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Forest Management Handbook for Small-Parcel Landowners in the Sierra Nevada and Southern Cascade Range

Peter A. Stine, Steven M. Ostoja, and Stewart McMorrow



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Cover photos: Much of California's Sierra Nevada and southern Cascade Range forest lands are owned by small-parcel private landowners. Managing that land as part of the larger ecosystem benefits these private forests and beyond. Main photo: Soda Springs, California; Peter Stine, USDA Forest Service. Left inset: brush cleared near a home in the upper Clear Creek watershed; USDA Natural Resources Conservation Service. Right inset: California trail hikers; Placer Land Trust.

Abstract

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Forests in the Sierra Nevada and southern Cascade Range are being stressed by a number of factors that put them at risk. High-severity wildfire, drought stress, insect outbreaks, disease, and a backdrop of changing climate all pose a threat to the persistence of these forests. These factors can work individually or combine to magnify the impacts on forests. For example, the 2012–2016 drought led to tree stress that increased susceptibility to bark beetles. However, there are land management options that can help landowners increase forest health.

A significant portion of Sierra Nevada and southern Cascades forests are owned and managed as small parcels (10 to 100 acres) by nonindustrial private landowners. This handbook is for such landowners; it provides succinct, straight-forward, and thorough information to help them develop a sound forest management strategy for their property. This handbook was assembled by synthesizing information from a large body of current scientific literature, including printed and online sources, that provides relevant technical information for forest landowners. It is organized in a step-by-step manner to help landowners assess the condition of their property to make informed decisions rooted in the best available science. The handbook is built around four main chapters with attending worksheets that enable landowners to build a California cooperative forest management plan. The plan will help determine what, if any, management action(s) is needed on your land; how to obtain technical and financial support; and what, if any, permits may be necessary. This handbook uses easy to understand language that does not require any specific training in forest science or management.

Keywords: Forest restoration, forest management, nonindustrial private forest landowners, climate change adaptation, handbook, Sierra Nevada, southern Cascades.

Preface

Forest health has never been a more important concern in California. Over the past century, significant changes have occurred in California's forests as a result of multiple factors, including fire exclusion; historic logging practices; increased development and fragmentation; and more recently, the effects linked to a changing climate. Collectively, these factors have intersected to create a heightened risk of high-severity wildfire, susceptibility to pests and disease, and drought-linked tree mortality. These dynamics emphasize the importance of providing relevant information and resources to help the more than 350,000 private-forest landowners in California who own and manage more than 7 million acres (about 23 percent of all conifer and hardwood forests and woodlands in the state) manage their forest parcels in this period of unprecedented change. To address this need, the California Department of Forestry and Fire Protection, in partnership with the U.S. Department of Agriculture, California Climate Hub, has produced this handbook. This handbook walks the small-parcel forest landowner step by step through the processes of setting objectives for their property, site inventory, basic risk assessment, potential management options, and identifying available resources. It provides easy-to-understand, scientific information to help landowners make informed decisions. The state and federal governments have set an ambitious goal of treating 1 million acres of forest land annually to increase forest health, reduce the risk of catastrophic wildfire, and safeguard California's treasured forest resources for inhabitants who depend on our forests. We trust this handbook will help small-parcel private landowners understand how they can be part of this initiative.

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Introduction

Purpose of This Handbook

This handbook provides nonindustrial private forest land owners, generally people with parcels from 5 to 100 acres, with information to help them develop a sound management strategy for their forested land. The basic purpose of this handbook is to help you, the landowner, gather the information you will need to achieve your forest management objectives. As you work through each of the four main chapters and their corresponding worksheets in appendix 3, you will assemble the information needed to build a California cooperative forest management plan. The management plan template provided in chapter 5 meets management plan requirements for grant agreements and other provisions available through the California Department of Forestry and Fire Protection (CAL FIRE), U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), USDA Forest Service, and the American Tree Farm Association. The plan will help you determine what, if any, management actions need to be done on your land, how to obtain technical and financial support, and what, if any, permits may be necessary.

This handbook focuses on the productive and scenic forests of the Sierra Nevada and Cascade Range regions. Managing these forests should include approaches appropriately tailored for the climate, topography, and soils of this region. It would not be effective to provide forest management guidance for the entire state, given the broad variability of statewide ecological conditions. We begin with some relevant background information to familiarize readers with the issues surrounding forest management. Chapters 1 through 4 detail what information is important and needed to build a forest management plan for your property. Chapter 5 provides more information on developing the actual forest management plan. The appendices provide additional information on a variety of topics related to the types of support available to landowners.

The Sierra Nevada and Cascade Range Region

More than 350,000 individuals or families own and manage small parcels of forest land in California. A total of 30.6 million acres in California (30 percent of the state) support conifer and hardwood forests and woodlands (fig. 1). More than 7 million acres of these forest lands are owned and managed by private individuals (fig. 2). About 90 percent of these landowners own less than 50 acres. We have prepared this handbook to address the needs of any small-parcel private landowner, regardless of specific objectives.

Nonindustrial private forest land owners have a wide variety of forest management objectives that depend on their goals and individual preferences. Managing forestland also can be difficult given the many technical, legal, and operational challenges involved. Moreover, current conditions in forests today present many challenges to all forest managers.

Private, small-parcel forest land owners likely have many questions about how to manage their lands. Many do not have training or experience in managing forests. Yet it is becoming increasingly evident that forest lands in the Sierra and Cascades, no matter who owns or manages them, need attention. Trees are dying at accelerated rates as a result of several natural causes, forest fires are becoming larger and more intense, and changing climates are exacerbating these conditions and increasing risks of converting forests to shrublands or grasslands.

Past, Present, and Future Forest Conditions

Forests are ever-changing plant communities, dominated by trees and punctuated by periodic disturbance events that remove some trees and maintain the capacity of forests to sustain themselves over time. There is abundant scientific evidence of the role of fire as a critical disturbance event in the Sierra and Cascades. Periodic, low-intensity fire is the primary mechanism by which a forest thins itself and reduces fuels. Low-intensity fire was a common occurrence until about 100 years ago in most of the mixed-conifer forest of the Sierra and Cascades region. Fire would typically return every 10 to 20 years, consuming small fuels on the ground and killing small trees. This opened the forest and made it more resistant to disturbances and recurrent stress until the next low-severity fire occurred. It is the exclusion of these smaller fires that has driven the current behavior, frequency, and intensity of recent large, destructive fires.

Fire exclusion and the removal of the largest, most fire-resistant trees over the past 100 years has changed forest conditions significantly. Much of the forests today are denser, contain smaller trees that are more vulnerable to being killed by wildfire, and have accumulations of fuels on the forest floor. Figure 3 illustrates a healthy, multistructured forest with large, dominant trees with canopies at least 20 feet above ground surface, much as it would have been prior to fire exclusion. Figure 4 illustrates current forest conditions throughout much of the Sierra Nevada's

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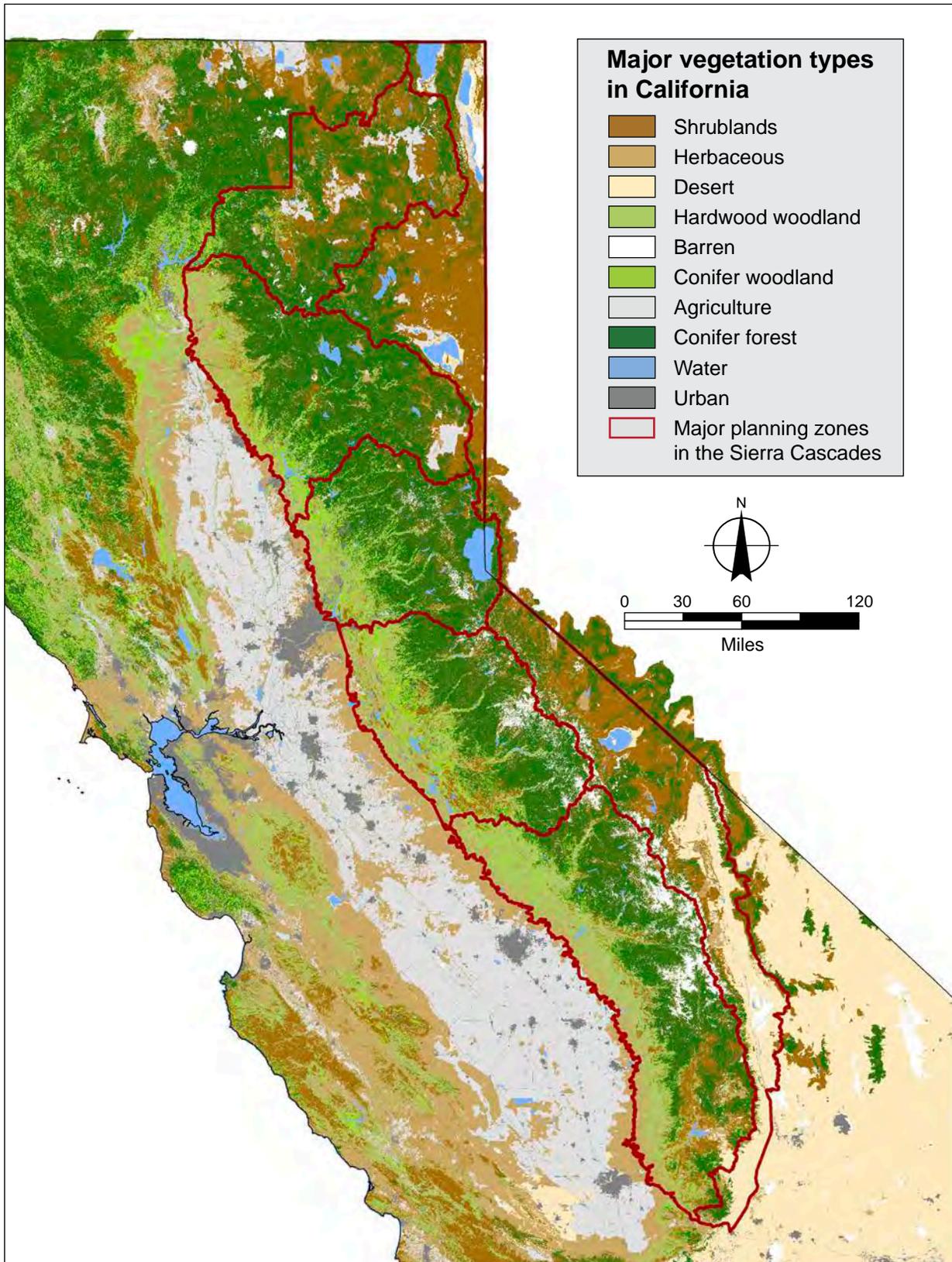


Figure 1—Major vegetation types in the Sierra Cascades. From California’s Forest and Rangelands 2017 Assessment, Fire and Resource Assessment Program, California Department of Forestry and Fire Protection. Vegetation types most common in Sierra and Cascade forests include Jeffery pine, lodgepole pine, ponderosa pine, red fir, Sierran mixed-conifer, and white fir.

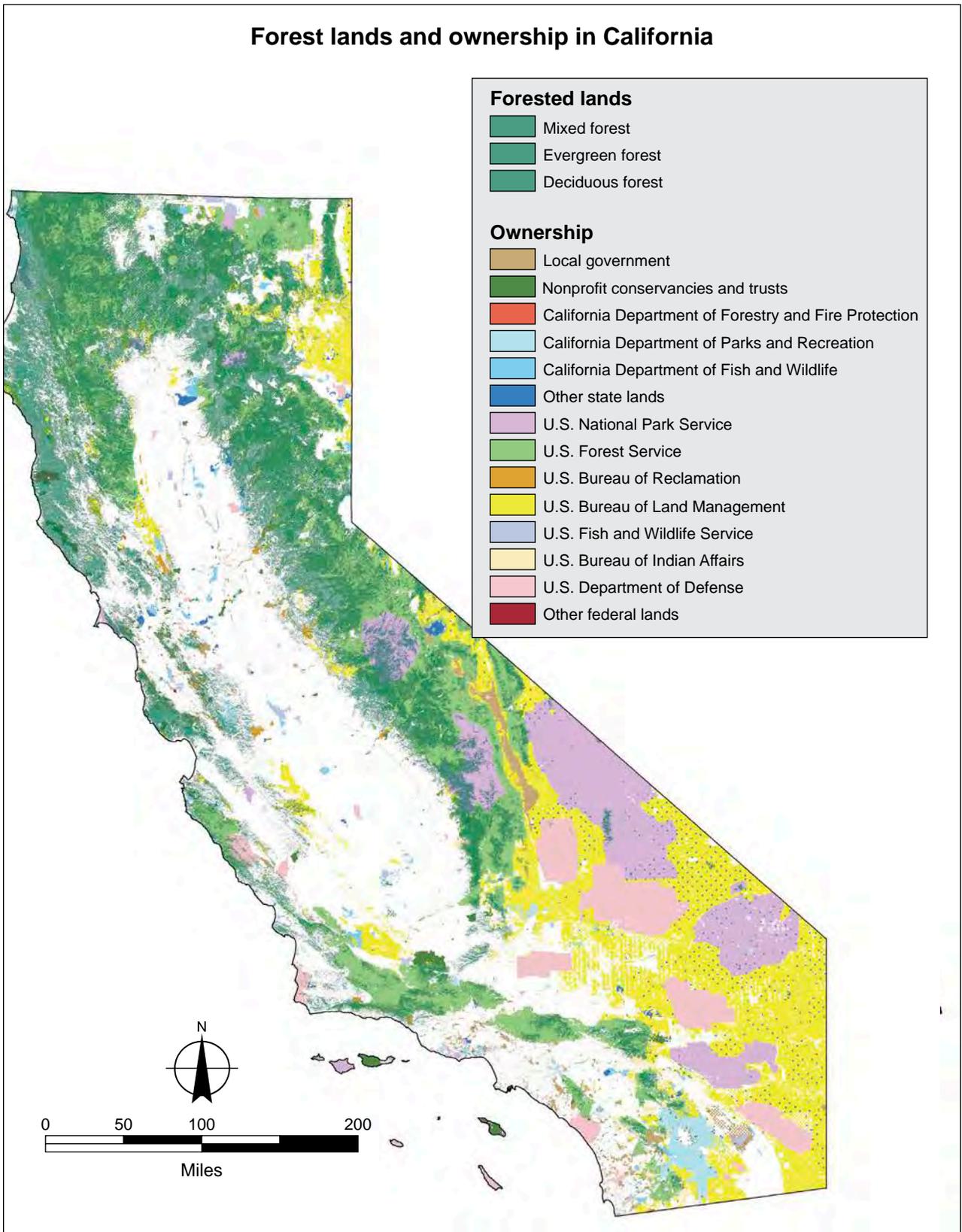


Figure 2—Forest land ownership in the Sierra Cascades. Data from California’s Forest and Rangelands 2017 Assessment, Fire and Resource Assessment Program, California Department of Forestry and Fire Protection and from the National Land Cover Database.

Malcolm North



Figure 3—Healthy multi-structured forest with large dominant trees.

Peter Stine



Figure 4—Dense forest stands common throughout much of the Sierra Nevada.

dense stands of small trees and canopies that are close to, or even touch, the ground. These current conditions, combined with warming trends and longer fire seasons, have significantly increased the threat of larger, higher severity fires. Many fires that occur today can burn through an entire forest under certain weather conditions. The once-rare, high-intensity fires will now burn and kill even the largest trees, often resulting in mortality of virtually all trees in a stand and the likely loss of forest cover for decades. The noteworthy expansion of human habitation throughout much of these forests over the past 50 years promotes a wildland-urban interface that is vulnerable to destructive fire.

Historical forests in the Sierra and Cascades (before Euro-American management) were characterized by low-density stands of large, old trees. Typically, stands of mixed-conifer forests were dominated by large pines (larger than 40 inches in diameter) with little vegetation in the understory and about 50 to 80 trees per acre. Of course, there was always a degree of forest variability driven by periodic disturbances (fire, occasional insect or disease outbreaks) and the inherent variability of the landscape influenced by ecological features such as topography and soils. Some areas had higher densities of trees (owing to deeper soils, northern exposed hillslopes, or cooler temperatures in drainage bottoms), other areas had very sparse stands intermixed with shrubs (owing to shallow soils on exposed ridgetops and south-facing slopes). It is important to keep in mind that forest structure (the horizontal and vertical distribution of trees, shrubs, and ground cover) and composition (the species and relative abundance of trees) are naturally variable. Nonetheless, current forest conditions have departed significantly from past structure and composition in some important ways. Many areas, especially those that have escaped fire for many decades, have tree densities that are 3 to 10 times what they were 100 years ago. There has also been a shift **from** pines and black oak (which grow under full or partial sunlight and can survive low-intensity fires) **to** firs and cedars (which are typically killed by fire, but can survive in the shade of other trees). There are also significantly higher proportions of smaller, younger trees and far fewer large, old trees.

Three major factors have driven the changes to the forest structure that we see today in California's Sierra Nevada and Cascade Range regions:

- Much of the Sierra has been logged with an emphasis on harvesting larger, fire-resistant trees.
- Fire suppression/exclusion has been the predominant policy for the past century, leading to the steady recruitment of small, shade-tolerant trees.
- Treatments/management strategies have been executed along ownership boundaries, resulting in a patch quilt of forest environments, particularly in the wildland-urban interface, which has expanded significantly in the past 50 years.

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Recent changes in climate, such as warmer temperatures, more erratic precipitation patterns, and less snow, all interact to make growing conditions more stressful for forests that emerged under this changed environment. These changing climates are leading to prolonged fire seasons and the increased possibility of large-scale landscape change.

How to Use This Handbook

Developing and executing an effective forest management plan for your property may seem like a large and complex task. Indeed, it is not always easy, but it is achievable. This handbook uses simple terms to help you consider important factors and take the necessary steps to get the job done. There are many resources available for forest land owners. The information contained herein will assist you in understanding what is needed and how to access the resources and support required to achieve your goals for maintaining a healthy forest on your property.

This handbook was created by synthesizing information from a large body of current scientific literature, including in-print and online sources that provide relevant technical and legal information for forest land owners. We have organized this handbook in a stepwise manner to help landowners make decisions (fig. 5). The reader is encouraged to become familiar with each step and skim through sections and material with which they are already familiar. There is a wealth of information and many sources of assistance in California that can be useful to private forest land owners. We provide a list of resources for additional help and information in appendix 1.

Step 1 entails carefully considering the management objectives tailored to your specific forest and your goals for that forest (chapter 1). Some may want to manage commercially for timber, others may want to emphasize scenic and ecological value, and still others may want some combination of values. Whatever your choice, it is important to be clear what your objectives are from the outset. In step 2, you will need to conduct a **condition assessment** (chapter 2). This will include some level of understanding of the history of the property and how the forest has changed. Further evaluation involves assessing current conditions (What types of trees do I have? How many trees are there per acre? How are they arranged on the property? etc.). Step 3 will help you **identify the kinds of disturbances and stressors** your forest will face (chapter 3), and in step 4 you will be **evaluating what treatment options**, if any, may be deemed appropriate or even necessary (chapter 4), including possible long-term strategies for enhancing the resiliency of your forest. Chapter 5 offers options for compiling the information into a **forest management plan**.

