California
Native Plant Society

FIRE RECOVERY GUIDE

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The science of fire recovery is advancing rapidly, and there are still differences of interpretation among experts. We welcome new information and will apply your feedback to improving future versions of the Fire Recovery Guide.

Cover and top right: Oaks (*Quercus* sp.) from charred earth after the 2017 Nuns fire. Photo by Saxon Holt

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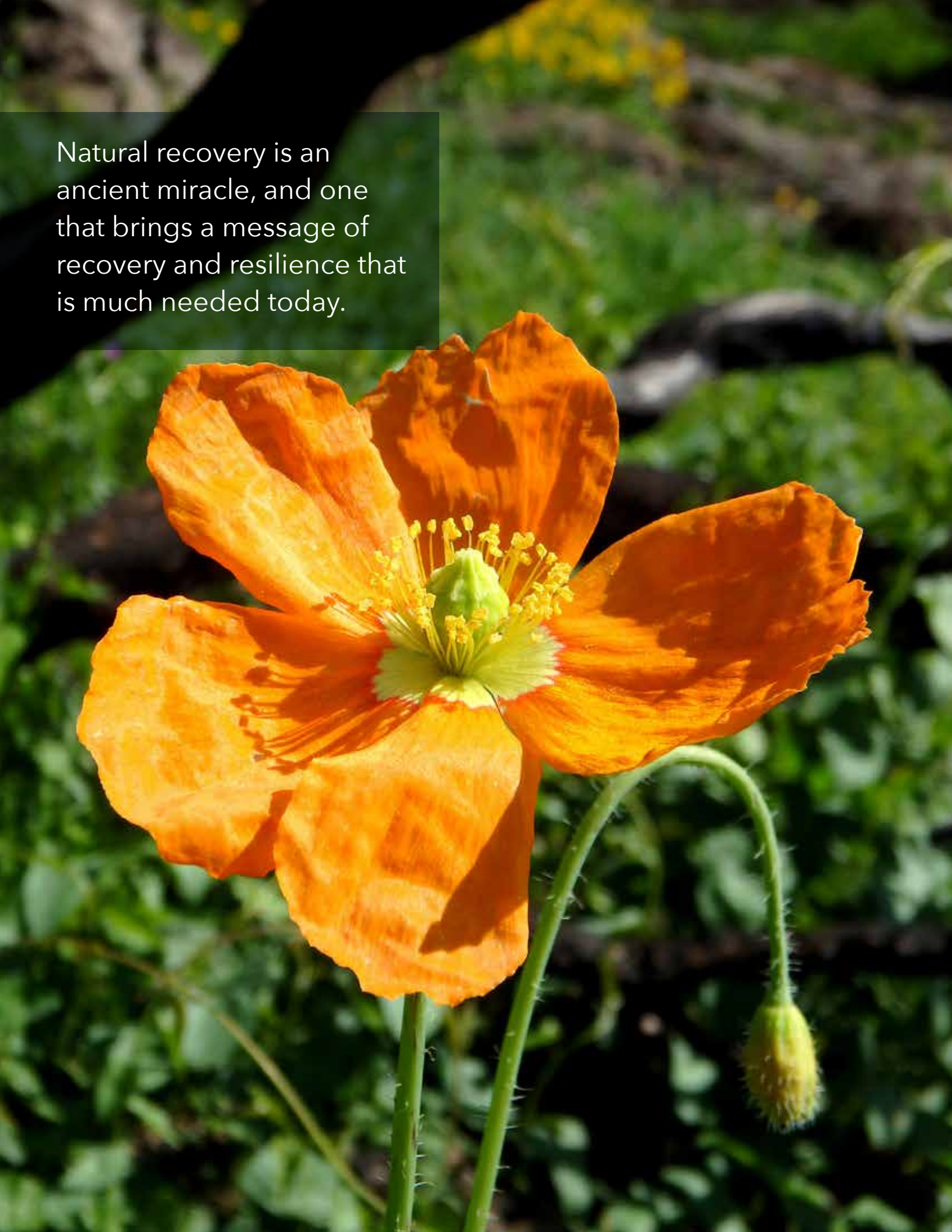
Top: Panoramic view of Mount Saint Helena.
Photo by Tom Greco


Natural recovery is an ancient miracle, and one that brings a message of recovery and resilience that is much needed today.

Introduction

California has experienced its deadliest and most severe wildfire seasons in recent history. Although wildfire is a natural part of California's ecosystems, the changing fire regimes are something new – a "new normal" that demands forward-thinking and thoughtful solutions. Municipalities, state leaders, scientists, and neighbors are working quickly to advance our knowledge, protect human life, minimize property damage, and carefully manage our sensitive natural resources.

This updated statewide guide is intended to support California's ongoing efforts to skillfully address our wildfire challenges. With input from leading experts, it offers science-based guidance for those working toward recovery of their land while reducing risk going forward. It has been a community effort, and we owe a debt of gratitude to the numerous partners who worked hard to bring this information forward.

We hope you will find this guide useful – helping you to identify actions to benefit your land and the biodiversity you steward, while also helping you avoid actions that may actually be detrimental. We'd like to see this information encourage conversations about how we can live with fire in an increasingly fire-prone state, while protecting clean water, healthy forests, and the survival of the beautiful plants and wildlife that make California home.

Even though many California communities continue to face difficult recoveries, we know that the land will heal, and help rebuild and support a vibrant human community. Already trees are beginning to flush with new growth, blackened soils are greening up with tender sprouts, and fields of wildflowers are emerging. Natural recovery is an ancient miracle, and one that shares a much-needed reminder of resilience and healing. Today, in coming together to care for sensitive natural places and observing their recovery, we also can discover a message of hope that brings healing to our communities and ourselves.

For more information about CNPS Fire Recovery resources and ongoing natural resources management, please go to cnps.org/fire-recovery.

Left: A symbol of resilience and hope, the fire poppy (*Papaver californicum*) in bloom at Foote Preserve. Photo by Land Trust of Napa County

Above Left: Beargrass (*Xerophyllum tenax*) resprouting. Photos by Audubon Canyon Ranch

Above Right: 2017 Nuns Fire at the base of Hood Mountain in Sugarloaf Ridge State Park, a week after the fire began. Photo by Bob Bowman Photography

Since most of California's landscapes are naturally prone to burn, we need to make our human developments more resilient.

