d) ecoregions. In California, elevations of the ecoregion are mostly 5,500 to 8,500 feet (1,676–2,591 m), but are lower in Oregon at 4,000 to 8,200 feet (1,219–2,499 m). Cryic soils support mixed-coniferous forests dominated by mountain hemlock, lodgepole pine, and, in Oregon, some Pacific silver fir; the soils are colder than the mesic and frigid soils of the Low Southern Cascades Mixed Conifer Forest Ecoregion (4f). White fir and Shasta red fir also occur in the ecoregion, with some grand fir in Oregon. This region has a longer summer drought and more intermittent streams than the Cascade Crest Montane Forest Ecoregion (4c) to the north in Oregon and Washington.

4f The **Low Southern Cascades Mixed Conifer Forest Ecoregion** generally is lower in elevation and less rugged than the more highly dissected Western Cascades Montane Highlands (4b) to the north in Oregon. Although still mostly a mesic mixed-conifer region, the climate is drier than in the Western Cascades of Oregon (Ecoregions 4a and 4b), and the vegetation reflects this. Western hemlock and western redcedar, indicator species of Ecoregions 4a and 4b, decrease in abundance southward in this ecoregion in Oregon and are replaced by Sierra Nevada species, such as incense cedar, white fir, Shasta red fir, and Jeffrey pine that tolerate prolonged summer drought. In California, shrubs such as manzanita and ceanothus are common. Curleaff mountain-mahogany, big sagebrush, and antelope bitterbrush occur as well, with their dispersion centers in the Great Basin regions farther east. River and stream discharge is significantly

less than in systems to the north. Soil temperature regimes are mesic and frigid, and the soil moisture regime is xeric. Elevations in the California part of this ecoregion are about 3,000 to 7,600 feet (914–2,316 m).

4g The **California Cascades Eastside Conifer Forest Ecoregion** is drier than the other California Cascades regions. It is dominated by ponderosa pine and, in some areas where conditions are harsher, Jeffrey pine. In lower, drier areas, the region blends into the western juniper and sagebrush fields more typical of adjacent Ecoregion 9. The region wraps around to the western side (that is, the Mount Shasta foothills), as similar dry conditions exist from the rain shadow cast by the Klamath Mountains to the west. Elevations range from 3,000 to 7,100 feet (914–2,164 m).

4h The **Southern Cascades Foothills Ecoregion** of volcanic hills and plateaus is mostly in the 2,000- to 4,000-foot (610–1,219 m) elevation range, stretching from the town of Paradise in the south to the Pit River in the north. It contains dry-mesic mixed-conifer forest and lower montane black oak-conifer forest and woodland. Ponderosa pine is abundant along with some Douglas-fir, and, at higher elevations, white fir. Hardwoods typically are black oak and canyon live oak. Soil temperature regimes are mostly mesic with some frigid, and soil moisture regimes are xeric.

Level III Ecoregion 5—Sierra Nevada

5c The **Northern Sierra Upper Montane Forests Ecoregion** ranges in elevation mostly from 6,000 to 8,000 feet (1,829–2,438 m), and its forests have a mix of conifers, including red fir, white fir, Jeffrey pine, sugar pine, incense cedar, and some lodgepole pine. Intermixed are areas of quaking aspen groves. Some montane chaparral also occurs in areas of harsh exposure, repeated fires, and clear cuts. Geology types are mostly Mesozoic granitic rocks and Tertiary volcanics, although in the north these occur along with some areas of slate, sandstone, metavolcanics, and metasedimentary rocks. Soil temperature regimes are mostly frigid, with some cryic. Soil moisture regimes are mostly xeric, but are udic in areas where snow persists through spring.

5d In contrast to the volcanic and granitic rocks of similarly zoned Ecoregion 5g to the south, in the **Northern Sierra Mid-Montane Forests Ecoregion**, metamorphic rocks are abundant, with Paleozoic

metasedimentary argillite, phyllite, and quartzite, and some metavolcanics, as well as Mesozoic peridotite and serpentine. Elevations range mostly from 3,000 to 6,000 feet (914–1,829 m), with some lower west-end canyon elevations. This higher-elevation mixed-conifer forest has more white fir and Douglas-fir and less ponderosa pine than in the lower-elevation Ecoregion 5h to the south. Jeffrey pine occurs on ultramafic rocks and some drier areas to the east. Black oak and tanoaks are common hardwoods, along with canyon live oak. Soil temperature regimes are mostly mesic and soil moisture regimes are mostly xeric.