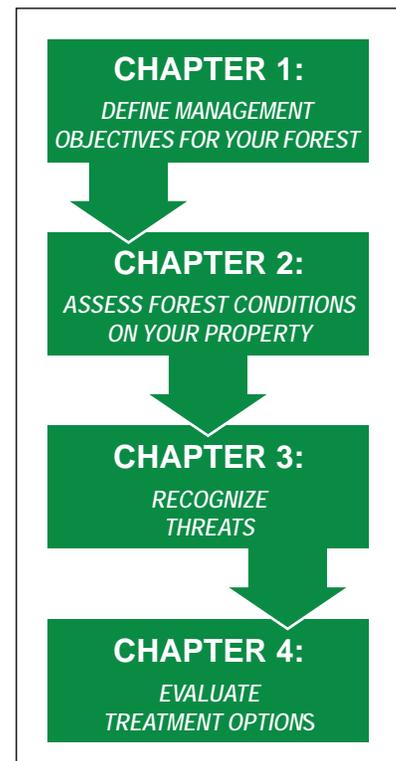


Figure 5—Four-step forest evaluation process for your property.

Chapter 1: Management Objectives

It is essential that landowners have a clear idea of what they want from their forests before they determine what, if anything, they need to do to manage their forest. Defining objectives will aid you in recognizing concerns and selecting different management tactics needed to achieve your objectives. After completing this section, you will have a clear description of your objectives and what you want your forested property to provide for you and your family. There are many different directions your decisions can take you, depending on the desired conditions and what you learn from the subsequent steps.

Fire Safety Measures for Home and Property

We believe that the first objective for **every** homeowner within or adjacent to wildlands is fire safety and prevention. Prevention of unplanned or unwanted fire in what is commonly called the wildland-urban interface is a major consideration for the California Department of Forestry and Fire Protection (CAL FIRE) and the many local fire jurisdictions around the state. California has millions of acres of wildland-urban interface where housing and wildland vegetation directly intermingle. The forests of the Sierra Nevada burn periodically, and despite the best efforts to protect property, some fires may not be contained before they move into developed areas. Therefore, it is vitally important that homeowners imbedded in and around forests take some basic precautions.

The first and most critical thing that all forest land owners with homes on their property should consider is taking these immediate steps to protect their homes from wildland fire:

- Create and maintain a 100-foot clearance, often referred to as “defensible space,” around your house. This includes on the ground around your house **and** the tree canopy near your house. Prior recommendations only called for a 30-foot defensible space; however there have been far too many examples of severe fire weather conditions in which 30 feet was not enough. This is the single most important action a forest land owner can take. (A 100-foot defensible space is now state law.) For more information, see the CAL FIRE Defensible Space Web page: <https://www.fire.ca.gov/programs/communications/defensible-space-prc-4291/>.
- Follow proper, legal guidelines for burning debris, including only burning on permitted burn days.
- Cut weeds and dry grass before 10 a.m. when humidity is higher, and temperatures are lower.
- Consider landscaping the area around structures with fire-resistant vegetation and materials.

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- Be careful when using power tools, even hammers; sparks from active tool use can also ignite a fire.
- Implement similar vegetation clearing on areas adjacent to access roads or evacuation routes under your control as the landowner.

Another critical consideration for homeowner safety is the home itself. Home construction along with several other features can be controlled by the homeowner to reduce the vulnerability of physical structures to fire. These include the following:

- Carefully consider where best to build a home on your property. The position of the house relative to the slope and the vegetation around it (for example, a house on the crest of a hill is more vulnerable to a fire pushed upslope by strong winds). Building on flat ground is best.
- Maintain a greenbelt of well-watered plant materials and rock or brick around the house.
- Do not store firewood or other flammable material under the house or deck.
- Use fire-resistant materials to build or to replace flammable materials. It is especially important to construct the roof with tile, metal, or asphalt roofing materials. Using fire-resistant materials for siding is also important.
- Enclose decks, porches, eaves, and cover vents with noncombustible screening.
- Use double-pane windows.
- Bury your power lines if possible; if not, keep all vegetation away from power lines.

For more details on protecting homes from fire in the wildland-urban interface, see the following publications and websites:

- U.C. Cooperative Extension guidance on preparing your home for wildfire: https://ucanr.edu/sites/fire/Wildfire_Preparation_-_Recovery/Building/.
- California Fire Safe Council brochures on hardened homes and defensible space: <https://cafiresafecouncil.org/resources/fire-safety-information-for-residents/>.
- National Fire Protection Association on preparing homes for wildfire: <https://www.nfpa.org/Public-Education/By-topic/Wildfire/Preparing-homes-for-wildfire>.

Define Management Objectives for Your Forest

Establishing the objectives for your forest is an important decision that will serve you and those around you for many years, and in some cases, change the trajectory of your forest for those who come after you. Nonindustrial private forest lands in the Sierra Nevada and Cascades are typically in small parcels, largely at the lower elevations. Your forest property is likely nestled among many other small-parcel forest land owner properties (see fig. 6); what you do on your forest will not only affect its future conditions, but potentially your neighbors and community as well. There are several objectives for owning and managing small tracts of private forest lands. The National Woodland Owner Survey, conducted by the U.S. Forest Service in 2006, identified 12 reasons for owning family forests in the United States. The main reasons for owning small tracts of forest land likely still holds true today and into the foreseeable future. Figure 7 illustrates the relative importance of these various purposes.

Many landowners have more than one purpose for their land; if there are several objectives, it will require some level of reconciliation among these different goals. Some objectives are compatible with others, at least to some degree (such as passing land on to heirs). But there may be instances where you will find objectives that are not as compatible, requiring prioritization and ultimately tradeoffs. The most common objectives or uses of small parcels of privately owned forest land in the Sierra fall into six general categories:

- Recreation and aesthetic enjoyment (such as wildlife habitat)
- Timber production (some tracts of family-owned forest lands have valuable stands of timber and provide some periodic income for those families)
- Minor forest products (such as firewood)
- Other agricultural products imbedded within a forest environment (such as agricultural production, grazing)
- Watershed health and ecological processes to provide for an array of ecosystem services
- Forest health to ensure integrity of the forest is sustained to provide all of the above benefits

U.S. Forest Service

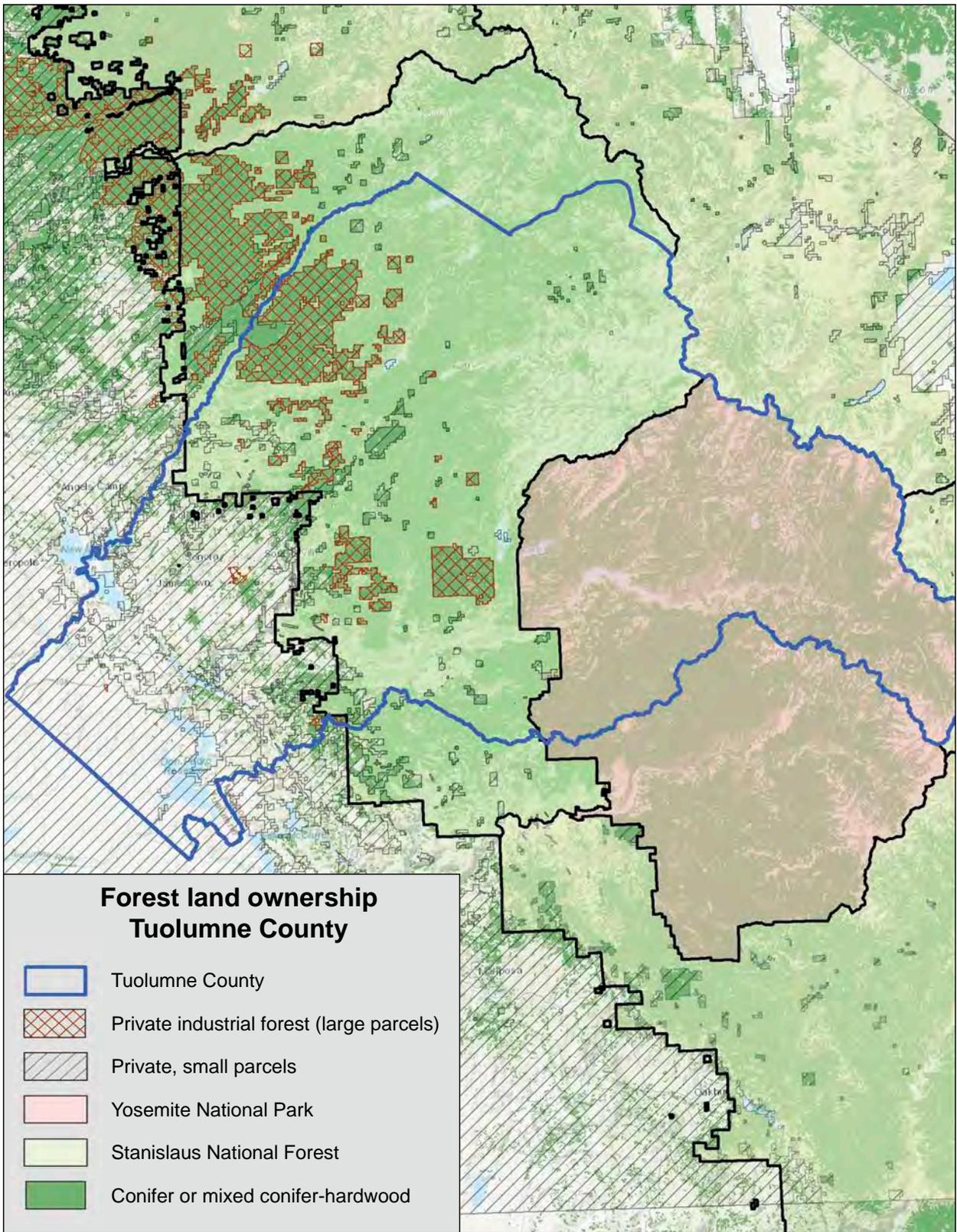


Figure 6—Distribution and abundance of private nonindustrial land parcels relative to other ownerships of private forest lands in the Sierra Nevada.

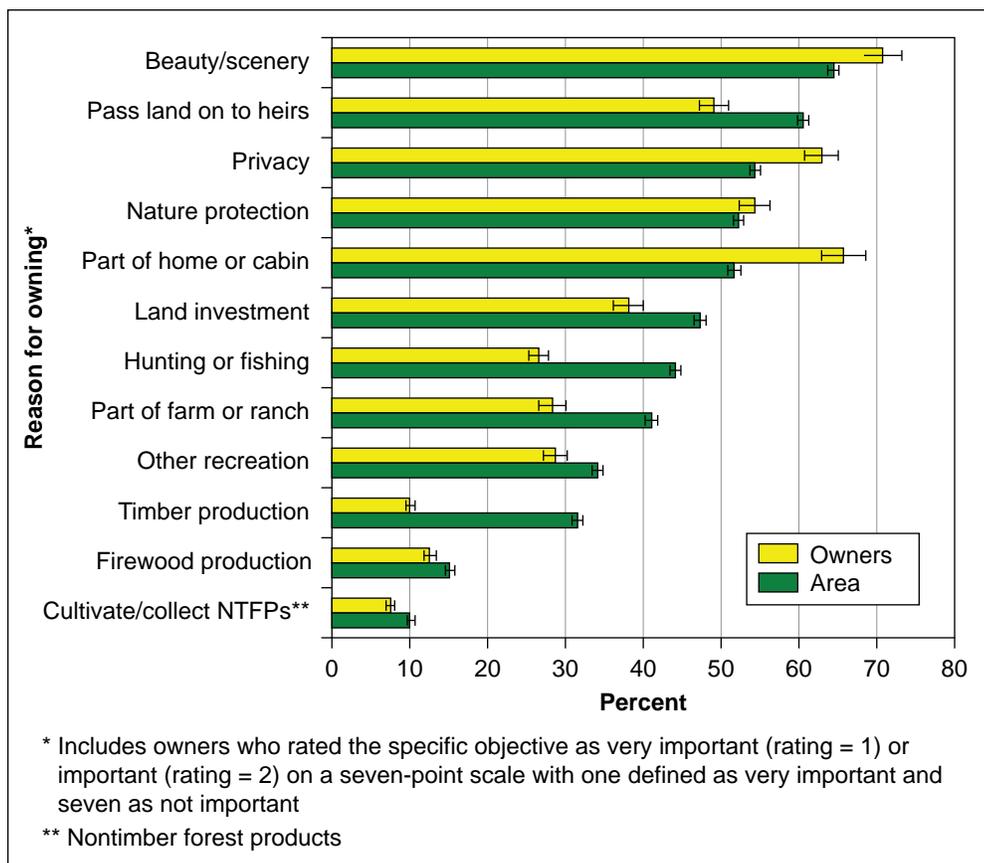


Figure 7—Reasons for owning family forests in the United States. U.S. Forest Service.

These are not mutually exclusive uses, and landowners often blend two or more of them to the extent that they are compatible. Decisions on what, if anything, needs to be done (discussed in chapter 5) will depend on what you want your forest to provide for you and your family in the coming years and decades. Barring a significant disturbance, forests tend to change relatively slowly. Therefore, setting objectives promptly and taking appropriate actions toward those objectives will change the trajectory of your forest, but it may take some time to see the results.

Many family forest owners may not be inclined or able to actively manage their forests in the near term. However, your forest is changing whether you do something or not. Trees and shrubs continue to grow and produce seed and likely regenerate. These changes in structure and composition over time are part of the natural process of forests. A striking example of changes that can happen quickly is the recent (2012–2016) drought period that resulted in millions of tree deaths, particularly in the central and southern Sierra.

The intention of this first section is to clarify and prioritize your objectives so you can give careful thought to which of the above-mentioned forest management objectives match what you want for your land. The University of California (UC) Division of Agriculture and Natural Resource publication, *Forest Stewardship Series 18: Stewardship Planning and Objectives*, is a helpful resource for considering goals for your forest. It discusses a variety of potential forest stewardship goals and objectives and the value of careful planning to address those goals. List the goals that you want to strive for, in priority order, and keep that information at the forefront of your planning as you move forward. It is usually not a simple or inexpensive undertaking to plan and manage a forest. Careful thought and planning will serve you well. However, if you know or quickly learn that your forest is now significantly vulnerable to fire, drought, or other disturbances, it may be advisable to take prompt action.

- *Stewardship Objectives and Planning*: <https://anrcatalog.ucanr.edu/pdf/8248.pdf>.

Additional Considerations for Your Forest

Forests provide a multitude of benefits to landowners, the human communities, and the ecological communities to which they belong. The following are additional objectives that are compatible with some of the six main objectives above, and that may only require some adjustments to meet. Use worksheet 1 in appendix 3 to complete this task.

Wildlife Habitat

Many forest land owners appreciate having wildlife on their land. There are more than 550 species of mammals, birds, reptiles, and amphibians found in the Sierra Nevada. Like humans, wildlife species require three basic elements from their habitat: food, water, and cover. There are several actions that a landowner can take to enhance conditions for wildlife on their property:

- Restore biological and structural diversity (i.e., different kinds and sizes of plants) to your forest. Forests were naturally diverse under historical conditions of frequent low-intensity fire.
- Restore springs, seeps, and other sources of water in your forest. Water is critical for wildlife and will attract wildlife and provide valuable habitat features.
- Retain important wildlife habitat features where safe and feasible. Certain features of a forest are especially important to wildlife. Such structures include snags (standing dead trees), broken-top live trees, and large trees. Other important features include large logs on the ground, patches of shrubs and other vegetation for cover, black oaks (mast crop), rock piles for cover, etc.

Carbon Storage and Other Ecosystem Services

Sustainable forest management practices can have a significant impact on the ability of forests to sequester atmospheric carbon while enhancing other ecosystem services, such as soil health and improved water quality. Forests are one of the most effective places to store carbon on earth. This objective may not appeal to everyone, but if you are interested, there are both socially valuable and practical reasons that may interest some forest land owners. Additionally, it may even be possible to voluntarily sell carbon offsets in the retail market to businesses interested in purchasing such credits.

Chapter 2: Current Conditions of Your Forest Property

The second step is to examine the current condition of your forest. We have outlined a straightforward approach with simple methods to assess what trees you have, how many trees you have, how big your trees are, and how your trees are arranged. After completing this section, you will have a record of what you have on your property today. With this information, you can move forward to assess potential threats to the forest and decide what, if any, management may be necessary to achieve certain objectives for the property. In appendix 3, we provide worksheet 2 to help complete this simple site assessment. In this worksheet, we explain how to gather the information listed below.

Assessing Site Conditions

It is important to take a careful look at your forest and the land it grows on; this is sometimes called a forest condition assessment. For this step, you collect or assemble some basic information about the trees in your forest. This is a task that can be more detailed if there is access to a professional resource manager. For an initial, cursory look, this would include a basic assessment of the climate, creating a map, and describing the forest setting and condition.

The General Climate of Your Area

To determine the general climate of your area, answer the following three questions:

- What is the average precipitation for your area?
- What are the average winter and summer temperatures?
- What proportion of your precipitation comes as snow?

To obtain this type of basic climate information, we suggest visiting a free resource such as the Cal-Adapt website: <https://cal-adapt.org/tools/>.

Here you can easily find annual averages of precipitation and temperatures for the specific location of your property. On their main page, go to the “Annual Averages” link and select “change location” on the map tool to find the 6- by 6-kilometer (3.73- by 3.73-mile) grid cell that includes your property. Press update chart and you will have the data on maximum and minimum temperature, and average precipitation by choosing one of the three banners at the top of the page. The quick stats box on the right will give you the historical data (1961 to 1990) for the variable selected. Projected future conditions will be discussed below under future climate; here we are interested in the current 30-year-running average.

Map Your Forest

The objective for mapping your forest is to delineate distinct forest units, or “stands,” on your property to assess current forest conditions. The term “stand” describes a group of trees that are similar in terms of species composition, age, and growing conditions. Figure 8 illustrates this concept of stand delineation. Forest stands typically range in size from a few acres to several hundred acres. It is relatively easy to map your forest. Start with maps and photos of your property such as a topographic map. The U.S. Geological Survey (USGS) provides topographic maps at a scale of 1 to 24,000 (1 inch on the map equals 2,000 feet on the ground), each covering a little less than 60,000 acres. Combine that with an aerial photo or image (such as one from Google Earth¹) and you can create a map of your property that enables you to divide the property into forest stands. Aerial photos are relatively accessible through your county or other local or state jurisdiction. Use these links to find access to maps and digital images for your property:

- USGS topographic maps: <https://www.usgs.gov/faqs/how-do-i-get-a-full-scale-plot-a-124000-scale-us-topo-map>
- Google Earth: www.google.com/earth/

Use large-scale photos if you can find them so you can distinguish geographic features such as stand boundaries, roads, and creeks. For example, 1 inch on the photo should equal 400 feet on the ground or in map terms 1:4800. In other words, 1 inch on a map or photo equals 4,800 inches on the ground (or 400 feet). Google Earth allows you to zoom in to any resolution you want.

¹ The use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service.



Google Earth image courtesy of Rob York, University of California, Berkeley Blodgett Experimental Forest.

Figure 8—An actual 10-acre ownership in El Dorado County with three distinct stands delineated.