Fire Guide Basics

About This Guide

After a disaster, the human impulse is to repair what's broken. Looking across a scorched and blackened landscape, we naturally want to make things better. But in our rush to help, we risk making things worse. Without the right information, even the best intentions can be harmful. This guide offers science-based perspectives to help you assess when and how to take action to support the places you love.

We begin with a brief overview of fire ecology to familiarize you with concepts like fire regimes, and the ways individual plants and plant communities respond to fire. Next, we dive into frequently asked questions and tools to help you assess your property post-fire. We then move into common areas of concern like erosion, fire-damaged trees, re-seeding, and defensible space.

Amazingly, wildfire stimulates new growth and shapes entire ecosystems. Many plants have evolved special traits and proliferate after fires. So, we've included educational sections on rare plants and California's different habitats. We hope you'll spend a few minutes getting to know a bit about the habitats where you live and the unique plants you may encounter.

What this guide is not

CNPS is not an authority on emergency preparedness and fire safety for your home. Many valuable resources are available to help you in these areas, and we encourage you to explore the resources listed at the back of this guide.

Your input matters

As each of us face California's "new normal" of extreme wildfire, we'll all continue to learn more about how we best care for each other and our natural resources. We welcome your feedback and encourage your suggestions for future versions of this guide. Please send your input to cnps@cnps.org with the subject line: Fire Recovery Guide Feedback.

If there were one key message we want to impress upon you, it is this:

Nature really does know best. The more we are able to leave our land to heal and recover on its own, the better.

Left: The Tehachapi Mountains contain a mosaic of habitats that are affected periodically by wildfires. Photo by Nick Jensen

Above Left: Prescriptive fire in May 2016 at Bouverie Preserve to reduce fire-risk, including areas with invasive plants. Photo by Audubon Canyon Ranch

Above Right: The land healing on its own with resprouting shrubs and germinating wildflowers. Photo by Reny Parker

Giant sequoia (*Sequoiadendron giganteum*). Photo by Todd Keeler-Wolf

How California Native Plants Respond to Fire: An Intro to Fire Ecology

California is special. Our golden state is home to more native plant species than any other state in the U.S. That's due in part to our Mediterranean climate, which is characterized by long, dry summers and cool, wet winters. During the dry season, low humidity, high heat, and winds set the perfect stage for wildfire – a natural force that, for millenia, has played an important role in dynamically shaping the structure and composition of habitats in California.

Wildfire itself is influenced by a variety of factors, including vegetation, topography, and local weather conditions. If you follow the news, you've probably heard about vegetation as fuel for fire. Plants do indeed burn, but not all plants respond the same way to fire. For example, fires in grassland habitats typically spread much faster than those in conifer forests. Understanding these differences is important for both fire prevention and recovery.

Plants do indeed burn, but not all plants respond the same way to fire.

Environmental conditions influence both plant community composition and fire regime (or fire patterns). Fire experts track both fire severity (the degree to which a habitat is burned) and the fire return interval (how often an area burns). Because the natural history of California has been influenced by wildfires, many species have evolved strategies to withstand fires – much like they have adapted to our Mediterranean climate.

Tolerate

Native plants like giant sequoia (*Sequoiadendron giganteum*) possess adaptations that allow them to live through and continue growing following a low intensity fire. Giant sequoias have thick bark that insulates living tissues from extreme heat. Fire also plays an important role in seedling recruitment in giant sequoia groves, as seeds that fall on the nutrient rich open soil following a fire have a higher survival rate. The ability of a plant to tolerate fire is dependent on the fire's intensity, since plants that are able to withstand low intensity fires may be killed by a more severe event.

Knobcone pines (*Pinus attenuata*) open and disperse seeds following fires. Photo by Erik Jules

Seed banks

Many California plants die during a fire and later re-emerge from seeds stored in the seed bank. Many species even require the heat and chemicals produced by fire for germination. As a result, these species rely upon periodic fires for their survival. A special case of seedbanks is found in some pines (*Pinus* spp.) and cypresses (*Hesperocyparis* spp.). These "serotinous" conifers store seeds in unopened cones on their branches until a fire occurs. When a fire burns through a forest of knobcone pine (*Pinus attenuata*), the heat kills mature trees while allowing cones to open and release the seeds that germinate to become the next generation of pines.

Burn and regrow (resprout)

If you visit a burned area immediately after a fire you might be tempted to think that the habitat will never recover. Yet, in a return visit you might observe that many trees, shrubs, and perennials have begun to resprout. A wide variety of trees and shrubs, including coast live oak (*Quercus agrifolia*) and a number of manzanita species (*Arctostaphylos* spp.), have the ability to regrow following a fire. In the case of coast live oak, trees will resprout from living tissue at the base of a trunk or along branches. Some manzanitas possess a large underground storage stem from which growth resumes. Many perennial herbaceous plants (e.g., bulbs and perennials herbs) also have the ability to regrow from underground vegetative structures.

Disappear and disperse

When a high severity fire sweeps through a habitat some plants don't survive. For example, ponderosa pine (*Pinus ponderosa*) and some other conifers will be completely wiped out from an area following a fire. If the fire is spatially small, seeds of pines in adjacent unburned areas will disperse into and recolonize the burned area. The success of "disappear and disperse" is dependent on the scale of the fire.

Refugio manzanita (*Arctostaphylos refugioensis*).
Photo by David Magney

The goldilocks effect and obligate seeders

Many plants, especially species that regenerate from soil seed banks, require fire to remain in a habitat. These plants are often referred to as "obligate seeders." If the fire-return interval exceeds the longevity of the seeds in the seed bank a plant will disappear from that habitat. On the other end of the scale, fires that occur too frequently can also negatively affect some species. For example, some shrubs, including the rare Refugio manzanita (*Arctostaphylos refugioensis*), germinate following a fire and need to grow for a number of years before they set seeds. If a fire reoccurs before the plants set seed, the species will disappear from its habitat. Chaparral habitats dominated by shrubs that are obligate seeders have been converted to grassland in southern California when fires have occurred too frequently.

True fire followers

Some plants have been called "fire followers" since they are only seen in abundance following fires. A classic fire follower, whispering bells (*Emmenanthe penduliflora*), remains in the soil seed bank for years and is only seen in profusion in the years after a fire. Bush mallows (*Malacothamnus* spp.) have long-lived seeds that can remain in the soil seedbank for more than 100 years! While you may see a few bush mallows along a road or trail, a large number of plants germinate following a fire. Bush mallows then flower and set seeds in abundance, only to be outcompeted by other trees and shrubs. Plants such as these remain dormant in the seed bank and may appear to be absent in an area for decades.