- 5e Generally lower in elevation than adjacent Ecoregion 5d, the **Northern Sierra Lower Montane Forests Ecoregion** has a mix of montane hardwood, montane hardwood-conifer, and mixed-conifer forests. Elevations range mostly from 2,000 to 4,000 feet (610–1,219 m), with a few higher areas. Ecoregion 5e has less ponderosa pine than Ecoregions 5h and 5n to the south. Douglas-fir is a more widespread conifer, and hardwoods include canyon live oak, interior live oak, black oak, and tanoak. Annual precipitation is somewhat higher than in Ecoregion 5h immediately to the south. Geology is a complex mix of Mesozoic granitic rocks, Jurassic to Triassic metavolcanics, and some Mesozoic to Paleozoic metasedimentary and ultramafic rocks.
- 5f The **Northeastern Sierra Mixed Conifer-Pine Forests Ecoregion** includes many of the drier eastside forests of the Northern Sierra Nevada that occur north of Bridgeport, in the Lake Tahoe area, and to the northern extent of the Sierra near Susanville. These are mid-elevation dry forests, typically between 5,000 and 8,000 feet (1,524–2,438 m), with a diverse mix of conifers, such as Jeffrey, ponderosa, and sugar pines; incense cedar; and California white fir. The understory can include sagebrush, antelope bitterbrush, and a fire-maintained chaparral component of snowbrush and manzanita. Soil temperature regimes are frigid and soil moisture regimes are mostly xeric.

Level III Ecoregion 6—Central California Foothills and Coastal Mountains

- 6a The **Tuscan Flows Ecoregion** is a gently southwest-sloping plateau with some steep canyons and a few steep volcanic cones. Although the region is geologically related to the southwestern end of the

Cascades Ecoregion (4), it has ecosystem similarities to the Sierra Nevada foothills part of Ecoregion 6. Blue oak woodlands, annual grasslands, and foothill pine occur.

Level III Ecoregion 9—Eastern Cascades Slopes and Foothills

- 9g The **Klamath/Goose Lake Basins Ecoregion** covers river floodplains, terraces, and lake basins. Various wildrye, bluegrass, hairgrass, sedge, and rush species once covered the basins, but most of the wet meadows and wetlands have been drained for agriculture. Sagebrush and bunchgrass occur on most of the upland areas. Several marshland wildlife refuges here are critical to preserving the regional biodiversity, particularly for at-risk bird and fish species. In California, Butte Valley also is included in the ecoregion. Although the Butte Valley area differs somewhat from the Lower Klamath and Tule Lake Basins, it also has pasture and cropland.
- 9h The **Fremont Pine/Fir Forest Ecoregion** occurs mostly in Oregon, with a small area west of Goose Lake in California. It contains mid-elevation mountains and high plateaus that rarely exceed timberline. Closed-canopy forests contrast with the savanna of the Klamath Juniper Woodland/Devil's Garden Ecoregion (9j). Ponderosa pine is widespread, but white fir, sugar pine, lodgepole pine, and incense cedar also grow at elevations greater than 6,500 feet (1,981 m) and on northern slopes. Residual soils are common in contrast to ecoregions farther north in Oregon where residual soils have been buried by pumice and ash. Ecoregion 9h has a high density of lakes and reservoirs.
- 9j The **Klamath Juniper Woodland/Devil's Garden Ecoregion** is composed of undulating hills, benches, and escarpments covered with a mosaic of rangeland and woodland. Western juniper grows on shallow, rocky soils with an understory of low sagebrush, mountain big sagebrush, bitterbrush, and bunchgrasses. Other shrubland/grasslands include shrub species uncommon in eastern Oregon, such as woolly mule-ears, Klamath plum, and birchleaf mountain-mahogany. The diverse shrublands provide important wildlife habitat. Reservoirs dot the landscape and are important to lowland irrigation. Soil temperature regimes in the California part of Ecoregion 9j are mesic, whereas soil temperatures in the Oregon part are mesic and frigid.

The Devil's Garden place name appears on topographic maps in both States, 60 miles (97 km) apart.