Forest Setting

After mapping your forest, you will want to collect some basic information on the setting of the forest to further assess its status. This can be accomplished by answering the following questions, which you can input on worksheet 2.

- What is the aspect (the compass direction that a slope faces) of your property: west, east, north, or south? Aspect is important because the angle of exposure to the sun influences solar exposure, soil moisture retention, and heat stress, thus directly affecting tree and shrub growth and survival. Figure 9 illustrates the potentially very different structure and composition of north- vs. south-facing slopes in the Sierra Nevada.
- How steep is your property? Steepness is measured as slope or grade and refers to the change in the elevation of land over a given distance. Easy instructions for calculating this are available online at <https://sciencing.com/measure-slope-grade-6079564.html>. Steepness is important because rainfall on steeper slopes runs off more quickly and thus less water can infiltrate the soil. Steeper slopes also cause fire to move up a slope more quickly.
- What are the soils like (deep, shallow, rocky, etc.)? The Natural Resources Conservation Service (NRCS) Web Soil Survey enables anyone to determine the predominant soils on their property. Deeper, well-developed soils are generally more productive. This information is available online: <https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>.
- What are biological and archeological features of the property? Are there streams, ponds, or other special habitat features that support wildlife species? Are there plant species that are recognized as “rare,” important wildlife food sources, pollinator habitat, or American Indian tribal or historic sites that need to be protected? Consult your local California Department of Fish and Wildlife or CAL FIRE office for information on the potential presence of important natural or cultural resources on your property.

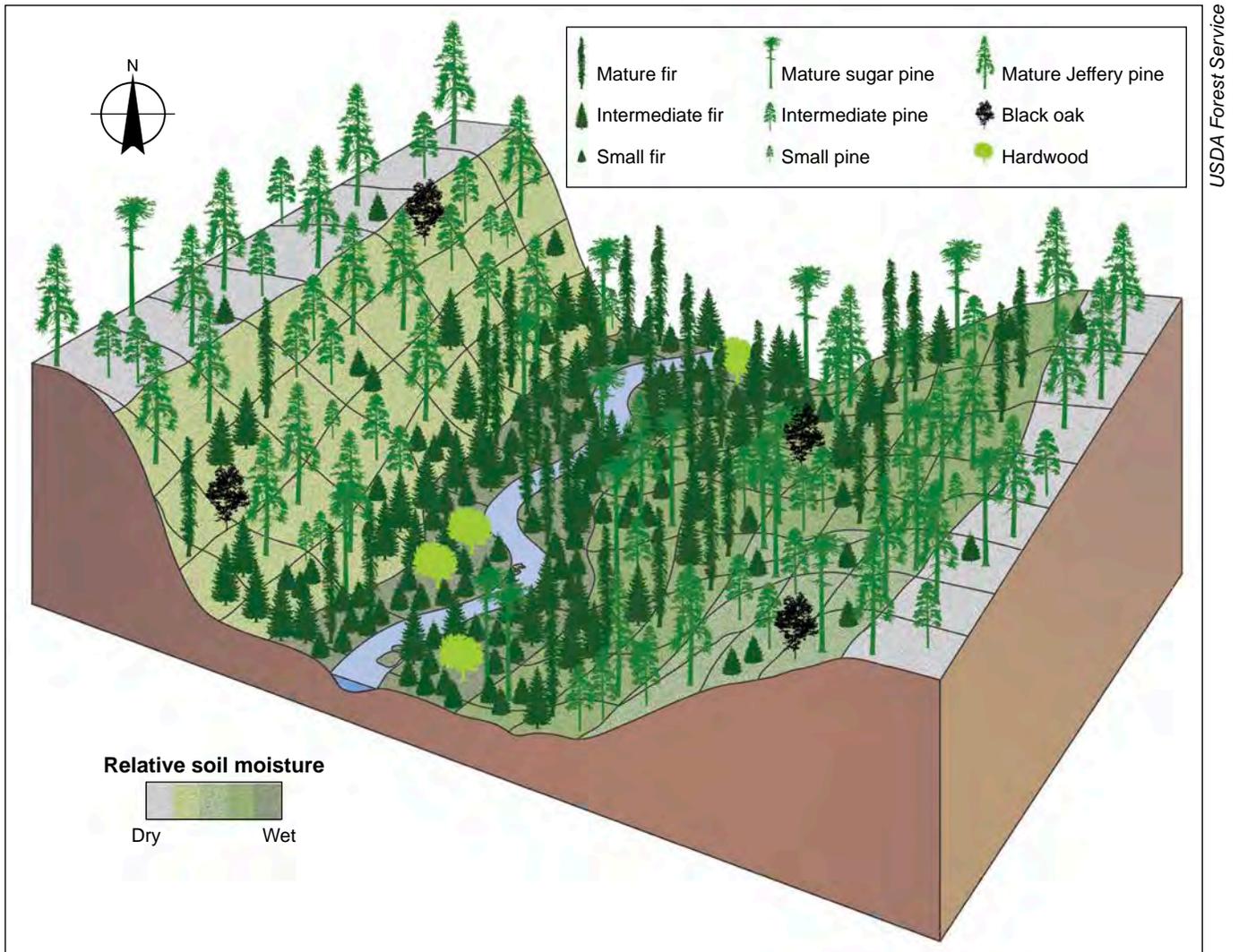


Figure 9—Landscape schematic of variable forest conditions produced by management treatments that differ by topographic factors such as slope, aspect, and slope position. Ridgetops have the lowest stem density and highest percentage of pine in contrast to riparian areas. Midslope forest density and composition varies with aspect: density and fir composition increase on more northern aspects and flatter slope angles.

Types and Condition of Trees

The answers to the following questions will provide a good description of the condition of your forest stands and help you understand your forests composition and structure.

- What species of trees do you have?
- What are the size and shape of distinct stands on your property?
- What are the dominant species?
- How many trees do you have per acre?
- What proportion of your forest has trees with canopy near ground level?
- How big (diameter at breast height, or d.b.h.) are the trees? General size classes of 0 to 10 inches, 10 to 20 inches, etc. is sufficient.
- Are there any seedlings coming up?
- Is there any evidence of disease or insect infestation in the trees; what percentage of trees show this?
- Are there any dead standing trees? How many?

Use worksheet 2 in appendix 3 to gather and compile the information discussed in the section above on climate, mapping, forest setting, and tree condition to complete the simple assessment of current conditions of your property

History of the Property: Forest Growth and Development

The next step in considering the site conditions for a given area is to learn how your forest got to its current condition. As discussed above, we are using the forester term “stand” as the primary unit for assessing forest conditions. We use the term “stand initiation stage” to describe the point in time when new tree seedlings emerge after a disturbance. This can occur in a small opening (such as a 25- by 25-foot clearing) or among larger trees created by a patchy, low-intensity fire, or even a large tree dying and falling. It can also occur in a large area (10, 20, or more acres) that was created by a more extensive disturbance such as a larger wildfire, a beetle kill area, or even a clearcut logging site. Understanding the history of your forest involves asking the following questions:

- What types of significant disturbance have occurred in your forest over the past 25 years (such as fire or insect kill) or whatever timeframe for which you have information.
- How old are the trees in your forest?
- Is there more than one age group of trees growing in your forest?
- Was your forest harvested in the past and, if so, when?

There can be more than one stand on your property, especially in a place like the Sierra where there are steep slopes, variable soils conditions, different solar exposure on north- vs. south-facing slopes, and fire and other disturbances occurring frequently. This depends in part on answers to the questions above as well as the size of your property. Small nonindustrial private forest parcels (such as 5 acres) are more likely to contain one uniform group of trees (or stand) than a larger nonindustrial private forest parcel (such as 30 acres), which is more likely to contain more than one stand.

Determining the history of the property can be easy. If you do not already have the basic history of your property readily available, perhaps your neighbors have some historical knowledge. Local offices of CAL FIRE, NRCS, the Forest Service or other resource management agencies may have records and maps indicating the history of the larger region. Aerial photos at different time sequences may exist, and agencies in the area may have such records. You do not need precise dates, but you want to answer the above questions to the nearest 10-year increments. Developing existing condition data for your forests will help to (1) quantify how far your forest is from your desired condition and (2) determine how vulnerable your forest is to mortality from wildfire, insects, disease, or drought. This leads you into chapter 3, which focuses on assessing threats to your forest property.

Future Conditions

It will help with planning for your forest if you have some idea what kind of climate conditions your forest is likely to face in the coming decades. Changing climate will potentially affect the kind(s) of forest(s) that will be suitable for your property in the future. Changes in vegetation conditions have been observed throughout the world in the past few decades in response to changing temperature and precipitation conditions. From 2012 to 2017, California experienced the most severe drought on record in the past 1,200 years. The direct and indirect impacts of this drought resulted in a massive die-off of trees, killed by bark beetles in large part because of water stress. Figure 10 illustrates how the recent drought affected forests in the Sierra Nevada. And while that drought was historic, the state has experienced more frequent, longer, and intense droughts in the last half of the past century as compared to the first half of the 1900s.

Being aware of anticipated changes in climate conditions is important for planning either thinning treatments or reforestation when you must make choices for what and how much to remove or to plant. If you expect to plant, you will need to have a good idea what species of trees (and shrubs, if desired) from your region

Changing climate will potentially affect the kind(s) of forest(s) that will be suitable for your property in the future.



Figure 10—Recent drought impact on forests in the Sierra National Forest, southern Sierra Nevada.

are best suited to future conditions. You will also need to know what mixture and density of tree and shrub cover will be sustainable under somewhat warmer and more variable precipitation conditions. The lower your property is in elevation, the more important this factor will be.

The **Cal-Adapt** website (<https://cal-adapt.org/>) is a simple resource for developing future projections on the same three basic climate variables of maximum temperature, minimum temperature, and annual precipitation. Cal-Adapt is produced by the state of California's scientific and research community and is a widely trusted source of climate-related data and information. To obtain projections, use it in the same manner as described above. In chapter 3, you will find guidance to help assess the vulnerability of your property to disturbance, including changing climate conditions. This will help you decide if some remedial action needs to be taken on your land.

This simple exercise will provide you with some idea of what climate conditions your forest will face in coming decades through the 21st century. The trees and shrubs on your property germinated and matured under climate conditions (such as in the 1940s and 1950s) that likely differ from those that are anticipated in the future.

The example of this tool in figure 11 shows maximum temperature projected through the end of the 21st century, based on different assumptions about how severe climate change is likely to be. You identify your location and the tool will provide you with estimates for that area. There is clearly some uncertainty in what will actually happen, but this will give you some sense of how much change to expect in key climate conditions such as temperature and precipitation. Using other tools on this website, you can also explore possible changes in the intensity and frequency of extreme precipitation and temperature events for your specific area.

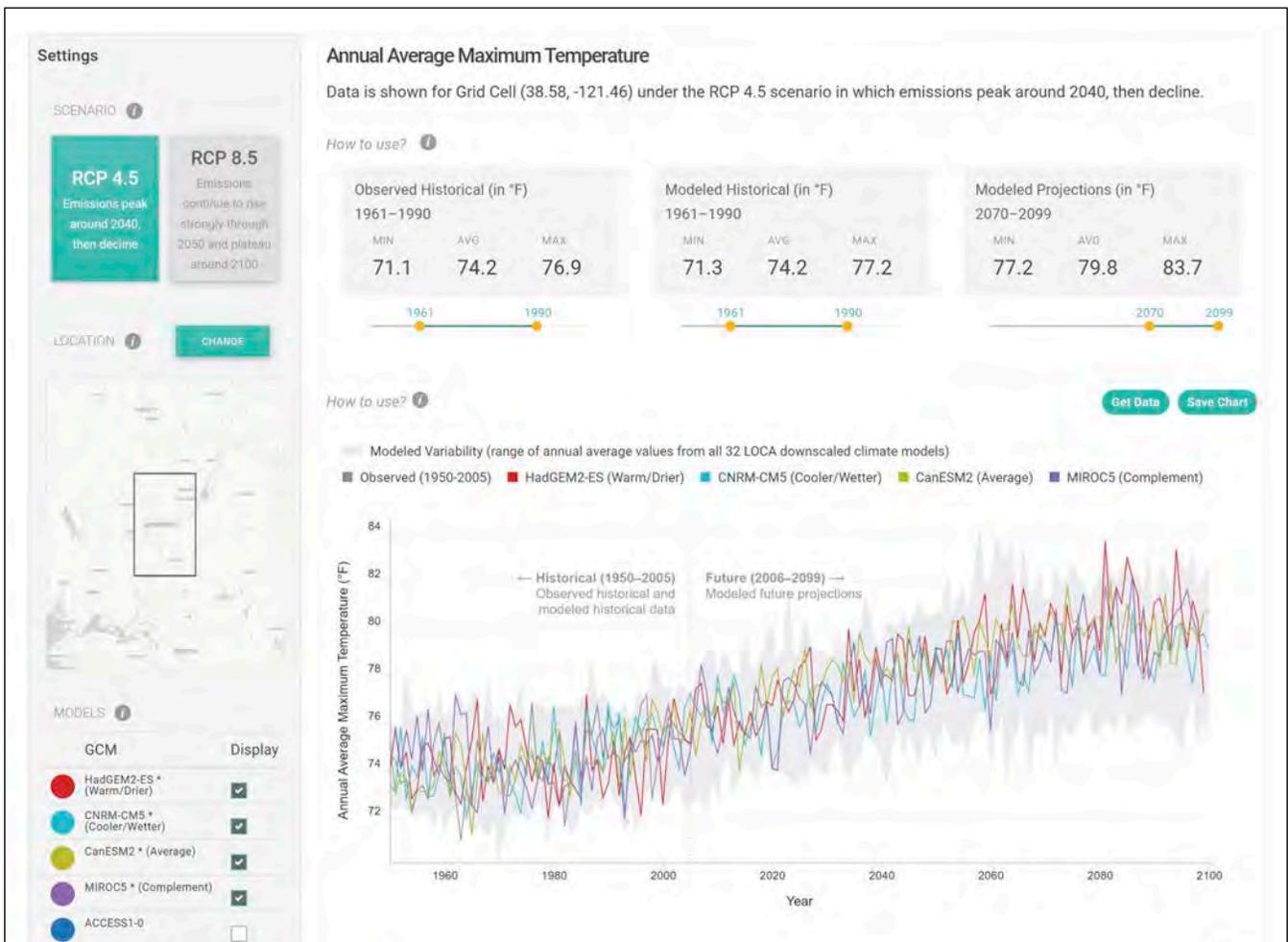


Figure 11—Maximum temperature projection the Sacramento region from the Cal-Adapt.org online tool; an example of how maximum temperature is projected to increase for the period of now until end of the century, based on various assumptions within different modeling approaches.

Chapter 3: Recognizing Threats to Your Forest

Next, we look for an array of potential threats to your forest. The major threats include fire, wood-boring insects, disease, and stress (typically from drought or too many trees). You want to be able to identify these threats before they become serious. In this chapter, we describe these threat factors in detail, including how the condition of your forest (as identified using the previous chapter) tends to increase or decrease the chances of each threat affecting your forest. It is important to identify the trajectory of forest health on your property and, in turn, evaluate how your forest will respond to the inevitable disturbances (fire, insect infestation, disease, etc.) and stress from drought that can threaten your forest. After completing this section, you will have an assessment of the threats that your property could be exposed to today and in the coming years.

You want to be able to identify threats before they become serious.

Identifying Threats to a Forest

Periodic disturbance in conifer forests of the Sierra Nevada is an essential component of this ecological system. These forests evolved over the past approximately 10,000 years within a setting of intermittent disturbance, principally fire. Other disturbance factors are also active in the Sierra, and their effects can depend on the location and time of the last fire. For example, the large-scale tree mortality observed in the southern Sierra Nevada from 2014 to 2017 was largely a direct result of native bark beetles (fig. 12). However, this major bark beetle mortality event was triggered by five concurrent circumstances: (1) a historic drought from 2012 to 2016 that is estimated to be the driest 4-year stretch in the past 1,200 years, (2) almost 100 years of fire exclusion that enabled dense forests to fill in openings over most of the Sierra, (3) hotter conditions in recent years, and (4) lack of forest management to reduce vegetation density, and (5) historic logging practices that removed the large trees that were more resistant to disturbance. It is important to keep in mind that disturbance is an inevitable event, and the various types of disturbance will interact with one another. The primary threat factors for a landowner to assess include the following:

- Fire (high severity)
- Insects
- Drought stress
- Pathogens
- Other factors

Again, these disturbances are intrinsic components of Sierra forest ecosystems; however, these disturbances can have undesirable effects on nonindustrial private forest lands depending on size, scale, and intensity. It is important to recognize and address your forest's vulnerabilities to these **disturbances** early. You need to be prepared to address a potential problem before one or more disturbance factors can result in significant changes to your forest. Worksheet 3 in appendix 3 contains a list of evaluation topics to help you develop a basic overview of the conditions of your property and will include a basic assessment of threats.

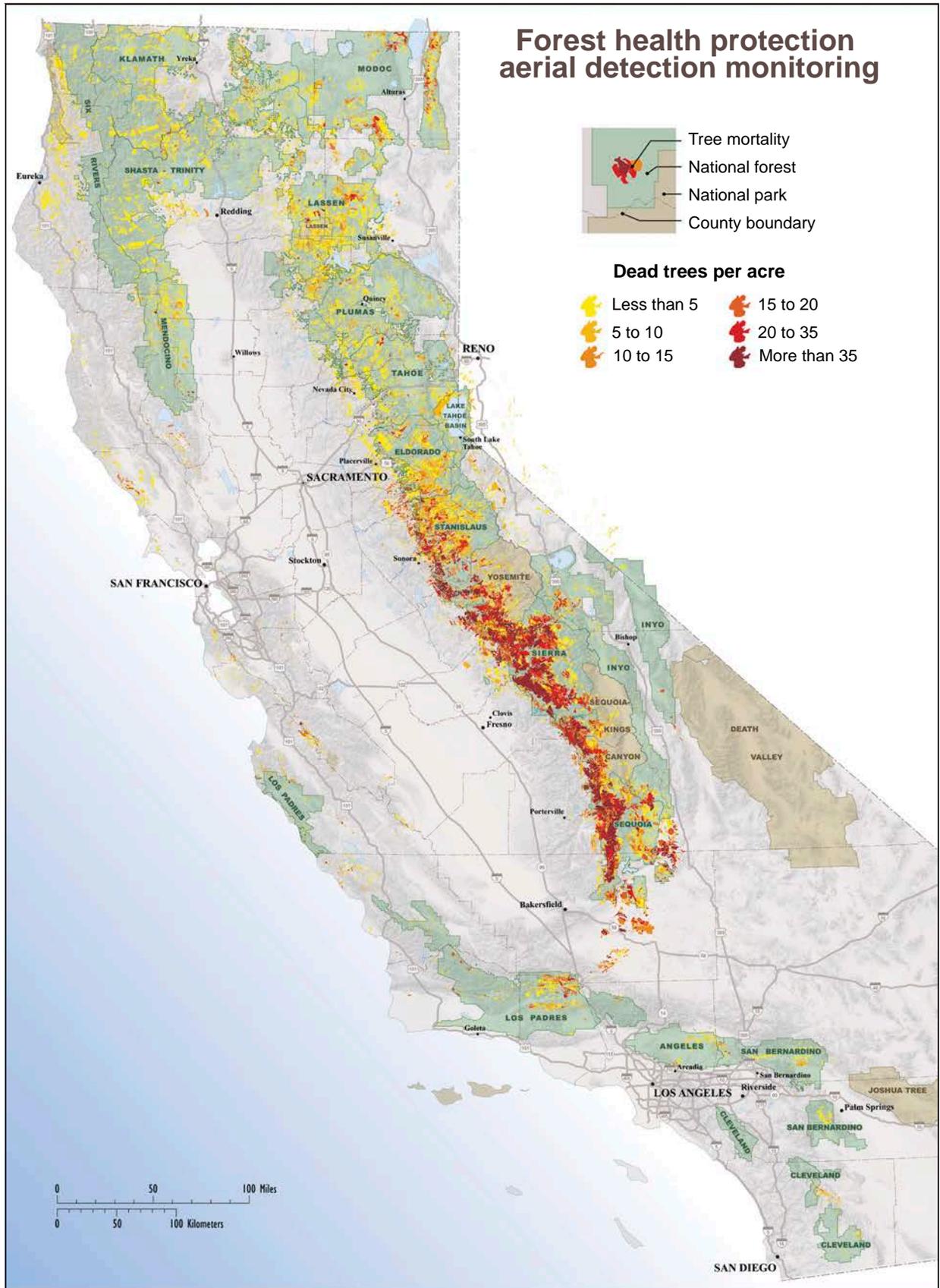


Figure 12—Large-scale tree mortality in the southern Sierra Nevada as a result of the 2014–2016 drought.