Whispering bells (*Emmenanthe penduliflora*). Photo by Lech Naumovich

Frequently Asked Questions

Why have California's fires become so intense?

Fire is a natural part of California. Today we face extreme fire conditions due to the combined factors of a build-up and restructuring of forest vegetation, a changing climate, and more people living at the wildland urban interface (WUI).

In Sierra Nevada and northern California forests, over a century of fire suppression, forest management practices favoring the removal of more fire resilient, large trees, and replanting in dense, homogeneous "pines-in-lines" have helped high-intensity wildfire accelerate across our forests. In southern California, unnaturally frequent fires and invasive species have contributed to the conversion of coastal scrub and chaparral habitat to highly flammable grassland. Similarly, invasive grasses and broom species contributed to the severity of the wind-driven 2017 Wine Country fires and the 2018 Camp Fire. The changing climate brings rising temperatures, longer drought, and drier vegetation. These factors set the stage for high-intensity wildfire.

Post-burn mosaic of vegetation exhibiting mixed fire severity, just after the 2017 Nuns Fire in Sonoma County. Photo by Saxon Holt

Concurrently, California's population has nearly doubled since the 1970s, from around 20 million to nearly 40 million people today. As people and development encroach on once sparsely populated areas, we increase the chance of igniting destructive wildfires.

How does native vegetation interact with wildfire?

All plants can burn, but many native California habitats are adapted to fire. Communities like chaparral naturally burn with high-severity, and very little is left after a chaparral fire; in contrast, oak woodlands and Douglas-fir (*Pseudotsuga menziesii*) forests usually burn with mixed severity. Consequently, we see areas where fire reaches into the crowns of the trees, killing them, and other areas where fires stays on the ground, burning mostly the understory shrubs and only scorching mature trees. Such mixed-severity fires create complex and dynamic post-fire environments that provide important habitat for a large diversity of species.

In recent decades the structure and composition of vegetation in certain areas changed dramatically. In some forested locations we've seen an accumulation of dead and dried material and a denser understory with trees and saplings of all sizes, material that can carry flames to the crowns of mature trees. Additionally, flammable invasive trees, shrubs, and grasses lengthen the fire season and increase chances of ignition, especially in grassy areas and along roadsides.

Under extreme fire weather conditions, like we've had in recent fire seasons, there is abundant fuel for spreading the flames, and the wind provides the mechanism for propelling burning embers (Note: Cal Fire's David Shew estimated that 80-90 percent of structures burned were started by tossed embers not the fire front itself). In such situations, it takes nothing more than dry grasses to easily fuel devastating infernos. So while the density and type of wildland vegetation plays an important role in fire behavior, research has shown that under extreme fire conditions (low humidity, high winds, and drought), regardless of the fuel type, large, intense wildfires should be considered inevitable in California.

Large hardwood trees like this oak (*Quercus* sp.) after the 2017 Tubbs Fire have evolved to withstand fire. This tree, although charred, will likely fully recover its leaves and branches within one year of the fire. Photo by Tom Greco

Does nature need our assistance after the fires?

For the most part, the natural post-fire environment will do fine without us. In our residential neighborhoods and around our homes the situation is different. Erosion can be a serious problem in these areas, washing sediment into local creeks and endangering fish and other aquatic life, and so communities are tackling the removal of debris, toxic waste, damaged foundations, burned structures, restoration around homes, and erosion control. Invasive weeds may quickly spread in disturbed areas. Restoring these areas can be challenging, but many efforts have succeeded, resulting in much richer, biodiverse habitats.

Where the vegetative cover has been burned off, erosion is a major concern if communities and streams are nearby. Although post-fire water repellency of the soil is often suggested as a problem, the loss of vegetative cover and the natural, internal stability of the soil are of greater concern.

Efforts to prevent erosion such as spreading mulch and laying netted rolls of hay (wattles) can help. However, downstream flooding and slope failure caused by excessive amounts of rain can be difficult to prevent, and so carefully planned restoration efforts will be ongoing. Local resource conservation districts and other municipalities are employing emergency protection strategies to address risks and manage natural resources wisely.

What role do disease and pests play in fires?

The relationship between fire behavior and tree pests or diseases is far from straightforward. While some evidence shows a positive relationship between disease and fire, most evidence also indicates the relationship is strongly time-limited: Disease and pest outbreaks may increase fire intensity, but only for a limited window of time. In general, disease and pest outbreaks in their middle stages have the greatest effects, while very recent or distant outbreaks have very a limited effect on fire.

For example, during the Big Basin fires of Big Sur, oaks suffering from early-stage Sudden Oak Death (SOD) seemed to have had no effect on fire. Mid-stage SOD created openings and led to intense fire hotspots capable of killing even some fire-tolerant adult redwoods. Late-stage SOD may increase ground fuels that allow fires to burn longer, but this may have limited effect on fire intensity. SOD can also have an indirect effect on woodlands' composition, as it kills oaks but does not impact California bays (*Umbellularia californica*). As a result, SOD-invaded forests can see an increase of gaps and in the number of smaller, fire-intolerant bay trees, potentially increasing fire intensity depending on conditions.

All studies have identified a strong direct effect of wind, topography, and aspect on fire behavior. The recent North Bay fires were certainly driven by very strong winds, with possible localized, but indirect effects of SOD due to changes in forest structure (more openings) and composition (more fire-intolerant bays). It remains to be determined whether local hotspots may have also occurred due to drought-related tree mortality and gaps.

Since the timing of fire occurrence is unpredictable, addressing disease or pest outbreaks in trees is always desirable in populated areas in or near fire prone ecosystems.

Common Questions about Your Property

A quick overview of common concerns. Please see subsequent sections for more detail.

Remember the 4 "S" RULE of stormwater runoff:

- Slow it
- Spread it
- Sink it
- Store it

What, if anything, should I do now or during the winter following a fire to protect my soil from erosion and/or slopes from sliding?

One of the most important rules is to be careful not to disturb the soil and slopes during the rainy season, as the soil can become unstable. Keeping vegetative cover (both live and dead plants) will reduce the rain's impact, and any roots will help keep soil in place.

It is imperative to identify and deal with drainage issues, such as stormwater drainage. Remember to slow, spread, sink, and store rainwater runoff. A variety of measures may help, including the use of properly installed straw wattles to slow run off, to keep soil in place, and deter soil and toxic waste from entering storm drains, culverts, and creeks.