- 9m The **Warner Mountains Ecoregion** comprises the low to mid-elevations of the Warner Mountains. In contrast to the mesic soils of the surrounding lower ecoregions, soil temperature regimes here are frigid. Soil moisture regimes are xeric. Vegetation includes big sagebrush, low sagebrush, perennial bunchgrasses, and western juniper at low elevations. At higher elevations, ponderosa pine, Jeffrey pine, Washoe pine, aspen, and white fir are common. Streams on the western side of this fault-block mountain drain to Goose Lake or the Pit River, and streams on the eastern side, which are much shorter, drain to Surprise Valley in Ecoregion 80.
- 9n The **High-Elevation Warner Mountains Ecoregion** is a subalpine/alpine area that ranges in elevation from about 7,800 to 9,892 feet (2,377–3,015 m) at Eagle Peak. This high-elevation zone contains aspen and lodgepole pine, with whitebark pine as the primary subalpine and timberline tree above about 8,500 feet (2,591 m). Drought-tolerant alpine cushion plants also occur. Soil temperature regimes are cryic. Annual precipitation is about 28–32 inches (711–813 mm) with deep winter snow.
- 9o The small **Likely Tableland Ecoregion** is a gently sloping footslope west of the Warner Mountains (9m). Relief is only about 100–300 feet (30.5–91 m). Elevations range from 4,500 to 5,500 feet (1,372–1,676 m). The sagebrush and grassland of Ecoregion 9o contrast with the adjacent higher relief hills and mountains of Ecoregion 9p that have abundant piñon-juniper woodland and some pine. Annual precipitation is only 12–15 inches (305–381 mm). The Quaternary andesite and basalt are younger than the Tertiary volcanics of Ecoregion 9p. Some perennial streams cross the region from the Warner Mountains to the Pit River. Soil temperature regimes are mesic and moisture regimes are aridic and xeric.
- 9p The **Modoc/Lassen Juniper-Shrub Hills and Mountains Ecoregion** is a faulted and eroded volcanic plateau with many volcanic hills and mountains. Soil temperature regimes are mesic and frigid. Soil moisture regimes are mostly xeric and aridic. Vegetation is mainly western juniper, big sagebrush, and perennial bunchgrasses. On the higher-elevation mountains, however, some small areas of Jeffrey pine, ponderosa pine, and white fir occur. There are few streams and most of those are dry during summer. Streams that flow from the ecoregion drain to either the Pit River, the Madeline Plains, or in the south, to the Honey Lake Valley.
- 9q The **Adin/Horsehead Mountains Forest and Woodland Ecoregion** consists of mountains to the north, east, and south of Big Valley. Elevations range from about 5,000 to 7,036 feet (1,524–2,145 m). Ecoregion 9q has more pine and mixed-conifer forest than the drier Ecoregion 9p to the east or the adjacent lower Ecoregion 9r. Soil temperature regimes are frigid and mesic and soil moisture regimes are mostly xeric. Vegetation is a mix of Jeffrey pine, ponderosa pine, and some white fir, and at low elevations, western juniper, big sagebrush, birchleaf mountain-mahogany, and other deciduous shrubs. There are a few streams and springs, but almost no lakes.
- 9r The **Adin/Dixie Low Hills Ecoregion** consists of hills and lava plateaus to the west of Ecoregion 9q that are lower in elevation (4,000–6,000 feet; 1,219–1,829 m) with less relief. The vegetation is mostly big sagebrush, low sagebrush, and scattered junipers, and generally lacks the pine of the nearby mountain ecoregions (9q, 4g). Soil temperature regimes are mesic and soil moisture regimes are xeric. Some streams cross the ecoregion to the Pit River, and several small shallow reservoirs occur here. Ranching and livestock grazing are predominant land uses.
- 9s The **Modoc Lava Flows and Buttes Ecoregion** is a volcanic plateau surrounding the Medicine Lake Highlands of the Cascades Ecoregion (4). It is lower and drier than those highlands, with more juniper and pine. Soil temperature regimes are mesic and soil moisture regimes are aridic and xeric. Vegetation includes western juniper, big sagebrush, and native perennial grassland. Water drains down through joints in the basalt rock to the groundwater reservoir, limiting overland flow of water and development of stream channels on the plateau.

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