High-Severity Wildfire

A high-severity wildfire is the single largest threat to your property. Fire under certain conditions (low humidity, high wind, dry fuels) can move quickly and be very destructive. The most important action you can take (apart from constructing your home with fire-resistant materials) is to reduce fuels, especially immediately around your home and other structures on your property. Your assessment of current conditions will help you determine this. The following list of conditions for forest stands are the most important things to look for when evaluating fire risk to your forest. A more detailed description of these characteristics and what to look for are provided on worksheet 3 in appendix 3. These are some of the forest conditions to assess:

- Tree density, sizes, and arrangement
- Condition of fuels (ground, surface, ladder, crown [see below])
- Fuel and soil moisture
- Aspect and slope steepness and position (bottom, mid, or top of slope)

Fire behavior (that directly influences the size and intensity of the fire) is strongly influenced by the above factors. A “fuel profile” is the most critical component of the fire hazard and should be considered first. The fuel profile is the combination of **surface ladder fuels** and **crown fuels**. Surface fuels include needles, twigs, branches, logs laying on the forest floor; ladder fuels include both live and dead trees and shrubs that are close to the ground and lead up into the canopy of larger trees. Crown fuels include the canopies of live and dead standing trees. Each of these fuel types are flammable depending on fuel moisture, relative humidity, windspeed, and density of the fuel. Another critical factor is the weather conditions at the time of the fire. Strong winds and unusually low relative humidity (such as below 20 percent) can turn a moderate fire into a severe fire quickly. Because there is no way to control weather conditions or fuel moisture, the only thing a landowner can do is manage the fuels.

Land management agencies and other forest management institutions use selective logging treatments, other mechanical techniques such as masticating woody material, prescribed fire, and chemical herbicides to reduce fuels and make their forests more resilient to wildfires and other disturbances. Small-parcel forest land owners generally do not have the expertise or capacity to conduct logging operations, rent heavy masticating or mulching equipment, or conduct prescribed burns, but they can reduce density of forests through simpler mechanical or manual treatments (such as thinning by hand, chipping, machine thinning or harvesting of trees, etc.) as needed. It is possible to partner with adjoining landowners and reach out to your local UC Cooperative Extension forester or other professional forest managers to conduct carefully controlled prescribed fire. Pile burning is also a practice some landowners use. These approaches require experience and skill and, in some cases, permits; so be sure to work with your local CAL FIRE unit to explore these options. An alternative treatment to reduce fuels without burning is removing the debris from the property. While an effective wildfire reduction treatment, this is an expensive option when few markets are available to pay for the woody debris.

Because there is no way to control weather conditions or fuel moisture, the only thing a landowner can do is manage the fuels.

The two most likely reasons today for a tree to become stressed and susceptible to bark beetle attack are drought and high stand densities that stress trees as a result of competition for water.

Insect Infestation

There are about 200 species of bark beetles found in California's forests. These species are native to these ecosystems and provide an important function in maintaining forests. They play a role in the natural process of stand thinning and creating gaps in forests, and are an essential food item for many species of wildlife, particularly woodpeckers. However, only a few of these species can kill trees directly. The bark beetles that pose a threat are less than ¼-inch long and bore through the outer bark of trees to lay eggs in the inner bark. All sizes, ages, and species of trees are potentially susceptible, but bark beetles are most likely to infest trees that are weakened (stressed) by some other factor, such as disease, damage (such as broken limbs), soil compaction, and even air pollution. However, the two most likely reasons today for a tree to become stressed and susceptible to bark beetle attack are drought and high stand densities that stress trees as a result of competition for water.

Initial attacks by bark beetles typically go unnoticed. When bark beetles attack a tree, they exude a chemical that signals other bark beetles that there is a susceptible tree. When there are enough such trees, it can lead to an outbreak of beetles and widespread tree mortality. This is what happened in the southern Sierra from 2014 through 2017 when an estimated 129 million trees died as a result of bark beetles.

Bark beetles are always in these forests at low population levels. Outbreaks (massive increases in populations that result in large-scale tree mortality) are relatively rare, but recent increases in the frequency and severity of outbreaks have been clearly linked to widespread forest health problems and changing climate. With so many acres of overly dense, or "overstocked," forests, tree stress can be more acute in times of climate-related impacts, such as drought. The widespread tree stress caused by today's overly dense forests and severe drought has set the conditions for major fire disturbances. Fire has burned millions of acres in the Sierra in the past 10 to 15 years; and in the overly dense stands that did not burn, bark beetles were able to infest and cause widespread mortality. There are steps that a landowner can take to recognize and address this issue. Much of what you can do is described above; more details are available in the following online publications:

- *Bark Beetles of California: Are You Seeing Trees Susceptible?:* https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5384837.pdf.
- *Bark Beetles: Integrated Pest Management for Home Gardeners and Landscape Professionals:* <http://ipm.ucanr.edu/PMG/PESTNOTES/pn7421.html>.

Assessing your forest for bark beetles—

Do the following to assess your forest for bark beetles:

- Determine what species of trees you have, and roughly in what proportions (for example, 40 percent ponderosa pine, 30 percent white fir, 20 percent incense cedar, and 10 percent sugar pine).
- Determine the likely susceptibility of your trees and stands of trees (information in chapter 2 on the setting and condition of your trees will address this).
- Look for signs on your trees to determine if they have been attacked.
 - For pine beetles:
 - Pitch tubes emerging from the bark; reddish color with boring dust suggest successful attacks; amber or cream colored may suggest unsuccessful attacks. Figure 13 shows red pitch tubes caused by the red turpentine beetle. Figure 14 shows the “galleries” (where the larvae chew the wood of a tree) of the mountain pine beetle, a species that can cause large-scale damage when populations become large. Figure 15 shows the scope of bark beetle infestation (multiple species) and resulting mortality in the southern Sierra, primarily as a result of the mountain pine beetle.

Chris Fettig, USDA Forest Service



Figure 13—Red turpentine beetle pitch tubes. Attacks from this species mostly start near ground level. These pitch tubes are a result of the tree’s defensive reaction to the attack of this beetle, a good indicator of the presence of this species.



Figure 14—Mountain Pine beetle galleries. A common sign of mountain pine beetle attack is the presence of fine sawdust in the bark crevices along the trunk of the tree, an indicator of the beetle larvae feeding on the nutrient-rich tissue (phloem) of the tree.

Chris Fettig, USDA Forest Service

- Examine the entire bole (main trunk), first attacks tend to be mid-bole.
- Needles changing color, fading to light green and yellow.
- For fir beetles and engravers:
 - Crown fade (when tree needles turn yellow)
 - Boring dust on the ground or on the bark

Once a tree has been attacked, the likelihood of saving the tree is limited and would require immediate response. Once a tree is fully infested by bark beetles, there is no hope of saving it. There are no registered chemicals approved for treating bark beetles once they are already in your trees. There may be some resolute steps one can take to protect high-value pines. Work with local resource managers and trained technicians to explore these options. However, there are some basic things that can be done to protect nearby trees:

- Remove the infested trees so the spread can be minimized.
- Thin your stand (reduce the density of your forest by removing small trees less than 10 inches d.b.h.) to provide spacing between trees.

Craig Thompson, USDA Forest Service



Figure 15—Bark beetle-caused tree mortality in southern Sierra National Forest.

- Avoid damaging healthy trees; weakened trees are more susceptible to insect infestation.
- Certain applications can be used on healthy trees that repel insects. Work with local resource managers and trained technicians to apply these treatments.
- In general, maintain a healthy, self-sustainable density of trees that minimizes stress to individual trees.

There are also insects that can affect oak trees in lower elevation oak woodlands, such as the goldspotted oak borer. This invasive shot hole borer, or tiny tunneling beetle, can infect several tree species with a disease-causing fungus. It is currently more of a threat in southern California, but could also become a threat in the foothills of the southern Sierra.

Worksheet 3 (in appendix 3) summarizes the steps needed to evaluate the potential threat levels such insects pose to your forest. If one of your objectives is to maintain or enhance wildlife habitat, you may want to consider leaving some of the dead trees that are not a threat to human safety or property. Standing dead trees and live trees with broken tops or cavities provide critically important food and shelter for many species of wildlife (fig. 16), including some mammals and many species of birds, especially woodpeckers. Be careful determining which dead or damaged standing trees to keep because they can also be a safety concern.



Rebecca Green, USDA Forest Service

Figure 16—Dead and broken trees provide habitat for wildlife. Cavities in trees provide shelter for many species of wildlife.

Drought Stress

California has been subject to periodic drought for millennia, but all evidence suggests that the frequency and intensity of drought in the future will increase. Drought can have many affects, but the key concern for forests is the period of time that soil moisture is low, which has a direct impact on the physiology of a tree. The dry season, characterized by warm temperatures and no precipitation, has grown longer by as much as 60 days a year (shorter springs and longer autumns).

Trees and shrubs in the Sierra have adapted to a dry season, but these longer dry periods are stressing vegetation productivity and survival.

Trees and shrubs in the Sierra have adapted to a dry season, but these longer dry periods are stressing vegetation productivity and survival. Drought also interacts with ecosystem processes and functions, and can exacerbate the effects of other, naturally occurring stressors and disturbances, such as increased insect outbreaks and wildfire.

It is not simply increasing temperatures and extended dry seasons, but also more extreme conditions of extended heat and years with low precipitation. All these factors combined create challenging conditions for mature trees to survive and for seedlings to become established. Climate change projections forecast further increases in these trends, warmer conditions, and more variability in precipitation. Forest managers, including private landowners with small parcels, will need to monitor the health of their trees and be prepared to address signs of drought stress through selected management actions, such as thinning to reduce the number of trees drawing on scarcer water availability.

It is best to be proactive and take preventative steps before conditions become serious. The Oregon Department of Forestry has an online factsheet with tips on coping with drought stress:

- *Drought Stress in Conifers: Forest Health Fact Sheet*: <https://www.oregon.gov/ODF/Documents/ForestBenefits/Drought.pdf>.

Pathogens

A tree disease basically involves the relationship between a biological organism known as a pathogen, a host (tree), and an environment where the pathogen can thrive. Forest pathogens are typically microscopic organisms that can infect trees, causing disease and even death. Low levels of disease are often not obvious nor necessarily a problem. However, when the disease affects many trees, it may require a management action. The most common pathogens that affect trees include fungi, bacteria, and viruses. Fungi and parasitic plants are the most important causal agents of disease in Sierra Nevada trees.

Pathogens and the diseases they cause can affect roots, foliage, and the heartwood of a tree. A disease caused by a given pathogen can often be identified by a set of symptoms or signs in trees. Symptoms are the visible reaction of a tree to the pathogen. These include needle loss, foliage color change, decreased growth, resin production, and decayed wood. Symptoms may be found in a particular part of the

tree or throughout the tree. Signs of pathogen-borne disease are visible structures on the tree, such as the fruiting bodies, spores, and threads of branching (typically) white filaments (fig. 17). Such signs are usually more reliable indicators of infection than is confirming symptoms.

As with the bark beetles, most pathogens found in Sierra Nevada forests are indigenous and often have no large-scale impacts on forests. Low levels of infection always exist in a forest and do not represent an immediate threat, particularly if your forest is otherwise healthy. However, the presence of pathogens on a small parcel can become a problem, particularly with respect to landowners' plans for their forest. Landowners should always be aware of the possible presence of pathogens common to their properties.

Other conditions that can lead to significant disease concerns include nonbiological, noninfectious factors, such as air pollution (including ozone and sulfur dioxide). Introduced pathogens may also represent a dangerous threat to forests. Currently, there is only one significant introduced pathogen affecting trees in the Sierra, white pine blister rust. Sugar pines and higher elevation western white pines are susceptible to this fungus that was accidentally introduced to North America in the early 20th century. There are a handful of other introduced tree diseases that have been identified in or near the Sierra, but none currently represent a major threat. However, the risk of additional introduced diseases remains a real concern. For example, sudden oak death, found principally along the northern California coast, has infected many trees, especially tan oak and some true oak species. It has been detected in the Sierra Nevada, but the drier conditions appear to limit the impacts.

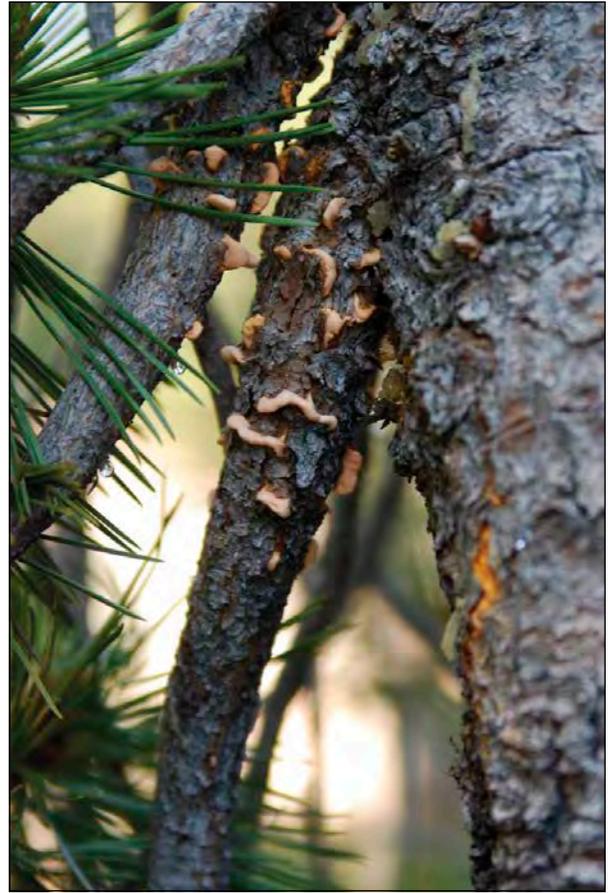


Figure 17—Fruiting bodies of white pine blister rust, a common and destructive introduced fungus in the Sierra Nevada that affects sugar pines and western white pines.

Courtesy of Patricia Maloney, University of California, Davis

Major tree diseases—

The major tree diseases of concern in the Sierra are listed here by type. An evaluation approach to assess the level of threat posed by pathogens to your forests is summarized in worksheet 3 in appendix 3.

Foliage/canopy diseases—

- **True mistletoes:** Leafy or scaly plants in a tree canopy; the Christmas mistletoe.
- **White pine blister rust:** Needle spots, cankers (dead section of bark or branches), sap flow from cankers, yellow to red needles in dying branches (fig. 17).
- **Dwarf mistletoe:** Small, jointed shoots in the canopy, sometimes masses that look like a broom (fig. 18).



Courtesy of Patricia Maloney, University of California, Davis

Figure 18—Dwarf mistletoe with small, jointed shoots in the canopy; sometimes masses look like a broom.

- **Western gall rust:** Pear-shaped galls on the main stem or branches; galls can become large and have conspicuous orange spores.
- **Sugar pine needle cast:** Needles turn brown in spring after infestation; needles later drop.
- **True fir needle cast:** Heavy dark streaking on underside of second-year needles; thin crowns.
- **Elytroderma disease:** Reddening of needles in spring; black streaking on needles, often in conspicuous clumps.

Root diseases that often occur in patches of trees—

- **Armillaria root disease:** White leathery growth between bark and wood of roots and trunks (fig. 19).
- **Heterobasidion root disease:** Usually starts around infected stumps. The crowns of affected trees are pale green to yellow and thin, starting from the bottom and inside of the crown up and then out.
- **Black stain root disease:** Dark brown to black stain of sapwood in roots, sometimes up into lower trunk of tree.

Tree decays that attack the main trunks of trees—

There are several varieties of tree decays. Heartwood rot causes the main damage; they typically have conks (fruiting body of the fungus) on the bark of the tree, but it is not always obvious. Wounds and broken tops or branches are better indicators of hidden decay.

Canker diseases on stem portions, branches, or on a tree with dead bark and cambium—

There are many types of cankers. They are usually not lethal. Dead tissue is eventually sloughed off and the wound is covered with a callus.

Accurate diagnosis of insect or disease infestation is difficult. Signs must be gathered leading to an educated guess. The more evidence you can gather, the better your diagnosis will be. In the final analysis, if you suspect a serious insect or disease problem, it is best to consult a professional forester. The following links provide useful information on insects and disease in the Sierra:

- *Conifer Insects and Diseases in the Tahoe Basin:* http://www.trpa.org/wp-content/uploads/Conifer-diseases-tip-sheets_2012-version-MS.pdf.
- *Natural Environment Pest:* <http://ipm.ucanr.edu/NATURAL/index.html>.



USDA Forest Service

Figure 19—Armillaria root disease: white leathery growth between the bark and wood of tree roots and trunks.

Developing a Simple Vulnerability Assessment

The information you have gathered on the worksheets will enable you to develop an overall assessment of the threats to your forest. This will provide a simple “vulnerability assessment” to evaluate how susceptible your forest is to environmental disturbances, including the overarching impacts of climate change. This ultimately leads to assessing the capacity of your forest to adapt to impending changes. This section will equip you with the information needed to cope with climate and environmental changes and sustain your forest.

Vulnerability assessments are a common tool in natural resources management and many other sectors of our society. It is important for a landowner to have some idea of the degree to which their forest is vulnerable to the full array of threats described above. Vulnerability of a forest is essentially a function of three factors:

- **Exposure:** How exposed your forest is to climate change-related stress and disturbance.
- **Sensitivity:** How likely your forest will be affected or change in response to environmental disturbances.
- **Adaptive capacity:** Your forest’s ability to tolerate or adjust to changes in conditions.