Is a burned tree dead or at risk of falling?

Looks can be deceiving. After a fire, a tree's survival can remain unclear for three years or more. Its fate is often tied to factors such as the following year's weather, the thickness of its cambium, and capacity to resprout. Many native trees and large shrubs are adapted to fire and can recover over time, sometimes by resprouting at their branches and bases as soon as the next spring. If a compromised branch or tree poses a risk to people or property, consult a professional forester or arborist. Otherwise, leave the blackened vegetation in place and wait until spring when it will be easier to tell if your plants are dead. Even when completely dead, trees can provide important habitat. Their roots also will help hold soil in place and prevent erosion.

What are the best plants to use in replanting areas damaged by fire?

A fire safe landscape approach maintains a defensible space from the house out, with a no-fuel zone in the first 5 feet surrounding the house and other zone recommendations out to 100 feet. Regular maintenance that removes all dead combustible materials is especially important during "red-flag" (i.e., high danger) weather. Plants should be low maintenance, have high moisture/low flammability, and careful spacing designed to reduce fire spread and ladder fuels into tree canopies. No plant is fireproof, but some have more fire resistant characteristics than others; select trees with low sap or resin such as hardwoods like oaks (*Quercus* spp.), instead of highly flammable pines (*Pinus* spp.) and non-native eucalyptus (*Eucalyptus* spp.).

Will fire affect soil fertility, and will the ash negatively affect future plant establishment and health?

Fire can actually have a positive benefit by increasing soil formation and fertility, removing thatch and litter and returning nutrients to the soil with the ash. The heat of the fire, temperature and duration of soil heating, and pre-existing soil and plants can impact the degree to which fertility increases or decreases.

However, conditions following a fire can favor invasive plants. This makes it more important to protect and encourage local native plant populations and refrain from seeding or spreading invasive grasses and plants that could cause other negative impacts down the road.

Ash contains various chemical compounds, depending on what the fire burned and its temperature. With the uncertainty of what is contained in ash, controlling erosion, sediment, and runoff may be necessary to keep contaminants out of waterways, protecting our water supplies and riparian wildlife. The following sections will help further expand on these post-fire recovery measures.

Mixed severity of fire in chaparral, oak woodland, and conifer forest communities. Photo by Sonoma County Ag + Open Space

Natural post-fire regeneration of chaparral and meadow vegetation along Butts Canyon Road, spring 2016 after the 2015 Valley Fire. Photo by Reny Parker


Minimize foot traffic,
equipment, and disturbance
on burned landscapes.

Post-Fire Checklist for Land Care

Every fire is different, and landowners will face unique challenges in securing and restoring their land. These general principles can help guide sound decisions.

- ✔ Safety first! Before entering a burned site, make sure you have the go-ahead from local fire officials. Hazards include hotspots, unstable structures, trees, power lines, landslides, mudslides, and toxic ash and debris. Vegetation ash is not toxic, but ash from human made materials may contain asbestos, heavy metals, or other hazardous substances.
  - Do not enter where a building has burned or handle the ashes without prior testing and protective gear. Wear proper clothing, boots, gloves, respirator, eye protection, etc.
  - Consult county officials and obtain professional help to remove potentially toxic materials, ideally before rain washes toxic runoff into storm drains and waterways.
- ✔ Minimize foot traffic, equipment, and disturbance on burned landscapes. Activity on slopes will increase the likelihood of erosion by weakening soil bonds, dislodging soil particles, and trampling newly sprouted plants. Activity on flat ground can compact soil, lower water absorption rates, and increase runoff.
- ✔ Consult a professional to determine whether you need to install soil stability measures and how to do so while still minimizing soil and slope disturbances.
- ✔ Check drainage systems and clear out culverts, roof gutters, street gutters, infiltration and detention basins, concrete waterways, etc., to allow water to drain. Also, decrease velocity and/or volume of runoff at culvert and drain outlets (e.g., using rock) to slow down or dissipate large volumes of runoff to prevent soil erosion.
- ✔ Slow water from channeling on slopes; instead allow water to dissipate across the soil. Well-placed and properly installed wattles, mulch, rocks, and branches can act as velocity dissipators for the runoff, limiting erosion and sediment (*see page 27*).
- ✔ *With professional assistance and extreme caution,* ensure excess storm flow is properly diverted away from important property improvements or unstable slopes. Release collected drainage into existing or prepared stormwater systems and/or return concentrated runoff to natural "sheet flow" over stable, well-vegetated areas.

Left: Sonoma County Ag + Open Space staff surveyed properties post-fire to assess effects and land management action. Photo courtesy of Sonoma County Ag + Open Space

Above Left: Straw wattles placed to slow runoff and trap debris. Photo by Judy Bellah

Above Right: Post-fire landscape in spring 2016 after the 2015 Valley Fire. Photo by Reny Parker

Manzanitas (*Arctostaphylos* spp.) like that pictured here following the 2017 Tubbs Fire will resprout and flourish. Photo by Michelle Halbur