Figure 20 provides a simple diagram of the relationships between exposure (the degree of stress) and sensitivity (the degree of the effects of stress) that combine to indicate the potential impacts. The level of vulnerability your forest will ultimately face is the combination of the adaptive capacity of your forest along with these potential impacts. A vulnerability assessment also recognizes the growing role that climate change may play in combination with existing threats. We are already seeing evidence of a warming climate increasing drought stress, lengthening fire seasons, and exacerbating the impact of fire, insects, and other disturbances.

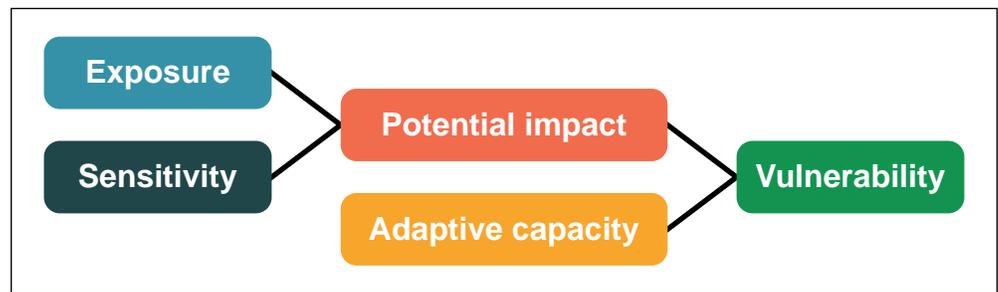


Figure 20—Simple diagram illustrating the primary factors that influence forest vulnerability.

What we offer here is a simplified version of an evaluation process that scientists are performing all over the world. The goal is to determine what management actions you can use to achieve better health and resiliency. This is based on tools developed by Forest Service researchers (Chris Swanston and colleagues) for adaptation to climate change in the Northeast and upper Midwest. There are two principle steps to this basic approach:

Evaluation of possible impacts of threats facing your forests—

The first step is assessing the basic conditions and characteristics of your forest, relative to fire, insect outbreaks, pathogen outbreaks, and drought stress to form the basis for evaluating its vulnerability.

- Threat of fire
 - Tree density
 - Proportion of forest in low, medium, or high density
 - Amount of fuel (surface and ladder fuels)
 - Physical environment (aspect, slope)
- Threat of tree-killing insects
- Threat of tree-killing pathogens
- Potential drought stress

After completing worksheet 3, you will have the basics for determining a coarse measure of the current threat to your property. It is a simple compilation of four threats to your forests: fire, insect outbreaks, pathogen outbreaks, and drought stress. Each threat contributes a measure of vulnerability rated as low, medium, or high. Adding these ratings together in the assessment will give you a sense of the magnitude and urgency of concern you should have regarding current threats (see the bottom of worksheet 3). The condition of the human environment can have an influence on the vulnerability of your forest. Issues like the threat of human-caused fire can vary from place to place and should be considered when assessing overall vulnerability.

Adaptive capacity of your forest—

The second step is determining how adaptable your forest is likely to be to these threats. What is the ability of your forest to cope with the various anticipated impacts and retain the basic forest structure and composition that you currently have? Depending on the condition of your forest, the potential threats, and the timeframe you are using, your forest may have strong adaptive capacity, or it may be vulnerable to changes that will result in fairly significant changes to your forest (such as different tree species and forest structure) in the coming decades. Adaptive capacity is a function of the degree of threat combined with your overall ability to

manage your forest and respond to these threats. Evaluating the factors below will provide you with a subjective assessment of your overall capacity to address the current situation in your forest. This can help guide your next steps.

- Biological factors
 - Overall condition of the forest to cope with disturbance
 - Diversity of species, size classes
 - Arrangement of trees
- Organizational factors
 - Agency assistance
 - Professional help
 - Local ordinances and regulations
- Financial capacity
 - Availability of personal resources
 - Access to agency financial assistance
 - Partnerships with neighbors

Identify Suitable Adaptation Strategies to Address the Resiliency of Your Forest

Regardless of the objective(s) you have for your forest, all landowners with forest land in the Sierra Nevada will have to cope with changing climate. Forests in the Sierra Nevada region expected to experience many changes in the next few decades, including warmer conditions, shifts from snow to rain and, increased occurrence and intensity of extreme events. Indeed, change is already happening as we have seen with longer fire seasons and larger, more intense wildfires in the past couple of decades.

One of the biggest challenges we face is translating the complex understanding of global climate change into locally appropriate and effective, specific treatments for your forest. While each individual landowner has limited capacity to mitigate changes, there are several treatments that a landowner can apply to adapt to on-going changes. The most likely changes expected for the Sierra Nevada region in the next few decades are warmer temperatures, longer dry seasons, and changes in precipitation in the form of less snow and more rain, depending on elevation. Scientists are less certain about changes in precipitation, but average annual total precipitation is generally expected to be about the same or perhaps slightly higher with possibly more pronounced variation from year to year. We also believe that precipitation will shift to more rain and less snow. We have already observed elements of this trend at most weather stations in the past 20 years. Evidence also suggests there will be more extreme weather events in the near future.

Adaptation Approaches

There is no routine method for adapting to warming temperatures and increased variability in precipitation. The wide variation in forest conditions coupled with an inevitable degree of uncertainty and the variety of objectives private landowners have for their property offers many choices. However, we are learning more as land managers and researchers try different approaches to cope with changing climate conditions. The adaptation approaches presented here will enable a landowner to do the following:

- Choose among a wide variety of treatments that will improve the health of a forest.
- Choose from treatment options suited to specific management goals.
- Evaluate treatments used by others, and look at ways to implement them on your property.

However, keep in mind what the approaches presented here cannot do. They cannot lead to decisions for a landowner; it is up to each landowner to decide what is best for their property. They also cannot guarantee a particular outcome given the variability across the Sierra and conditions on a given property. The basic intent of adaptation approaches is to direct the path that your forest is on toward a healthier, more sustainable course that is less likely to be affected by climate-related stress and disturbances. Forest Service researchers have developed a template that describes a series of approaches that enable a forest manager to achieve adaptation based on three broad adaptation options:

- **Resistance:** Actions that enhance the capacity of a forest to resist changes and remain relatively unchanged. This adaptation option seeks to maintain the status quo as much as possible.
- **Resilience:** Absorbing some degree of change but enabling the forest to return to something close to prior conditions after a disturbance.
- **Transition:** Accepting that some degree of change in forest composition and structure is inevitable and adapting to the new conditions.

These various adaptation approaches are summarized in the Forest Service publication, *Forest Adaptation Resources: Climate Change Tools and Approaches for Land Managers* (see the link below). It was written by researchers for the Northern region of the United States, but the basic principles apply to any forested area in the country. Its strategies attempt to achieve resistance to climate change, or resilience if resistance is not feasible. If neither is likely through whatever approaches are taken, then the last option is to transition to a new condition as a last, inevitable resort. Figure 21 illustrates this forest adaptation approach. Again,

this comes back to the personal choices of the landowner. You can choose a combination of treatments to move your forest toward your desired future conditions. Additional adaptation suggestions specific to California are available in “Adaptation Strategies and Approaches for California Forest Ecosystems” (see link below). The UC Cooperative Extension publication, *Adapting Forests to Climate Change*, is another useful resource.

- *Forest Adaptation Resources*: <https://www.nrs.fs.fed.us/pubs/52760>.
- *Adaptation Strategies and Approaches for California Forest Ecosystems*: https://www.climatehubs.usda.gov/sites/default/files/CA%20Forest%20Adaptation%20Strategies%20and%20Approaches_0.pdf.
- *Adapting Forests to Climate Change*: <https://anrcatalog.ucanr.edu/pdf/8574.pdf>.

The types of forest practices used to establish this forest resilience, resistance, and when necessary, transition are limited to a few methods of vegetation management. The next step will be choosing which management options to use to reach the adaptation goals (chapter 4). The most widely used forest management practices for managing heavy fuels accumulation include the following:

- **Thinning:** Cut excess understory, smaller size trees, and shrubs.
- **Treat woody debris:** Onsite disposal or removal of excess woody debris left by thinning or catastrophic events.
- **Resprout control:** Suppress unwanted resprouting vegetation after treatment or reforestation.
- **Reforest:** Plant trees and shrubs to restore desired conditions.

Chapter 4: Evaluate Vegetation Management Options

Once you have defined your objectives, assessed the current conditions of your forest, and determined current and future threats, it is time to consider options for potential treatment to address any concerns and determine what on-the-ground management actions will meet your objectives.

Most private landowners, particularly those who have relatively small parcels (such as 20 acres), will likely have basic objectives that do not require a complex strategy. If you are interested in a more rigorous tree production objective, we recommend consulting with a registered professional forester. For most of you who simply want to have a healthy forest that is resilient to inevitable disturbances, particularly fire, we focus on tactical measures to move your forest toward your objectives.

A forest land owner has limited management (treatment) options for how they can change forest conditions and redirect forest development. The main ways to modify vegetation on your property include four options: mechanical or manual treatments of various kinds, prescribed fire, chemical herbicides, and by planting desired species. We summarize these four treatment options below.

Mechanical and Manual Treatment of Vegetation

Mechanical and manual treatment includes cutting down vegetation by machinery or hand and leaving it onsite (masticating or piling material) or removing logs or chips for disposal or use elsewhere. This can be accomplished by using the following methods:

- Thinning forests by reducing density with large mechanical equipment. This may include harvesting trees for commercial use. Thinning treatments can target small (for example, less than 10 inches d.b.h.), live trees that are ladder fuels as well as medium and large trees to improve tree growth and vigor.
- Hand removal of trees and shrubs using chainsaws and other hand equipment. Hand thinning targets ladder fuels for removal.
- Mastication (grinding and chopping into small pieces) of shrubs, small trees, and tree slash. Mastication rearranges aerial fuels into a compact mat of surface fuels. It does not remove fuels, but the masticated material will decompose over time.

Vegetation can be modified with mechanical or manual treatments of various kinds, prescribed fire, chemical herbicides, and by planting desired species.

Use of Fire

The use of fire entails combusting slash, shrubs, litter, and other surface fuels and killing or removing small standing trees. We will describe two methods here: prescribed fire and pile burning. Prescribed fire is a highly effective treatment for reducing fuels and decreasing larger scale fire risk. Careful use of prescribed fire can be a highly effective treatment, but it should be executed or guided by experienced people under carefully controlled conditions. Here are two useful online references with more guidance on using prescribed fire:

- *Prescribed Fire*: https://ucanr.edu/sites/forestry/Wildfire/Prescribed_fire/.
- *Spring 2020 Prescribed Fire on Private Lands Workshops*: https://ucanr.edu/sites/forestry/Wildfire/Prescribed_fire/Rx_workshop/.

Burning piles of vegetation is a common treatment and is done in accordance with county and state regulations—often requiring a burn permit from your local CAL FIRE office. Piles are created by hand cutting dense vegetation (small trees and shrubs) and stacking debris in piles for burning later. Burning these piles can safely remove these fuels if done strictly according to county or state guidelines. Extreme care should be taken when using fire of any kind. Be sure to check for burning allowances for your situation on the days you plan to burn.

Vegetation Control Using Herbicides

In some cases, landowners can use approved herbicides to control shrubs or weeds. Considerations in selecting this approach include what vegetation you need to reduce, how extensive this vegetation is on your property, proximity of crops, and what it will require to apply the herbicides. For control of vegetation over an area larger than roughly 1/10 acre, it would be prudent to consult with foresters or other forest management experts.

Reforestation of Stands

There are circumstances in which a landowner might consider reforesting their property. Despite the disturbance or treatment history of your property, forest stands eventually require regeneration, and sometimes that necessitates some effort by the landowner. The array of disturbance factors that may affect your forest can result in the mortality of many trees, leaving you to decide whether to simply wait for the forest to regenerate on its own, or intervene. This choice is once again associated with your overall objectives for your forest. It also depends on the likelihood that natural regeneration will meet your objectives and the timeframe in which that may happen.

Reforestation efforts can take one of two primary paths, natural regeneration or planting. Reforestation using natural regeneration relies solely on germination and

growth of seeds from nearby trees, except for black oaks. Black oaks are common in the middle elevations (2,000 to 8,000 feet) of the Sierra, and they regenerate abundantly by sprouting from the stumps of trees killed by fire as well as through seedlings from acorns. Natural regeneration can be an effective and virtually cost-free approach if you have mature trees nearby (within one to two tree heights from where you want to reforest) and these are the species you want to regenerate. Keep in mind that if you want pines, there needs to be enough sunlight for seedlings to grow. Also, if white firs or incense cedar are nearby, they typically have lots of seed and you may have to thin stands (remove seedlings and small trees) to reduce their density. Planting can be expensive, but it will focus your regeneration on exactly what you want. However, reforestation creates future obligations to thin excess trees and competing weeds and shrubs to ensure the establishment of desired trees at the desired density. This can be a significant investment in time and expense.

Planting

Choosing trees for planting is an important task that must be carefully thought through. There are three critical considerations in this process:

- What species should you plant?
- Where does the seed stock come from?
- How should you plant and care for the trees in the first few years?

Generally speaking, purchasing seedlings from a local nursery is not advised. You will not know what geographic region these trees came from, and the nursery likely will not know either. It is important to know the source of the seed stock to ensure that the source location will have the correct adaptive traits for the area in which you will plant them. Consult the CAL FIRE California Forest Improvement Program for help with tree planting questions. Scientists in California are in the process of reevaluating and updating guidelines for the **California Tree Seed Zone** map which has been used for many decades to match seed source areas to planting efforts (fig. 22). These updates will consider moving seeds across the currently established seed zones based on the expected changes in physiological growing conditions in response to climate change. The revised seed zone map, when available, will enable anyone who needs to plant trees to locate the appropriate source for the trees they intend to plant. Landowners can also consult with experts at CAL FIRE's L. A. Moran Reforestation Center in Davis, California.

- L.A. Moran Reforestation Center: <https://www.fire.ca.gov/programs/resource-management/resource-protection-improvement/landowner-assistance/reforestation/>.

The climate of your planting site can be chosen to represent current climates

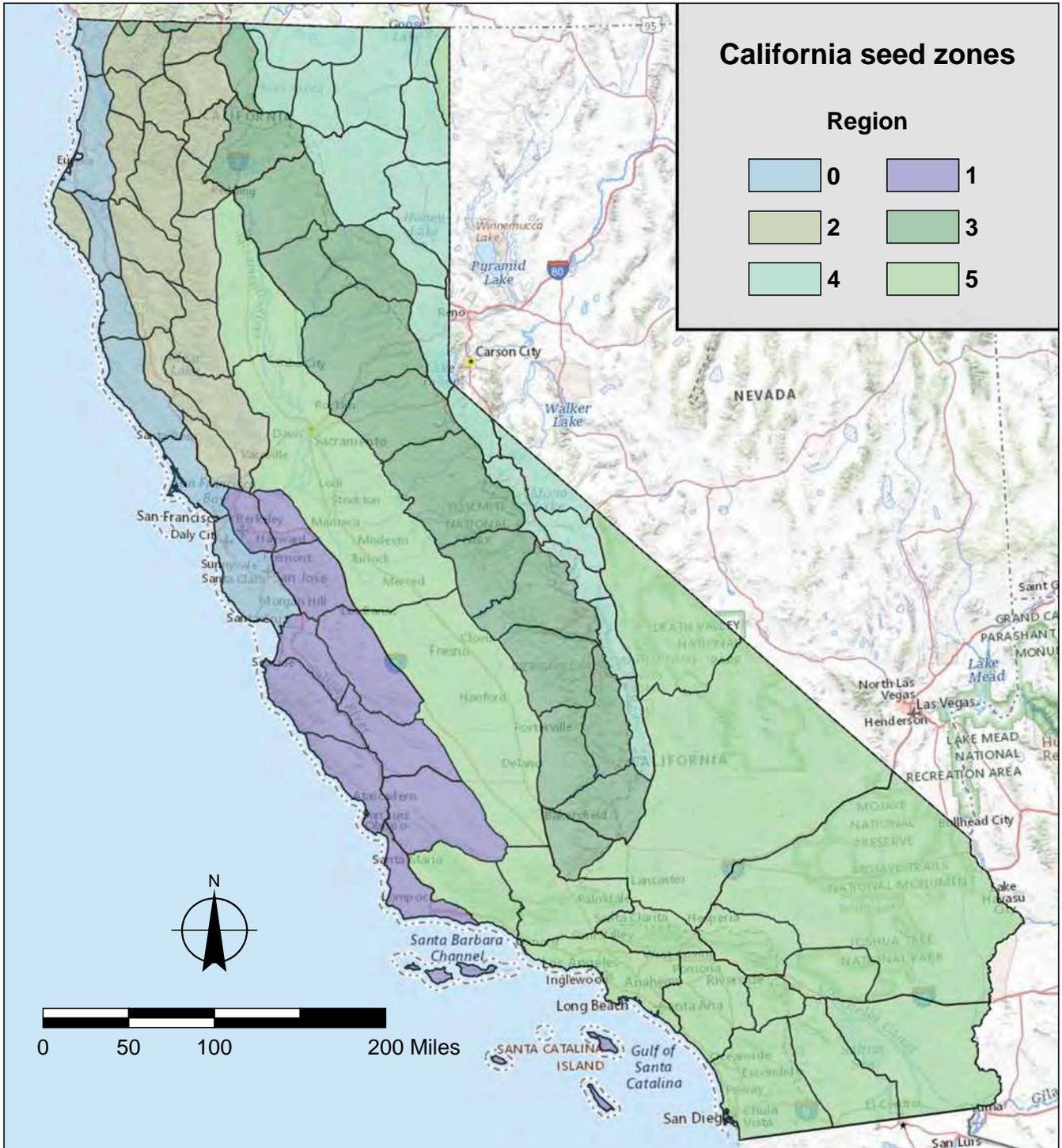


Figure 22—California tree seed zone map. Courtesy of California Natural Resources Agency, California Department of Forestry and Fire Protection. Black lines delineate individual seed zones.

or future climates based on various climate change scenarios. Consult with forest management experts who know about seed sources and what kinds of trees or shrubs are suited to your location. Both the Forest Service and CAL FIRE manage nurseries that take special care in locating and documenting the seed source. Check with your local office to determine if there is appropriate seed available for private landowner reforestation efforts. It is strongly advised that you do not simply collect your own seeds from any location (other than your own site) for planting on your property.

Active reforestation can take two approaches: (1) manual dispersal of seeds and (2) seedling planting. Manual dispersal of seed is generally not considered an effective or economical measure; the practice has been largely abandoned in the Sierra Nevada. Seed predation by small mammals and birds, the number of seeds required, and the cost of collecting and storing the seeds make conifer seed banks very precious resources. The preferred approach is to plant seedlings obtained from a trusted source.

Depending on the size of the area to be reforested, and the desired stand conditions, the planting process can be simple and inexpensive (for small areas) or can be rather involved and expensive for larger, more geographically diverse areas. The work will require activities such as ground preparation, ordering seedlings for planting, and controlling competing vegetation (largely shrubs that can quickly colonize a disturbed site). Active reforestation will also involve some followup activities (such as continued control of competing vegetation and thinning emerging stands) to maximize chances of seedling survival. A consulting forester will be able to advise you on the steps necessary to take either course.