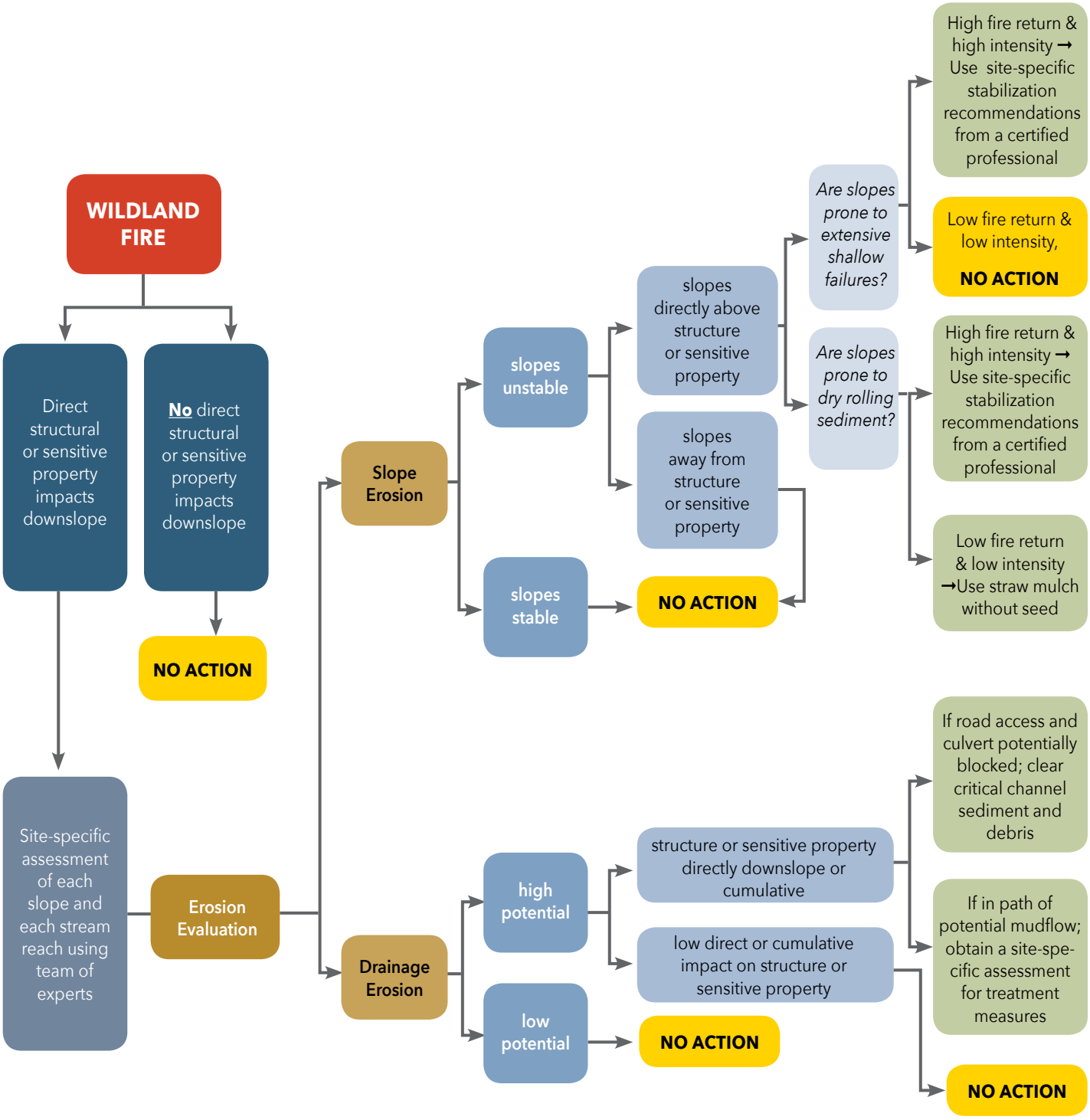
- ✔ Repair fire breaks so they blend evenly with the natural slope of the land (instead of installing "water bars" that channel runoff).
- ✔ If erosion control is necessary, mulch only with weed-free material, such as chipper material from a known source, hydro mulch without seed, or certified weed-free loose straw. Experts recommend barley, sterile wheat, or rice straws.
- ✔ Prune back and give fire-damaged vegetation time to recover. Many damaged and scorched native plants will resprout and come back, including oak trees that are not severely burned. Their underground roots will help stabilize the soil.
- ✔ Have an arborist or ecologist assess damage to vegetation before planting or seeding. Most trees and shrubs will recover on their own; new plants will emerge from the seedbank in winter and spring. Also, consult a professional to design and install (if deemed necessary) short-term or permanent methods to control runoff, prevent erosion problems, or address slope stabilization issues.
- ✔ Nix the non-native seed mixes, especially in wildlands or at the wildland urban interface. Most grasses found in seed mixes are short-lived with shallow roots and will be highly flammable by the next summer. Also, a sudden flush of grass can attract pests. Many "native," "wildflower," and erosion control seed mixes contain nonlocal and inappropriate weed species that can become extremely invasive. They are not for wildland or fire damaged soil/slope restoration. Invasive plants or annual grasses, such as ryegrass (*Festuca perennis*) or soft chess (*Bromus hordeaceus*) just add fuel to a fire.
- ✔ If you do seed, use *locally-sourced* native perennial plants. *Exception:* In highly managed areas, such as areas that are mown, it's okay to use short-lived annuals and perennials. However, do not re-seed a large burned site, not even with "native" seeds. Fire releases native seeds stored in the soil, and those seeds will restore the land. Save your money and invest in patience, which leads us to...
- ✔ Be patient. Lands have recovered many times after wildfires. Once human-made debris is removed, the land will heal on its own in most cases. It just needs time.

Straw wattles placed to slow and dissipate water, with rolls overlapping.
Photo by Rich Casale

Right page: Staff from the Pepperwood Preserve assessing Garrison Canyon after the 2017 Tubbs Fire. Photo by Michelle Halbur