Natural Regeneration

Natural regeneration from available seed has many advantages (including that it is far less expensive) and should be considered if the conditions are right. And landowners that have owned their property for even a few years have likely noticed some level of regeneration. Suitable conditions for natural regeneration include the following:

- An adequate seed supply of desirable species is nearby (within a few times the height of the nearby seed-bearing tree).
- Cone or seed production has been good in the year (or the following year) after the creation of openings. You can visually assess the relative cone production from year to year.
- Suitable temperature and soil moisture (hot, dry [typically south-facing] slopes are not good candidates for natural regeneration).

- Suitable microsites for tree regeneration exist. This includes such conditions as bare mineral soil, limited competition from other vegetation in the first few years, and openings with some shade (depending on the species) to reduce high and low temperature extremes at the soil surface.
- Small mammals (such as squirrels and chipmunks) are important for dispersing seeds. However, in some years, seed consumption by squirrels and chipmunks can use most or all available seeds. Look for seed availability and later seedling emergence as an indication of how successful natural regeneration is likely to be.

Facilitating the process of natural regeneration can be an appropriate approach but can be highly variable in effectiveness, success, and the time it takes for tree seedlings to grow above the shrubs. Therefore, this approach requires suitable conditions and patience. Doing some limited site preparation work such as clearing selected sites to expose bare mineral soil with no organic cover can aid in successful regeneration. However, if you are aiming for rapid regeneration of trees or have a more specific reforestation goal, then active reforestation will be a better choice. A complete manual on reforestation in California (Reforestation Practices for Conifers in California) will be published by the University of California Cooperative Extension in 2021 and will provide extensive and useful information on reforestation practices for forest land owners.

Choosing Management Treatment Options

Many subtle variations can be used for each of these four main methods of changing forest composition and structure (mechanical/manual treatment of vegetation, use of fire, use of herbicides, or regeneration of stands). After assessing your objectives and the existing conditions of your forest, you can select the best mix of treatment strategies suited to your property. With this information, you can then decide how to sustain or encourage the kinds of trees you want on your property. This includes the desired amount, distribution, and placement of small, medium, and large trees, given expected climate conditions. This will likely involve a combination of managing the trees you currently have to survive and thrive in the coming years as well as the possibility of planting and taking care of trees that will become part of your forest in the future.

Chapter 5: Assemble Information Into a Forest Management Plan for Your Property

Options for Developing a Management Plan

If you have worked through the suggestions in this handbook and recorded the related information for your property, you are now able to assemble a complete forest management plan. This management plan is a tool created by and for the landowner. Your forest management plan can range from a simple, informal, one-page summary of treatments that you will personally execute, to a complex, thorough forest improvement program that is approved and is potentially funded by the California Department of Forestry and Fire Protection (CAL FIRE) (or another assisting agency). What route you take will depend on the following:

- Complexity of your project
- Issues that need to be addressed
- Needed permits, if any
- Equipment and expertise needed to carry out the project
- Anticipated time horizon for the work and its results
- Funding requested or needed to execute the work
- Environmental protection or improvement complexities of the land

If your expectations are at the simpler end of the spectrum, use the information in the worksheets you have completed from this handbook to prepare your plan. It is prudent to take this plan to a resource management authority in your area (CAL FIRE, Natural Resources Conservation Service, or resource conservation district offices near your property) for technical assistance. UC Cooperative Extension also works collaboratively with California landowners to support responsible forest stewardship. The website below has more information on how to plan for managing a family forest.

- California family forests: <https://www.cafamilyforest.org/explore.html>.

You want to be as confident as possible that you are heading in the right direction and that you are personally capable of doing the work needed. See appendix 1 for more information. If, however, you have what appears to be a big job or you believe you will need assistance, it may be in your best interest to engage professional help. Details for how to find that assistance are also discussed in appendix 1.

The worksheets contained in this handbook will provide almost all the information needed for a forest management plan that CAL FIRE and other resource management organizations will want to see. You may wish to assemble your information in the format of a California cooperative forest management plan (see below) so you can more easily work with and receive technical and even financial

assistance from CAL FIRE, the Forest Service, the Natural Resources Conservation Service, the American Tree Farm Association, or other government and private organizations that are able to help you assemble and execute your management plan.

California Cooperative Forest Management Plan

If you choose to have a more detailed plan, whether you have professional help or not, CAL FIRE has provided a template for preparing a California cooperative forest management plan that you can use to organize your information. In summary, this forest management plan template includes the following information:

- Signature pages (for the landowner and agency partner[s])
- Certification page (if a registered professional forester will help evaluate the property and prepare the plan)
- Landowner information (basic information about the landowner and the planning effort)
- Property facts (basic description of the property)
- Property history (relevant knowledge about the history of the property)
- Current property conditions (basic information about the current conditions, as described in this handbook)
- Landowner management objectives (description of desired forest conditions, as described in this handbook)
- Management plan implementation (discussion about how the plan will affect resources and infrastructure of the property)
- Planned management activities and required permits (proposed set of actions to address needed changes on the property, discussion of any permits, as needed)
- Management activity tracking spreadsheet (to track actions, where they occur, treatments applied, costs, and dates)
- Maps will be a necessary and useful component of this management plan. You can use existing U.S. Geological Survey topographical maps or maps generated by your professional forester. There are specifications and standards required for map preparation.

This management plan includes an outline of the conditions of the property, documents the landowner's objectives and decisions, and identifies potential resource improvement projects. It is meant to be a flexible and functional document that considers a planning and implementation horizon of typically 5 years, but may include objectives that require a much longer time period. Your forest management professional can also help you prepare the necessary information for the management plan. See appendix 1 for more information on technical and financial assistance. More guidance for a California cooperative forest management plan is available online:

- California forest management plan: <https://www.fire.ca.gov/media/pe4fs-wrg/ca-cooperative-fmp-ada.pdf>.
- NRCS forest management plan criteria: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/ca/technical/cp/tsp/?cid=nrcs144p2_064056.

Monitoring for Success

Considering the time, effort, and investment required to manage your forest, it is prudent to also monitor what happens after you have finished implementing your management plan. Forests change relatively slowly, but continuously, and trees and shrubs in your forest will respond to the treatments that you implement. Therefore, monitoring those changes will let you know if your treatment program is achieving the objectives you have set. Monitoring can take a wide variety of forms, from quite simple for small-scale projects to very sophisticated and statistically valid for larger ones. Below is a simple, short list of features for monitoring changes in your forest after treatment:

- Number of trees per acre (roughly) by dominant species
- Size of trees by major size class (such as 10-inch increments)
- Amount of cover in shrubs (roughly what proportion, in 10 percent increments, of your forest is in shrubs; aerial photos are an ideal way to estimate this)
- Amount of surface fuels (accumulation of needles and branches)
- Evidence of increasing or decreasing tree health
- Signs of increased invasive species, pests, or tree diseases

If you can collect this information every 3 or 4 years, you can build a record of the changes that are happening after your treatments. This basic information will enable you to get a sense of the new trajectory your forest is on as a result of these treatments, particularly when you compare information to stand conditions prior to the treatments and your overall goals for your property. Discuss this plan with your local CAL FIRE, Natural Resources Conservation Service office or other source of professional assistance.

Should You Hire a Professional Forester?

It may not be feasible for some landowners to complete the tasks outlined above. The appendices of this handbook contain reference materials for finding a variety of technical and financial resources. Depending on its condition, you may need professional help once you have developed an initial evaluation of your forest. Professional assistance is available from local and state agencies as well as a contracted registered professional forester. For more details, see appendix 1.

Depending on its condition, you may need professional help once you have developed an initial evaluation of your forest.

Appendix 1: Technical and Financial Resources and Assistance

Individuals who own 5, 25, or 50, or 100 acres of forest land may want or need to seek additional information to better understand their situation and learn about suitable choices for maintaining or restoring healthy forest conditions. You may need assistance in determining your needs and assessing your options. Fortunately, there is a wealth of information available to guide you. Below are a variety of resources (websites, institutions, technical and legal information, etc.) that provide a wide range of technical and financial assistance.

Technical and Financial Assistance From Forestry Specialists

There are many sources of technical information. The most prudent choices will depend on such factors as personal understanding of management needs and options, urgency for treatment, size of property, location and condition of neighboring properties, and available finances. Many of the organizations that provide technical assistance also have financial assistance programs. We begin with the simplest approach, particularly for those who have the resources to invest.

Registered Professional Foresters

California requires foresters to register through the Office of Professional Foresters Registration. Managed by California's Board of Forestry and Fire Protection, the program ensures registered professional foresters pass a comprehensive examination and have sufficient experience and education in such disciplines as forestry, silviculture, forest biology, ecology, wildlife management, engineering, and forest economics.

These foresters can evaluate the conditions of your forest using scientifically accepted methods and develop proposals on where and how to treat your forest to achieve the goals you formulate with their assistance. You can search for one with expertise in areas that you want to emphasize. The actual work on the ground, the prescribed treatments, typically are conducted by other contractors such as licensed timber operators, licensed pesticide control advisors and qualified applicators, or certified arborists. Registered professional foresters should be able to work with you to find an appropriate timber operator once a plan for treatment is in place. Below are links to more details on California's Registered Professional Foresters Program and a complete list of its foresters:

- Registered Professional Foresters Program: <https://bof.fire.ca.gov/projects-and-programs/professional-foresters-registration/>.
- List of registered professional foresters by county: <https://www.clfa.org/resources>.

Using a registered professional forester to develop a comprehensive forest management plan for your property may require a significant investment, depending on many factors including property size location, type of needed management, etc. There also are other ways to get professional forestry assistance.

CAL FIRE

The California Department of Forestry and Fire Protection, or CAL FIRE, is the state agency with the lead on fire prevention and protection, emergency response, and natural resources protection services. CAL FIRE administers several state and federal forestry assistance programs to reduce wildland fuel loads and improve the health and productivity of private forestlands. It also seeks to expand and improve the management of trees and related vegetation in urban communities across California. The following three programs specifically assist small-parcel private forest land owners.

California Forest Improvement Program—

This program offers cost-share opportunities to assist individual landowners with land management planning, conservation to enhance wildlife habitat, and practices to enhance the productivity of the land. The scope of the California Forest Improvement Program includes the improvement of all forest resources, such as fish and wildlife habitat, soil, and water quality. Cost-share assistance is provided to landowners with 20 to 5,000 acres of forest land. Cost-shared activities include management planning, site preparation, tree purchase and planting, timber stand improvement, fish and wildlife habitat improvement, and land conservation practices.

- California Forest Improvement Program: <https://www.fire.ca.gov/grants/california-forest-improvement-program-cfip/>.

CAL FIRE administers several state and federal forestry assistance programs to reduce wildland fuel loads and improve the health and productivity of private forestlands.

California Forest Stewardship Program—

A collaborative project with the U.S. Department of Agriculture (USDA), Forest Service and several other organizations, the California Forest Stewardship Program was created to encourage good stewardship of California's private forest land. This program provides cost-share assistance for improving private, nonindustrial forest land for owners with 20 to 5,000 acres of forest land. Cost-shared activities include the following:

- Preparation of a forest management plan by a registered professional forester
- Registered professional forester supervision of the following:
 - Reforestation
 - Site preparation
- Trees and planting
- Tree shelters
- Stand improvement
 - Precommercial thinning or release
 - Pruning
 - Followup (including mechanical, herbicide or slash disposal)

Other programs may be able to assist landowners with less than 20 acres of forest land as funding becomes available. The Wildfire Resilience Block Grants are a flexible grant program that allows CAL FIRE to change the eligibility requirements in response to the specific needs of the funding available. Please see CAL FIRE's Forest Stewardship webpage for updates.

- <https://www.fire.ca.gov/programs/resource-management/resource-protection-improvement/landowner-assistance/forest-stewardship/>.

Historically, the California Forest Stewardship Program projects have been funded from the state's Forest Resource Improvement Fund. CAL FIRE may also receive funding from a variety of other state and federal sources. Different funding sources may have different requirements or additional application procedures. Be sure to discuss this with your forestry assistance specialist at the CAL FIRE unit in which your project resides, the regional forestry assistance specialists, or call the California Forest Stewardship Program manager in Sacramento. The program's quarterly newsletter, *Forestland Steward*, provides information on a broad range of topics. More information can be found via the link below:

- California Forest Stewardship Program: <https://www.fire.ca.gov/programs/resource-management/resource-protection-improvement/landowner-assistance/forest-stewardship/>.

Forest Legacy Program—

The intent of the Forest Legacy Program is to protect environmentally important forest land threatened with conversion to nonforest use. The program is entirely voluntary. Eligible properties are those managed to produce forest amenities and products and located where traditional forest uses are maintained. Priority is given to lands that can be effectively protected and managed and that have special value such as scenic, recreational, timber, riparian, fish and wildlife, threatened and endangered species, and other cultural and environmental values. Project costs covered by Forest Legacy Program grants include purchase of interests in lands, appraisals, land surveys, closing costs, establishing baseline information, title work, purchase of title insurance, conservation easement drafting, and other real estate transaction expenses.

- Forest Legacy Program: <https://www.fire.ca.gov/grants/forest-legacy/>.

CAL FIRE also has grant programs for public and nonprofit entities that may indirectly result in vegetation management work for willing small private landowners.

Forest Health Grant Program—

The California Climate Investments statewide initiative provides CAL FIRE funds for the Forest Health Grant Program. The program funds projects that proactively restore forest health to reduce greenhouse gases, protect upper watersheds where the state's water supply originates, promote the long-term storage of carbon in forest trees and soils, and minimize the loss of forest carbon from large and intense wildfires. The emphasis of the Forest Health Grant Program is to increase the carbon stored in living trees and protect forests, fish and wildlife habitats, native plant species, and water. This requires preventing epidemic tree mortality, protecting water quality in upper watersheds, and creating forests with optimally spaced trees that are resilient to disturbances.

- <https://www.fire.ca.gov/grants/forest-health-grants/>.

Wildfire Resilience and Forestry Assistance Grants—

Wildfire Resilience and Forestry Assistance Grants is a CAL FIRE grant program that was established to support ecological restoration of forests. The program is open to counties, resource conservation districts, and nonprofit organizations that are capable of providing technical assistance to nonindustrial forest land owners. This program enables these organizations to receive CAL FIRE funding that they use, in turn, to offer support for forest restoration activities for properties that have been subject to fire, insect infestations, diseases, and other disturbances that have had a serious impact. Using their land management expertise, prospective grantees will help landowners take actions to restore healthy conditions to their forest. Landowners can check with local offices (county, resource conservation districts, or other nonprofits) to learn if assistance through this program might be available to them.

California Department of Conservation Resource Conservation Districts

Resource conservation districts were established in the 1930s to work with private landowners and public land managers on a voluntary basis to manage and conserve various natural resources. They are special districts set up by the state to be locally governed agencies with their own locally appointed or elected, independent boards of director. California resource conservation districts implement projects on public and private lands and educate landowners and the public about resource conservation.

California has 98 such districts across the state. Some are designated simply by county, others by a more specific geographic location. The following link provides additional information:

- California resource conservation districts: <https://www.conservation.ca.gov/dlrp/RCD/Pages/CaliforniaRCDs.aspx>.

Although much of their work involves farmlands and rangelands, resource conservation districts also work with people to address topics, such as watershed planning and management, wildlife habitat enhancement, forest stewardship, fuels management, and many other land management objectives. Resource conservation districts provide information and assistance in a variety of formats:

- Field tours
- Personal contacts
- Public meetings
- Workshops
- Mailings
- Exhibits
- Websites
- Newsletters
- Informational brochures
- Professional journal publications, technical publications, reports

Regional Forest and Fire Capacity Program—

Resource conservation districts, which operate under the California Department of Conservation, manage the Regional Forest and Fire Capacity Program. The program seeks to increase the capacity to prioritize, develop, and implement projects at a regional level that will improve forest health and fire resilience, facilitate greenhouse gas emissions reductions, and increase carbon sequestration in forests throughout California. This is a block grant program that is intended for more than one landowner to support regional implementation of landscape-level forest health projects consistent with the California Forest Carbon. Launched in 2015, the program's objectives are to increase the pace and scale of investments

in the Sierra Nevada to address critical watershed needs. This program aims to increase regional capacity for projects that have broad support by stakeholders in and affected by the region. You can discuss this option with your resource conservation district representative.

- California Forest Carbon Plan: <https://resources.ca.gov/CNRALegacyFiles/wp-content/uploads/2018/05/California-Forest-Carbon-Plan-Final-Draft-for-Public-Release-May-2018.pdf>.

Forest Health Watershed Coordinator Program—

Resource conservation districts also manage the Forest Health Watershed Coordinator Program to help forest and watershed improvements restore the health and resilience of forests in California. Applicants that are eligible for its grants are (1) special districts, (2) nonprofit groups (tax exempt 501[c][3]), (3) local governments, and (4) tribal governments located within one of the two watershed coordinator zones. Individual landowners can work with other landowners and any of these qualified entities to obtain a grant for forest management. To contact your local resource conservation district, see the link below.

- Resource conservation districts: <https://carcd.org/rcds/find/>

University of California Cooperative Extension Forestry—

The University of California’s Division of Agriculture and Natural Resources is dedicated to reaching out to individual landowners and local communities to provide technical assistance in addressing a wide range of natural resources challenges. The division includes a team of forest science and stewardship specialists who work with residents and landowners to help them address forest management issues on their property. The Cooperative Extension Forestry program provides a variety of technical information, including a website with technical resources, publications, and other information on how to manage forest land in California. The program also offers a 25-part online educational series on a wide range of forest stewardship topics for landowners:

- UC Division of Agriculture and Natural Resources Forest Stewardship: https://ucanr.edu/sites/forestry/Forest_Stewardship/.

Cooperative Extension foresters are county-based advisors located in forested communities and focus on delivering science-based programs to serve local needs. Forestry specialists are attached to a University of California campus in most cases. While this is a small group of advisors, they have extensive expertise in a variety of disciplines, including forest management, ecology, disease, wildfire,

The U.C. Cooperative Extension Forestry program provides a variety of technical information, including a website with technical resources, publications, and other information on how to manage forest land in California.

water quality, and defensible space. You can contact one of them directly or fill out an online “ask an expert” survey that will be forwarded to the appropriate expert. See the link below for a list of forestry specialists and advisors to find an advisor near you:

- UC Cooperative Extension Forest Outreach: https://ucanr.edu/sites/forestry/Getting_Help/

Natural Resources Conservation Service—

The USDA Natural Resources Conservation Service (NRCS) was established by Congress in 1935 in recognition of the loss of soil and water resources, in particular as a response to the Dust Bowl in the Midwestern United States. NRCS employees provide a variety of technical and financial assistance to farmers, ranchers, forest land owners, local and state governments, and other federal agencies to maintain healthy and productive working landscapes.