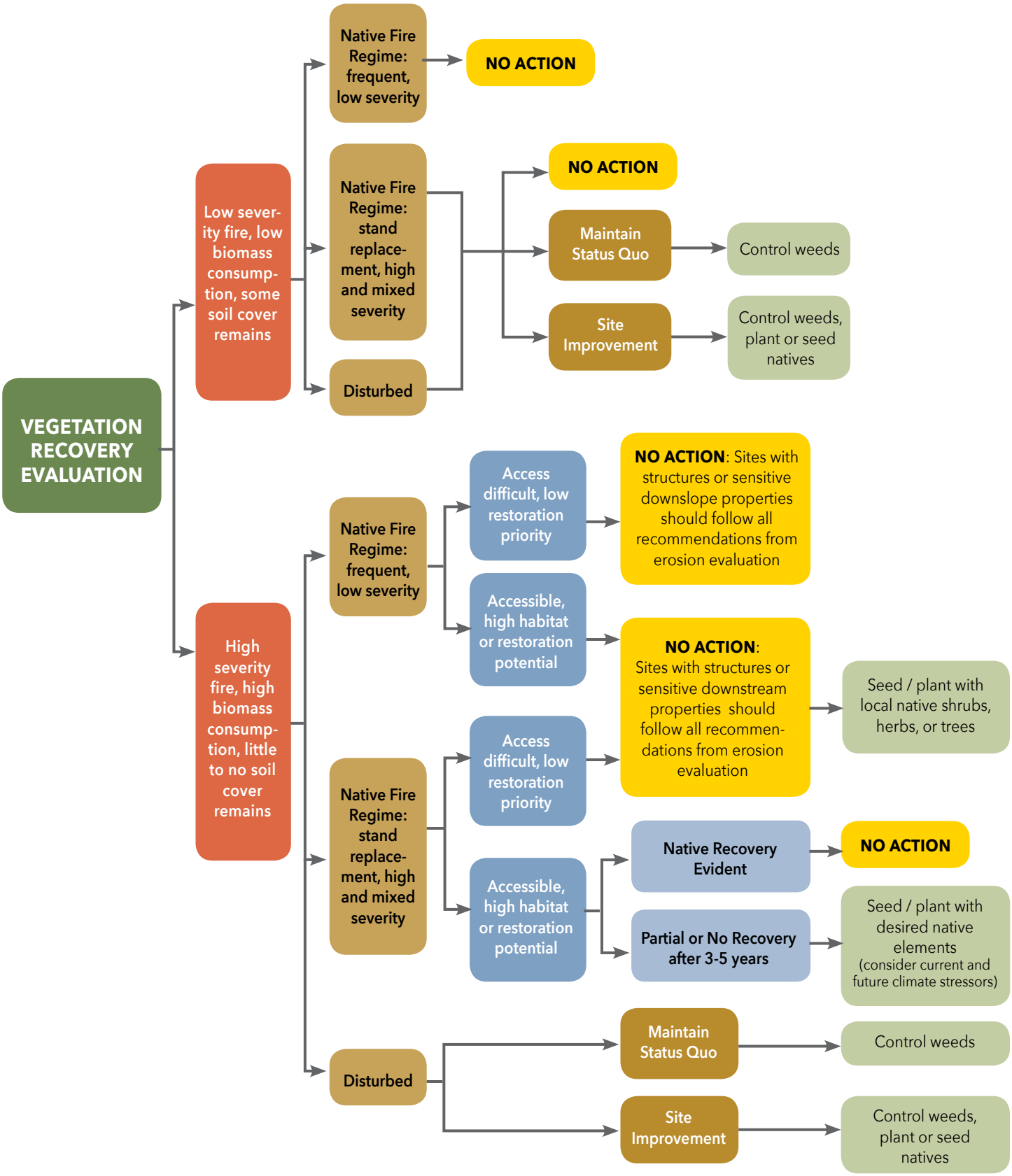
Information sources include Sonoma Ecology Center, North Bay Climate Adaptation Initiative, www.laspilitas.com/fire.htm, www.sonomacounty.ca.gov, First Aid for Fire-damaged Soil http://bit.ly/pressdemocrat2017, the National Park Service, University of California Cooperative Extension Fire Information, https://ucanr.edu/sites/fire/, and the USDA Natural Resources Conservation Service.

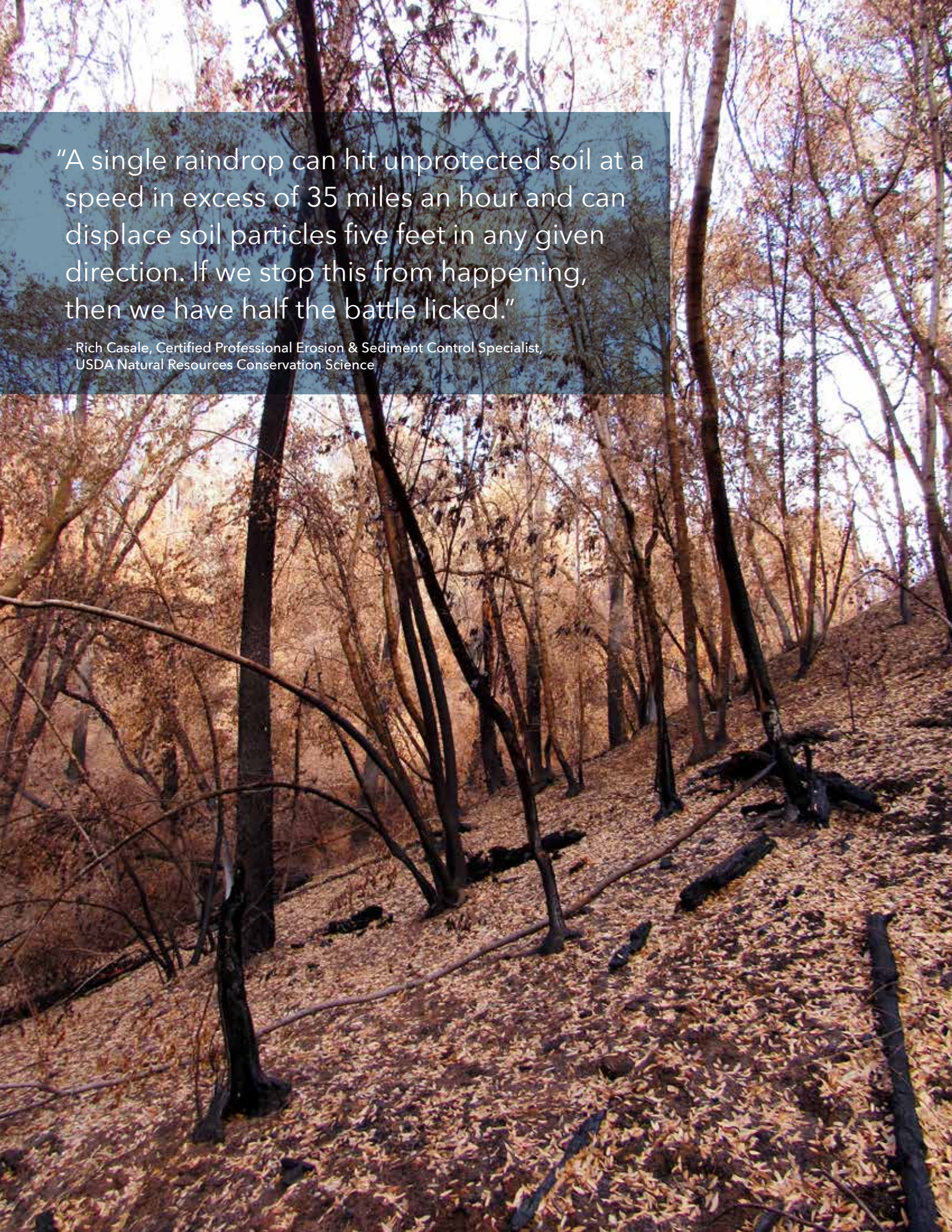
Decision Flow Diagram for Post-Fire Management and Fire Recovery Evaluations PART 1



From Keeler-Wolf 1995

PART 2


VEGETATION RECOVERY EVALUATION
Low severity fire, low biomass consumption, some soil cover remains
Native Fire Regime: frequent, low severity
NO ACTION
Native Fire Regime: stand replacement, high and mixed severity
NO ACTION
Maintain Status Quo
Control weeds
Site Improvement
Control weeds, plant or seed natives
Disturbed
High severity fire, high biomass consumption, little to no soil cover remains
Native Fire Regime: frequent, low severity
Access difficult, low restoration priority
NO ACTION: Sites with structures or sensitive downslope properties should follow all recommendations from erosion evaluation
Accessible, high habitat or restoration potential
NO ACTION: Sites with structures or sensitive downstream properties should follow all recommendations from erosion evaluation
Seed / plant with local native shrubs, herbs, or trees
Native Fire Regime: stand replacement, high and mixed severity
Access difficult, low restoration priority
Accessible, high habitat or restoration potential
Native Recovery Evident
NO ACTION
Partial or No Recovery after 3-5 years
Seed / plant with desired native elements (consider current and future climate stressors)
Disturbed
Maintain Status Quo
Control weeds
Site Improvement
Control weeds, plant or seed natives



"A single raindrop can hit unprotected soil at a speed in excess of 35 miles an hour and can displace soil particles five feet in any given direction. If we stop this from happening, then we have half the battle licked."

– Rich Casale, Certified Professional Erosion & Sediment Control Specialist, USDA Natural Resources Conservation Science

Soil Erosion Control

Wildfires can create immediate and potentially long-term soil erosion. Fires reduce or eliminate plant cover, burn off leaf litter, change soil properties, and expose the soil to the forces of rain drop splash, runoff, and wind. Patches of hydrophobic (water repellent) soils may develop beneath the ground surface, but this is a temporary condition that will be relieved once wet. The greater concern and focus should remain with the exposed soil surface.

Four tips to combat soil erosion

1. Leave the mess; keep it under cover

- Ash, debris, fallen heat- or smoke-damaged leaves, and even rocks on a fire-impacted site provide much needed soil protection. Charred remains of plants and garden features (such as retaining walls and rocks) protect the landscape from wind and water erosion and help prevent surviving seeds and plants from drying out. If a fire has burned so severely that no material is left on the ground, you may need to add chips or mulch from dead debris or weed-free rice straw.

- While you may be tempted to clear out burned vegetation, it is always a good idea to have a plan compiled by a fire restoration specialist, certified professional erosion and sediment control specialist, or local soil conservation expert from the USDA Natural Resources Conservation Service (NRCS) or Resource Conservation District (RCD).

- On properties where the fire severity was low to moderate, and in undisturbed areas away from home sites, doing nothing can be the best solution, allowing nature to restore vegetative cover. Also, fire is naturally high intensity in chaparral, so do not employ any unnecessary management action that can compromise the recovery of this ecosystem.

- Prune or remove only high hazard fire-damaged trees capable of falling onto buildings and roads and endangering people and livestock. Keep felled trees or prunings on-site. These trees can be a source of mulch if the site needs mulching.

Left: Copious leaf-drop below this mixed evergreen forest helps protect the soil from erosion. Photo by Julie Evens

Above: Oak trees (*Quercus* spp.) develop extensive lateral root systems that can spread 30m beyond the tips of their branches. Photo by Wernher Krutein/Photovault.com

In areas where trees or shrubs are damaged by fire, smoke, or heat, an enormous leaf drop will occur through the fall and winter, providing soil protection from rain and runoff. Leave the mess and let nature do the work for you!

Don't remove healthy or moderately damaged trees unnecessarily. Their root systems help hold soil and slopes in place. Plant cover (even partially dead) protects soil from the impacts of falling rain and reduces winter runoff.

Oak roots help stabilize the slope. Photo by California Native Plant Society

(Leave the mess; keep it under cover cont...)

- In extremely impacted areas, such as soils disturbed by dozers, some mulching may be necessary if vegetation cover does not establish naturally. Avoid imported mulch (and potentially invasive weed seeds) if possible.

2. Minimize disturbance and soil compaction

- Keep foot traffic and equipment off burned landscapes, and do not remove burned plants unless they bear a risk to people or property.

Activity *on slopes* will increase the likelihood of erosion by weakening a soil's bonds, dislodging soil particles, and trampling newly sprouted plants. Activity *on flat ground* can compact the soil and lower its water absorption rates, which increases runoff.

- While minimal disturbance is ideal, it is not always possible, particularly around home sites. Property owners may need to implement erosion control measures in the disturbed areas where debris and foundations are removed, particularly if these areas are on steep slopes.

Note: Less disturbance to soil and slopes after fire is better. Plan your work on fire-impacted lands only after a plan for restoration is developed and once the materials and tools are available for use.

3. Monitor stormwater runoff

- Property owners should focus first on the 4 S practices for runoff: slow, spread, sink, and/or store it. This is always important but particularly after a fire.

- Fast moving water can cause erosion and downstream flooding. Straw mulch is a great way to reduce the impact of rainfall and runoff. Note: A light application of wood chips provides protective cover but can be displaced by runoff and float away. (*See more about mulching on page 26.*)

- Once the rain starts running down a hill slope, well-placed straw wattles, a thin cover of mulch, and branches can help reduce the impact of rainfall and runoff, giving it a chance to seep down into the soil and filter out sediment.

- In your broader neighborhood, maintain your stormwater system by paying attention to how water moves through your neighborhood. Branches and sediment can clog drainage ditches and culverts. Try to clear the stormwater system so that roads don't flood and debris doesn't block drains and bridges.

(Monitor stormwater runoff cont...)

- Work with your neighbors to create a plan to slow runoff. These measures are typically not necessary in areas of low fire intensity, but in disturbed areas of moderate to high fire intensity, they can be critical in preventing sediment and fire debris from washing into sensitive creek habitats and contributing to flooding.
- Taking steps to decrease velocity and/or volume of runoff at culvert and drain outlets (e.g., using rocks at outlets) may be important to help slow down runoff or dissipate large volumes of runoff to prevent soil erosion.
- You also may consider detaining runoff and metering it over time to reduce impact on saturated soil and slopes during peak storm events and provide water storage for later use (e.g., irrigation during the dry season). Detention basins, rain gardens, and water harvesting systems are some ways to detain and later use runoff.
- Your local City or Resource Conservation District should be able to help you review runoff issues and maintain your stormwater system, especially if you had damage or continued issues post-fire.