NRCS specialists provide technical expertise and conservation planning for farmers, ranchers, and forest land owners wanting to make conservation improvements to their land. Farmers, ranchers, and forest land owners can also receive financial assistance from the NRCS to make improvements to their land. There are five basic steps to obtaining assistance with your project from the NRCS:

- **Planning assistance:** NRCS provides farmers, ranchers and forest managers with free technical assistance, or advice, for their land. Common technical assistance includes resource assessment, practice design, and resource monitoring.
- **Application:** Fill out an application for assistance with the help of NRCS staff.
- **Eligibility:** As part of the application process, NRCS will check to see if you are eligible (NRCS officials will review your ownership and property situation to determine this).
- **Ranking:** NRCS will look at the applications and rank them according to local resource concerns, the amount of conservation benefits the work will provide, and the needs of applicants.
- **Implementing:** If you are selected and sign the contract, you will be provided standards and specifications for completing the practice or practices, and then you will have a specified amount of time and funding for implementation.

Natural Resource Conservation Service specialists provide technical expertise and conservation planning for farmers, ranchers, and forest landowners wanting to make conservation improvements to their land.

For more information on obtaining assistance from NRCS, see the following link:

- NRCS assistance: <https://www.nrcs.usda.gov/wps/portal/nrcs/detail/nh/home/?cid=stelprdb1250138>. Prominent technical and financial assistance provided by NRCS includes the following:
 - Conservation planning, including preparation of a forest management plan.
 - Funding for clients to implement forestry field practices such as these:
 - Tree and shrub thinning
 - Woody debris treatment
 - Pruning
 - Establishing fuelbreaks
 - Prescribed burning
 - Planting trees and shrubs
 - Resprouting vegetation control
 - Forest road and trail construction and erosion control/restoration

The NRCS provides a wealth of information, much of which can easily be accessed on its website. The NRCS has agents throughout the state of California, including many working in the Sierra and Cascades area. The NRCS California office provides information on a variety of topics, including a list of agents.

- NRCS California: <https://www.nrcs.usda.gov/wps/portal/nrcs/site/ca/home/>.
- NRCS agent locator: <https://offices.sc.egov.usda.gov/locator/app?state=CA>.

The NRCS offers several voluntary programs to eligible landowners under the 2018 Farm Bill to provide financial and technical assistance to help manage natural resources, including forests, in a sustainable manner. Through these programs, the agency approves agreements to provide financial assistance to help plan and implement conservation practices that address natural resource concerns. Financial assistance is also approved for opportunities to help reduce wildfire; improve forest health; and improve soil, water, plant, air, animal, and other related resources on nonindustrial private forest land. The primary programs for individual nonindustrial private forest land owners through NRCS include the following:

- **Cooperative Conservation Partnership Initiative**
- **Conservation Stewardship Program:** This program helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resources concerns. Participants earn payments for conservation performance—the higher the performance, the higher the payment. NRCS accepts applications year-round and establishes cutoff dates to batch applications for ranking and funding decisions.

- **Environmental Quality Incentives Program:** This is a voluntary, conservation program that can provide financial and technical assistance to install conservation practices that address natural resource concerns. Environmental Quality Incentives Program funding decisions are based on an evaluation process that includes prescreening and ranking criteria. Prescreening is used to prioritize assistance based on factors such as a history of contract compliance. Ranking considers the anticipated benefit of a conservation system, or practice, to a natural resource concern and national, state, and regional priorities being addressed. NRCS accepts applications year-round and establishes cutoff dates to batch applications for ranking and funding decisions.
- **USDA Natural Resources Conservation Service financial programs:**
<https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/>.

Farm Service Agency—

The Farm Service Agency, in cooperation with partners, administers the Emergency Forest Restoration Program to help owners of nonindustrial private forests restore forest health to forest land damaged by natural disasters. The program does this by authorizing payments to owners of private forests to restore disaster-damaged forests. Only owners of nonindustrial private forests with tree cover existing before the natural disaster occurred are eligible to apply. Funding up to 75 percent of the cost to implement emergency conservation practices can be provided. There is a limit of \$500,000 per person or entity per disaster.

- **Emergency Forest Restoration Program:** https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdfiles/FactSheets/emergency_forest_restoration_program-fact_sheet.pdf.

U.S. Forest Service State and Private Forestry—

The U.S. Forest Service's State and Private Forestry organization is dedicated to assisting states, American Indian tribes, communities, and nonindustrial private landowners. State and Private Forestry programs bring forest management assistance and expertise to a diversity of landowners, including small woodlot owners through cost-effective, nonregulatory partnerships.

State and Private Forestry's Forest Stewardship Program fosters effective and lasting partnerships with state foresters, conservation districts, university cooperative extension, and others to provide technical assistance, education programs, and other activities to hundreds of thousands of landowners each year. The program

Assistance offered through the U.S. Forest Service Forest Stewardship Program provides landowners with enhanced access to other USDA conservation programs, forest certification programs, and forest product markets.

seeks to conserve, protect, and enhance private forest landscapes by connecting individual and family woodland owners with the information, technical assistance, and professional planning they need to achieve their stewardship goals. Assistance offered through the U.S. Forest Service Forest Stewardship Program provides landowners with enhanced access to other USDA conservation programs, forest certification programs, and forest product markets.

The Forest Stewardship Program provides technical assistance to nonindustrial private forest owners to encourage and enable active long-term forest management. The program offers several resources to help landowners develop a forest management plan (also known as a forest stewardship plan). This approach allows the landowner to define their objectives for their forest for now and into the future. A forest stewardship plan can be developed to identify goals for your land and the management activities needed to meet them.

- U.S. Forest Service Forest Stewardship Program: <https://www.fs.fed.us/managing-land/forest-stewardship/projects-and-partners>.

There are many resources for landowners that State and Private Forestry can help facilitate or help you access. In California, State and Private Forestry has a Forest Stewardship Program manager at its regional headquarters in Vallejo.

- U.S. Forest Service Cooperative Forestry: <https://www.fs.usda.gov/detail/r5/communityforests/?cid=fseprd487276>.

State and Private Forestry works with many state and private partners to provide a variety of financial assistance. The Cooperative Forestry staff, of State and Private Forestry, typically delivers its work through states and other partners. Working through CAL FIRE will lead landowners to programs that the Forest Service can provide. Programs like Forest Legacy, Forest Stewardship, Urban and Community Forestry, and Wood Innovations are tools the Forest Service, states, and communities use to address and sustain trees and forested landscapes.

- Forest Legacy Program: <https://www.fs.fed.us/managing-land/private-land/forest-legacy>.
- Urban and Community Forestry: <https://www.fs.fed.us/managing-land/urban-forests/ucf>.
- Wood Innovations: <https://www.fs.fed.us/science-technology/energy-forest-products/wood-innovation>.

American Forest Foundation—

The American Forest Foundation is a 501c3 nonprofit that works on the ground with families, teachers, and elected officials to promote stewardship and protect our nation's forest heritage. A commitment to the next generation unites this nationwide network of forest owners and educators working to keep America's forests healthy and our nation's children well prepared for the future they will inherit. This private organization has offices across the country, including in California. It offers a variety of programs and resources, many of which can be accessed via the following link:

- American Forest Foundation: <https://www.forestfoundation.org/tools-resources-for-woodland-owners>.

The foundation's My Land Plan program is particularly well suited to small-parcel forest land owners in California. The program offers guidance and ideas with tools to help map your land, set goals, and connect with other woodland owners and foresters. See more via the link below:

- My Land Plan program: <https://mylandplan.org/>.

Another valuable American Forest Foundation program for private forest land owners is My Sierra Woods, which provides forestry services by a registered professional forester to private forest land owners in 10 counties of northern California. Upon landowner request, the program ensures the forester will visit with a landowner to discuss objectives and management opportunities to improve forest conditions and use forest products.

- My Sierra Woods: <https://www.mysierrawoods.org/>.

Forest Land Owners of California—

Forest Land owners of California is a private organization based in Folsom, California, that is dedicated to helping small-parcel forest land owners. It is a membership organization providing a voice for nonindustrial family-owned forest in California. It promotes the benefits of sustainable, science-based forest management practices to policymakers, members of the public, and the environmental community. This organization also provides opportunities for family forest owners to meet and share common goals, challenges, and interests. Members are offered various resources to help with management issues on their lands. These resources include a resource guide, newsletters, webinars and podcasts, and access to professionals for technical assistance.

- Forest Landowners of California: <http://www.forestlandowners.org/>.

California Fire Safe Council—

California Fire Safe Council is a statewide nonprofit organization that provides links between local communities and the state and federal agencies that manage forests. As a nonprofit, it can receive federal grants that support local fire safe councils and other community organizations with efforts that include projects to reduce hazardous fuels, provide wildfire prevention education, create risk assessments, and develop community wildfire protection plans. Fire safe councils are grassroots, community-led organizations that mobilize residents to protect their homes, communities, and environments from wildfire. Local fire safe councils are distributed across the state.

- California Fire Safe Council: <https://cafiresafecouncil.org/>.

Firewise USA—

The National Fire Protection Association is a nonprofit organization devoted to eliminating death, injury, and property and economic loss due to fire. It supports a program called Firewise USA, in cooperation with the U.S. Forest Service, National Park Service, and National Association of State Foresters. The program strives to teach people how to adapt to living with wildfire and encourages neighbors to work together and act now to prevent losses. There are more than 1,500 recognized Firewise sites around the country that assist owners in preparing and protecting their homes against the threat of wildfire. The Firewise website (see below) includes information on preparing homes for wildfire, research fact sheets, virtual workshops, wildfire preparedness tips, and more.

- Firewise USA: <https://www.nfpa.org/Public-Education/By-topic/Wildfire/Firewise-USA>.

Role of timber operators—

Almost any management direction taken by a small-parcel forest land owner could include the need for working with a timber operator. These are professionals who are trained and experienced in tree cutting or removal, including dead trees. If your management plans for your forest involve cutting or removing a tree, or other mechanical activity, you will be working with a licensed timber operator. These professionals understand and comply with all laws relating to such tree cutting or removal. California state law requires that any person who harvests forest trees to sell logs or develop a building site on forest lands be a licensed timber operator. Landowners are required to obtain a permit from the Department of Forestry and Fire Protection (CAL FIRE) before allowing any tree cutting or removal. In some cases, a registered professional forester will be needed to complete the permit application.

If your management plans for your forest involve cutting or removing a tree, or other mechanical activity, you will be working with a licensed timber operator.

CAL FIRE provides an updated list of licensed timber operators (via the link below). Licenses fall into three categories. Type A is a commercial license that requires 3,000 hours of work experience in at least two different areas of timber operations, and valid proof of insurance. Type B and type C licenses are limited and restricted licenses, respectively, for less complex operations such as cutting or removing minor forest products such as firewood and Christmas trees (type B) or timber operations only on property owned by the license holder (type C).

- Licensed timber operators and permits for tree removal: <https://www.fire.ca.gov/programs/resource-management/forest-practice/timber-harvesting/licensed-timber-operators-ltos/>.

Associated California Loggers—

The Associated California Loggers has represented professional timber harvesters since 1973. It represents companies and individuals who harvest and transport forest products from the field to processing facilities. This organization offers classes, certification, and training, and it partners with agencies and select companies to provide their members with insurance and safety services.

- Associated California Loggers: <http://californialoggers.com/>.

Property Insurance Considerations

Despite your best efforts, it is still possible that a fire could burn your property. Thus, it is prudent to be prepared. Forest land owners would be wise to investigate their best options for property insurance. For more information on insurance in the event of a wildfire, visit the Insurance Information Institute’s website.

- Insurance Information Institute: <https://www.iii.org/insurance-basics/disasters-preparedness/earthquake-wildfire>.

More wildfire information that can be valuable to forest land owners is available on the Insurance Institute for Business and Home Safety’s “DisasterSafety” website. This site includes resources on reducing wildfire risk, getting help for those affected by recent wildfire, factsheets to reduce property damage risks, creating defensible space zones, checklists to protect your property from wildfire, reducing wildfire damage to roofs, and how to reduce the costs associated with fire damage.

- Insurance Institute for Business and Home Safety: <http://disastersafety.org/wildfire/>.

It is prudent, if not imperative, for homeowners to take steps to reduce risks. If a homeowner is not willing to take those steps, it may be difficult or even impossible to find suitable insurance.

It is prudent, if not imperative, for homeowners to take steps to reduce risks. If a homeowner is not willing to take those steps, it may be difficult or even impossible to find suitable insurance.

Taxation of Private Forest Lands in California

Tax requirements, including local property taxes as well as state and federal income taxes for revenue obtained from forest lands, apply to privately owned forest lands in California. Local “ad valorem” property taxes typically assess property based on the current assessed value of property at its “highest and best use.” This was once viewed as an incentive to convert forest land to subdivisions and homes, so California passed the Forest Taxation Reform Act in 1976. This law established provisions for a “timber yield tax” and a “Timberland Production Zone” to acknowledge the different financial conditions around investments and income associated with forest management. These taxation changes incentivized investments and enabled management of forests by matching income streams from relatively slow rates of return with appropriate taxation levels. It is in forest land owners’ interests to understand how specific property tax laws for forest lands apply to their own lands. For more information, see the UC Division of Agriculture and Natural Resource publication, *Forest Stewardship Series 22: Forest Taxation, Estate Planning, and Conservation Easements*, (see the link below) or consult with a registered professional forester.

- *Forest Taxation, Estate Planning, and Conservation Easements*: <https://anrcatalog.ucanr.edu/pdf/8252.pdf>.

Taxes on income derived from forest lands will apply to both state and federal income taxes. If you plan to derive income from the trees on your property, there are many complex and technical circumstances surrounding how income value is determined. We cannot adequately explain all these details here. Consulting a tax specialist would be prudent, particularly if you are making substantial investments and expect to obtain some significant revenues from harvesting trees on your property. In basic terms, there are several important considerations to address:

Timber Property Type

There are three basic types of timber property. Personal-use property involves no plans for deriving income. The other two types of timber property are an investment property that is intended for generating profit from growing timber or asset appreciation, or a business property with regular, active, and continuous profit-making timber activities. When timber is owned as a business, timber expenses can be fully deductible on Schedule C of Form 1040 if you are investing in forest management. These expenses may include a variety of fieldwork (such as thinning) and consulting fees.

Other issues to consider that will affect your income taxes include actual timber sales and associated reporting, the value of your timber when you purchased the property (“timber basis”), and timber depletion (deduction against the timber basis

after a timber sale). Because timber is a long-term investment, it is subject to capital gains or losses. If you lose timber in a fire or other natural disaster, it is possible that your loss could be tax deductible. Should you need to invest in reforestation, some costs are tax deductible. It is also possible to donate a qualified conservation easement and receive a tax deduction.

Financial assistance (cost-share or other payments) you receive for forest management or conservation practices recommended by federal and state forestry agencies, farm agencies, or natural resource conservation agencies on your woodland property may also have tax implications. The payment-issuing agency is required to report the cost-share payment and send copies to you and the Internal Revenue Service on Form 1099-G. You must account for the payments in your tax return.

In general, cost-share payments are considered taxable income unless they are from an approved program that qualifies for an income exclusion. Qualified cost-share payments may be partially or entirely excluded from your gross income to the extent allowed under Section 126 (Section 126 and Temporary IRS Regulation 16A.126-1 and 16A.126-2). If your cost-share payment was incurred for a reforestation project, the payment qualifies for reforestation tax deductions if it is included in your gross income.

To qualify for the income exclusion, the cost-share payment must come from approved programs (U.S. Department of Agriculture and U.S. Department of the Treasury for federal programs), such as the Forest Health Protection Program, Conservation Reserve Program, Conservation Security Program, Environmental Quality Incentives Program, and Wetlands Reserve Program.

More tax information is available online:

- USDA Tax Tips for Forest Landowners: <https://www.fs.fed.us/spf/coop/library/taxtips2018.pdf>.
- National Timber Tax Website: <https://timbertax.org/>.
- Federal Income Tax on Timber: A Quick Guide for Woodland Owners: <https://www.fs.fed.us/spf/coop/library/timbertax2012.pdf>.

A key consideration under California state laws now governing forests is the so-called yield taxation. Yield taxation is based on the value of the timber when harvested, or “stumpage value.” A *Harvest Values Schedule* is published every 6 months by the California State Board of Equalization that shows the average timber prices for “timber value areas” (see fig. 23 below). This is used to calculate the taxes owed from harvest. If you manage your forest property as a business, then it is important to keep detailed records of expenses and revenue.

Preserving Your Forest Legacy

Long-term planning is essential to ensure your property is passed on to your beneficiaries in the condition that you intend. A working forest conservation easement (WFCE) can be an important tool for ensuring the conservation and management values you want for your forest are not only preserved for the next generation, but in perpetuity. WFCEs do more than just restrict development and conversion on a property, they protect forest values by concentrating on sustainable forest practices that provide economic value from the land and encourage long-term land stewardship. They also ensure the land continues to provide such benefits as sustainable timber production, wildlife habitat, recreation opportunities, watershed protection, and open space. Intact forests also contribute significantly to the storage and sequestration of carbon. You can contact a local land trust to learn more. A listing of statewide land trusts are available from the California Council of Land Trusts.

- California Council of Land Trusts: <https://www.calandtrusts.org/map-ca-land-trusts/>.

It will take some work to arrive at long-term objectives, but the returns can yield benefits for generations to come.

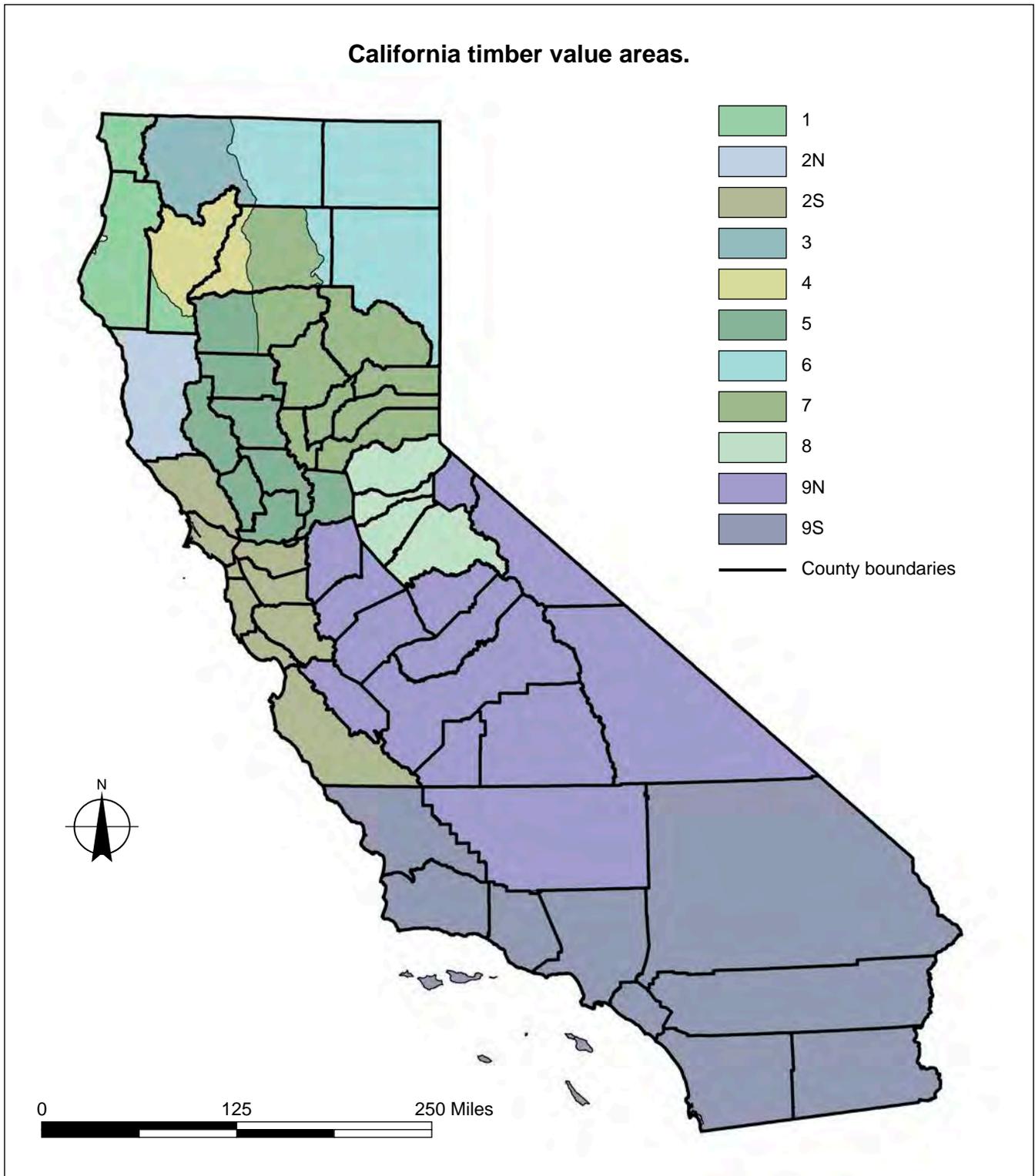


Figure 23—Timber value areas as established by the California State Board of Equalization. Actual timber values are published by the board every six months. Courtesy of The Resources Agency, California Department of Forestry and Fire Protection.

Appendix 2: Legal and Regulatory Requirements

Information on legal considerations is best provided by a qualified legal expert. However, there is some basic legal information and guidance that can provide a starting point.

Relevant State and Federal Laws

The state and federal laws pertaining to forests can be divided into those that are relevant to harvesting timber and those that are not. If you plan to harvest timber, the primary consideration is the Z'berg-Nejedly Forest Practice Act of 1973. This state law requires careful management of timber harvesting activity to protect forest resources for coming generations. The main feature of this law is the requirement to prepare a timber harvest plan for each project that will involve harvesting trees. Tree harvest includes logs that are offered for sale, barter, exchange, or trade as well as tree harvest that is part of a land management intent to convert timberland to nontimber land use. Any of these activities will trigger the requirement of a permit under the authority of the California Forest Practices Rules.

- California Forest Practices Act Rules: <https://bof.fire.ca.gov/regulations/bills-statutes-rules-and-annual-california-forest-practice-rules/>.

There are several other state and federal laws that accompany the oversight of timber harvest. If you are considering harvesting timber, seek help from a technical expert (discussed above). For other activities, such as development of a home site, water development, road construction and maintenance, pile and prescribed burning, well drilling, working near a stream, etc., there are various requirements for permits and approvals from different county and state agencies.

UC Division of Agriculture and Natural Resources have developed some useful guidance on timber harvest and nontimber harvest policies, laws, and regulations on its website.

- *Laws and Regulations Affecting Forests I: Timber Harvest*: <https://anrcatalog.ucanr.edu/pdf/8249.pdf>.
- *Law and Regulations Affecting Forests II: Activities Other Than Timber Harvest*: <https://anrcatalog.ucanr.edu/pdf/8250.pdf>.

Do You Need Permits?

You likely will need permits for all the above-mentioned activities. Typically, these are county permits, but some require state permits. A federal permit is rarely required. The management plan you are developing as a product of this handbook will prepare you well for most of these requirements. Basic, routine home and property maintenance are most likely under county jurisdiction, as with any homeowner. Questions should begin with your county government offices.

Removing Timber for Fuel Hazard Reduction

If your objectives do not involve timber harvesting, but you believe you need to remove trees and shrubs for reduction of hazardous fuels, there are some considerations to address. Some state and county agencies may require review of the plan to ensure that unintended consequences (such as impacts on streams) can be avoided or mitigated. Check with your local CAL FIRE office for guidance.

Appendix 3: Worksheets

These worksheets are intended to help you summarize the key information you have assembled on each of the four steps detailed in previous chapters. As you gather information for each step—objectives (worksheet 1), conditions (worksheet 2), threats (worksheet 3), and treatments (worksheet 4)—these worksheets help you briefly describe the information tailored to the needs you have for your property.

Each worksheet is designed to encapsulate information you collect; at the bottom of each worksheet, space is provided for you to summarize that input. You can then easily provide a succinct narrative of the key points from each step by taking the summaries in each worksheet (line C.1 of worksheet 1, line E.4 of worksheet 2, line E.6 of worksheet 3, and lines B.1–B.5 of worksheet 4). Assemble these summaries together into a brief overview of the forest management approach for your property.

This information should enable you, as the landowner, to better understand the context, condition, and management needs of our property. You can also use this summary to communicate a concise story of your property with forest management professionals, local county officials, and other sources of information and assistance.

Worksheets can also be downloaded using these links:

- Worksheet 1: https://www.fs.fed.us/psw/publications/documents/psw_inf001/Worksheet1.pdf
- Worksheet 2: https://www.fs.fed.us/psw/publications/documents/psw_inf001/Worksheet2.pdf
- Worksheet 3: https://www.fs.fed.us/psw/publications/documents/psw_inf001/Worksheet3.pdf
- Worksheet 4: https://www.fs.fed.us/psw/publications/documents/psw_inf001/Worksheet4.pdf

Forest Management Worksheet 1: Objectives for Your Forest

For each objective briefly describe the values you are managing for.

Objectives	Status (started, midway, completed)	Priority (low, medium, high)	Task	Objective description for your property	Notes
A. Primary objectives					
A.1			Recreation and aesthetic enjoyment	How many acres (and what percentage) of your property are dedicated to this purpose? List by total acres for each different purpose; how many acres for each type of recreational and aesthetic enjoyment.	
A.2			Timber production	How many acres (and what percentage) of your property are dedicated to this purpose? List by total acres for each different silvicultural purpose if there is more than one.	
A.3			Minor forest products	How many acres (and what percentage) of your property are dedicated to this purpose? List by total acres for each different purpose.	
A.4			Other agricultural products	How many acres (and what percentage) of your property are dedicated to this purpose? List by total acres for each different purpose.	
A.5			Watershed and ecological processes	Watershed and ecological processes represents management to restore and maintain a healthy, self-sustaining forest system. This can be compatible with other objectives, depending on the how singular the objective is and how aggressive specific management activities may be required. If general ecological health and processes is a primary goal for at least some portion of your property, list total acres devoted to this.	
B. Secondary objectives					
B.1			Wildlife habitat	How many acres of your property are dedicated to this purpose? Discuss what kinds of wildlife species you are targeting, and list by acres dedicated solely to these purposes.	
B.2			Carbon storage	How many acres of your property are dedicated to this purpose? How many acres are dedicated solely to this purpose?	
B.3			Other specific purposes	Describe in detail and list total acres dedicated to each additional purpose.	
C. Total summary of ownership objectives					
C.1			Property summary	Add all acres for each purpose and summarize	

This worksheet is from the Forest Management Handbook for Small-Parcel Landowners in the Sierra Nevada and Southern Cascade Range. 2021. McPherson, E. Gregory; Peper, Paula J.; van Doorn, Natalie. S. Info. For. PSW-INF-1. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 85 p.

Forest Management Worksheet 2: Conditions of Your Property

Task #	Status (started, midway, completed)	Priority (low, medium, high)	Task	Task description	Notes	If available, compile these data measurements
A. General climate of area						
A.1			Average precipitation	Seek data from nearby weather stations.		List average total precipitation.
A.2			Snow/rain proportions	Seek data from nearby weather stations.		List roughly what percentage comes as snow and what percentage comes as rain.
A.3			Average winter temperature	Seek data from nearby weather stations.		List average minimum and maximum winter temperatures.
A.4			Average summer temperature	Seek data from nearby weather stations.		List average minimum and maximum summer temperatures.
A.5 Briefly summarize the results of what was entered in A.1–A.4						
B. Geographic setting						
B.1			Stand aspect	Estimate aspect using tool in text (p. 20), or seek assistance. Estimate proportions of property with different aspects.		As best as you can, for each of your stands, estimate the aspect as northerly, southerly, or neutral.
B.2			Slope of property	Estimate steepness using tool in text (p. 20). Estimate proportions of property with different slope steepness.		As best as you can, estimate slope in 10-degree increments (0 to 10 degrees, 10 to 20 degrees, etc. 0 degrees is a flat plain, 90 degrees is a sheer cliff. Look for easy guides to measuring slope.
B.3			Soil type	Seek assistance from nearby technical experts.		Go to the NRCS Web Soil Survey: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm .
B.4 Briefly summarize the results of what was entered in B.1–B.3						

Forest Management Worksheet 2: Conditions of Your Property (continued)

Task #	Status (started, midway, completed)	Priority (low, medium, high)	Task	Task description	Notes	If available, compile these data measurements
C. Condition of trees						
C.1			Tree species	List the species you have in your stand in order of most to least common.		Pick a few specific areas within each stand and count by species.
C.2			Dominant tree species	List the top two or three most dominant species.		
C.3			Number of trees per acre	Count trees in a 1/10-acre plot (a circle with a 37.2-foot radius); measure three or four such plots and average.		Pick a few specific areas within each stand and take measurements.
C.4			Trees with canopy at or near ground level	Proportion of trees with canopy at or near ground level (0, 25, 50, 75, 100 percent?).		Use the same plots used estimating trees per acre.
C.5			Tree size	In your sample plots, estimate tree diameter at breast height, in increments of 10 inches (0 to 10 inches, 10 to 20 inches, 20 to 30 inches, 30 to 40 inches, above 40 inches). Estimate percentage of trees in each size class.		Use the same plots used estimating trees per acre.
C.6			Seedlings coming up	Number of seedling per acre; estimate from 1/10-acre plots (0 to 50, 50 to 100, more than 100).		Use the same plots used estimating trees per acre.
C.7			Number of standing dead trees (snags)	Count trees in your 1/10th-acre plot (a circle with a 37.2-foot radius); take three or four such plots and average.		Use the same plots used estimating trees per acre.
C.8 Briefly summarize the results of what was entered in C.1–C.7						
D. Property history						

Forest Management Worksheet 2: Conditions of Your Property (continued)

Task #	Status (started, midway, completed)	Priority (low, medium, high)	Task		Task description	Notes	If available, compile these data measurements
			Task	Task description			
D.1			Most recent fire		Seek assistance from nearby technical experts.		Estimate plus or minus 20 years.
D.2			Most recent large fire		Seek assistance from nearby technical experts.		Estimate plus or minus 20 years.
D.3			Number of old trees		Estimate age in 25-year increments. Obtain information from local federal, state, or local forest management organizations.		What is your oldest group of trees, and what is your youngest group of trees?
D.4			Number of age groups		Look for notably different tree heights; number of groups of different size trees.		List how many “cohorts” or age groups you have.
D.5			Number past harvests		Look for evidence of cut stumps or seek technical help.		
D.6			Other evidence of disturbance (when?)		Look for evidence of cut stumps or seek technical help.		

D.7 Briefly summarize the results of what was entered in D.1–D.6

E. Future conditions

E. 1			What species to plant		See reforestation discussions in the text (p. 46).		
E.2			Seed source		See reforestation discussions in the text (p. 46).		
E. 3			Planting and caring for seedlings		See reforestation discussions in the text (p. 46).		

E.4 Briefly summarize the results of what was entered in E.1–E.3

This worksheet is from the Forest Management Handbook for Small-Parcel Landowners in the Sierra Nevada and Southern Cascade Range. 2021. McPherson, E. Gregory, Peper, Paula J.; van Doorn, Natalie. S. Info. For. PSW-INF-1. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 85 p.

Forest Management Worksheet 3: Recognizing Threats to Your Forest

Task #	Status	Priority	Task	Task description	Notes	Measurements
A. Threat of High-Severity Wildfire						
A.1			Tree density (per acre)	Rate as follows: 1 = low (less than 60), 2 = medium (60–120), or 3 = high (more than 120). Tree density is a crucial factor, but difficult to generalize as a result of the variability in Sierran forests. If your property is in favorable growing areas (for example, good soil, north-facing slopes that retain water), the bounds of these categories may be larger.		List tree density rating (1, 2, or 3) for each stand on your property. Tree density is the most critical measurement for fire risk. Double this derived value.
A.2			Condition of fuels	Rate as low/1 (little to no surface fuels, little to no ladder fuels), medium/2 (less than 50% of your forest has both surface and ladder fuels), high/3 more than 50% of your forests has surface and ladder fuels)		Use a simple visual estimate of each stand. List tree condition rating (1, 2, or 3) for each stand on your property.
A.3			Fuel and soil moisture	This varies annually and throughout the seasons. Exposure and wind will increase vulnerability. If the branches, twigs, and soil are bone dry by June, you have low fuel and soil moisture.		High fuel and soil moisture is a 1, low fuel and soil moisture is a 3
A.4			Aspect	Determine which way your property faces (predominantly). South- and west-facing slopes are more vulnerable.		North facing is a 1, neutral is a 2, south facing is a 3.
A.5			Proportion of forest in medium- to high-density and condition of fuels	Low = 1 (less than 15%), moderate = 2 (16 to 35%), high = 3 (greater than 35%). If aspect or fuel and soil moisture contributes to drying, add 5% to your calculated total.		To keep it simple, this will have to be a visual estimate.
			Overall rating for fire threat			Add items 1 through 5 and divide by 6.
A.6 Briefly summarize the results of what was entered in A.1–A.5						

Forest Management Worksheet 3: Recognizing Threats to Your Forest (continued)

Task #	Status	Priority	Task	Task description	Notes	Measurements
B. Insect infestation						
B.1			Proportions of tree species	Use data from worksheet 2, "Stand conditions."		
B.2			Stand susceptibility	Stressed stands are vulnerable. If you have dense stands and evidence of trees dying your forest may be stressed.		1 is low stress, 2 is moderate stress, 3 is high stress.
B.3			Evidence of insect attack	Depending on the species, there may be various signs: pitch tubes coming out of the bark, boring dust on the bark at the base of tree, woodpecker feeding holes, fading needles, and insect galleries inside the bark. See "bark beetles in California" for details (p. 30).		
B.4			Proportion of trees affected by insects	Low = 1 (less than 5%), moderate = 2 (6 to 25%), high = 3 (greater than 25%).		Value of 1 for low, value of 2 for moderate, value of 3 for high.

B.5 Briefly summarize the results of what was entered in B.1–B.4

C. Drought stress						
C.1			What species	List the species you have in your stand in order of most to least common. Pines and oaks are more drought tolerant.		
C.2			Which species (one or two) are crown dominants?	List the top two or three most dominant species.		
C.3			How many trees per acre	Count trees in a 1/10-acre plot (see "Stand conditions" information developed for worksheet 2).		
C.4			Soils depth and available moisture	The average depth of the soils (shallow, moderate, deep).		
C.5			Exposure	Wind and direct sun increase drying conditions. If more than half of your forest is in low density, it is exposed to sun and wind.		
C.6			Aspect	Determine which way your property faces (predominantly). South- and west-facing slopes are more vulnerable.		
C.7			Proportion of trees impacted by drought stress	Low = 1 (less than 5%), moderate = 2 (6 to 25%), high = 3 (greater than 25%).		Value of 1 for low, value of 2 for moderate, value of 3 for high.

C.8 Briefly summarize the results of what was entered in C.1–C.7

Forest Management Worksheet 3: Recognizing Threats to Your Forest (continued)

Task #	Status	Priority	Task	Task description	Notes	Measurements
D. Pathogens						
D.1			Foliage diseases	Discolored needles, yellowish-green plants attached to tree branches.		
D.2			Root diseases	Leathery growth between bark and wood, wood decay, and sometimes conks (fungus fruiting structure).		
D.3			Tree decay	Conks (fruiting bodies of fungus) on trunk).		
D.4			Canker disease	Dead tissue peeled off trunk.		
D.5			Proportion of trees impacted by disease	Low = 1 (less than 5%), moderate = 2 (6 to 25%), high = 3 (greater than 25%).		Low = 1, medium = 2, high = 3

D.4 Briefly summarize the results of what was entered in D.1–D.3

E. Simple vulnerability assessment

E. 1			Overall rating for fire threat	Low = 1, medium = 2, high = 3		
E.2			Overall rating for insect threat	Low = 1, medium = 2, high = 3		
E. 3			Overall rating for drought stress	Low = 1, medium = 2, high = 3		
E. 4			Overall rating for pathogen threat	Low = 1, medium = 2, high = 3		
E. 5			Overall threat rating	A total score of 5 or less is a low threat, 6 to 8 is a moderate threat, greater than 8 is a high threat.		

E.6 Briefly summarize the results of what was entered in E.1–E.5

Forest Management Worksheet 4: Treatments for Your Forest

Task #	Status	Priority	Task	Task description	Notes	Measurements
A. Treatment methods for your forest						
A.1			Mechanical treatment of trees (thinning by removing smaller trees)	What acreage of your property requires mechanical treatments? This is based on your condition assessment data from worksheets 1, 2, and 3. Assess this by each stand on your property. If your stand is rated as high vulnerability due to tree density, address these acres with mechanical thinning.		Stand 1 - How many acres? Stand 2 - How many acres? Stand 3 - How many acres? ... Stand X - How many acres?
A.2			Mechanical treatment of shrubs	What acreage of your property requires mechanical treatments for shrubs? If your stand is rated as high vulnerability due to shrub density, address these acres with mechanical treatment of shrubs (for example, hand removal or mastication).		Stand 1 - How many acres? Stand 2 - How many acres? Stand 3 - How many acres? ... Stand X - How many acres?
A.3			Prescribed fire	What acreage of your property requires prescribed fire treatments? Is your property safe to conduct a prescribed fire? Work with local expertise to assess this option.		Prescribed fire will usually treat a predefined area with breaks placed prior to the fire. Establish boundaries of a prescribed fire area with the help of local prescribed fire experts.
A.4			Piling and burying	What acreage of your property requires prescribed piling and burning treatments?		Where you can use hand thinning to extract small trees and shrubs you can pile them and burn during suitable weather conditions. Stand 1 - How many piles? Stand 2 - How many piles? Stand 3 - How many piles? ... Stand X - How many piles?
A.5			Planting for reforestation	What acreage of your property requires planting?		See reforestation section for discussion on approaches.

B. Total treatments, by categories

			Summarize treatment needs	Tally treatment needs, as listed under A.1 to A.5, by each category.		A complete tally of acres for each of the five categories for your entire property will enable you to get estimates for costs from contractors. Ask your local CAL FIRE office or other technical assistance source for help in developing a proposal for bids from contractors.
B.1.				Total acres mechanical thinning of trees =		
B.2.				Total acres mechanical thinning of shrubs =		
B.3.				Total acres of prescribed fire =		
B.4.				Total acres of piling and burning =		
B.5.				Total acres needing reforestation =		

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