Unpermitted work near creeks and wetlands can result in severe penalties, so always consult a professional.

4. Professional, on-site assessment of fire damage:

After a fire, Cal Fire assembles a Watershed Emergency Response Team (WERT) to evaluate and compile a report on post-fire conditions and potential threats like debris flow and flooding. The team also analyzes the soils, geology, and hydrology to create maps showing which areas are at the highest risk. The WERT reports are a valuable resource and a good place to start your land recovery plan. *(See Cal Fire 2017 references at the end of this guide).*

If you are concerned that your property may be at risk from flooding or debris flows, arrange for an on-site assessment of fire damage conducted by one of or more of the following:

- city or county public works engineers,
- a Natural Resources Conservation Service (NRCS) specialist,
- a certified professional in soil erosion and sediment control,
- or a qualified hydrologist.

For erosion prevention on fire and fuel breaks or access routes, contact:

- your local Resource Conservation District (RCD),
- NRCS,
- or Cal Fire.

Large rocks may also be a concern. If you see large rocks that may release from slopes on your property or adjacent properties, seek professional assistance. Rock removal, rock fall catchments, or steel netting may be necessary.

On-site assessment of fire damage. Photo by Sonoma County Ag + Open Space

Common Questions about Soil Erosion

At the end of the day, experts agree that the less soil disturbance, the better the recovery.

Why do some soils become hydrophobic (water repellent) after a fire?

Water repellant soil can occur when a fire heats and melts waxes and resins found naturally in plants and organic material. These waxes cool and solidify around soil particles, and can create impermeable patches a few inches below the soil surface. However, water repellency is also a natural condition of many unburned soils and diminishes once the soils are wetted. The greater concern should be for the exposed soil surface.

Should I break up my soils if they seem hydrophobic?

It is not advisable to break up soils whether they are hydrophobic or not, especially on slopes prone to debris flows or landslides. If they are truly hydrophobic, they could actually help in preventing slope saturation that leads to soil movement.

Most soils will naturally lose their repellency within a year, while some may stay hydrophobic for one to six years. The amount of water repellency a fire creates is related to a fire's intensity, the amount of waxy plant matter present, and the size of a soil's particles; for example, larger soil particles like sand have greater rates of repellency.

Experts hold varying opinions on hydrophobic soils, and more research is needed to isolate other contributing factors to erosion, such as the loss of vegetation, litter cover, and soil aggregate stability. At the end of the day, all agree that the less soil disturbance, the better the recovery.

What techniques can I employ for erosion control landscaping?

Late season fires do not leave enough time to seed native perennial grasses and herbs for erosion control. The new growth won't come up quickly enough from seed to hold unstable slopes before winter storms. (*See Reseeding section on page 35 for more detailed information*.)

Fortunately, reseeding is usually unnecessary, especially in undisturbed areas where surviving roots hold the slope and existing underground plants and seeds will spring forth. In disturbed areas, loose mulch and straw wattles can be effective.

Monkeyflower (*Erythranthe* sp.), larkspur (*Delphinium* sp.), and other widlflowers springing up post-burn at Knoxville Recreation Area, Lake County, after the 2015 Rocky Fire. Photo by Evan Johnson

Dos and Don'ts for erosion control in or near home sites:

1. Do *NOT* use annual non-local grasses for erosion control or planting. These produce flashy fire fuels and continued fire risk.
2. Do not plant non-local reseeding, erosion control seed mixes in wildland areas or in the wildland urban or agriculture interface. Work to control invasive plants to reduce fire fuel loads.
3. If immediate protection from soil erosion is needed to allow gradual re-colonization by local ecotypes, then *do*:
   - use loose straw across the ground at no more than 2 inches deep:
   - use sterile or non-persistent plants (e.g., cereal grains like sterile wheat or barley) at low planting densities:
     - as a nurse crop for local natives,
     - to avoid cross-pollination with native vegetation,
     - and to preclude migration of weeds into adjacent natural areas.
4. Additional consultation is sometimes necessary to determine appropriate practices, such as when to sow or plant native plants. Many areas have rare and endangered taxa with significant plant populations (e.g., unique floristic areas containing highly localized or special environmental features) and important downstream habitats, whereby all restoration activities should be planned and executed with caution and the greatest respect for the ecological fragility of these areas.

What is hydromulching and when should it be used?

Hydromulching is a mixture of water, fiber mulch, and a tackifier (to increase stickiness) sprayed on burned slopes to prevent soil erosion or foster revegetation. Seed, fertilizer, or soil stabilizing polymers may also be mixed with the hydromulch. When seed is included, it is referred to as hydroseeding. Hydroseeding is typically applied by trained professionals with the proper equipment.

Hydromulching is an expensive erosion control method and therefore is generally limited to treating high-risk areas on severely disturbed 20 to 60 percent slopes to protect valuable properties, surface water supply sources, or important habitat. Because equipment access is an issue, the application of hydromulch is limited to areas within 300 feet of access roads or trails. Hydromulch is generally NOT recommended where there is more than 25 percent surface rock cover, in areas where there is appreciable needle- or leaf-drop, or where there is good potential for regrowth of vegetation within the first year after a fire. For more information on hydromulching refer to: http://bit.ly/hydromulch2017.

Below: USDA Hydromulching guide referenced in website on the right.

USDA United States Department of Agriculture

California 2018

Natural Resources Conservation Service

after the fire

Hydromulching

To Locate Your Local NRCS California Field Office, Please Visit: https://bit.ly/2rfhY5v

CAUTION: After a fire many trees are weakened from burning around the base of the trunk. The trees can fall over or blow down without warning. Shallow-rooted trees can also fall. Therefore be extremely alert when around burned trees.

What is hydromulching?

Hydromulching is spraying a mixture of water, fiber mulch, and tackifier on burned slopes to prevent soil erosion or foster revegetation. Seed, fertilizer, or soil stabilizing polymers may also be applied with the hydromulch.

When is hydromulching used?

Hydromulch is used on severely burned or otherwise highly erosive areas with 20 percent to 60 percent slopes. Hydromulching is an expensive erosion control method and therefore is generally limited to treating high risk areas to protect valuable properties, surface water supply sources, or important habitat. Due to its expense, conventional mulching is generally used on slopes less than 20 percent. Use of ground applied hydromulch is limited to areas within 300 feet of the roads or trails that are necessary to provide access for the application equipment.

Uniform aerial application of hydromulch is difficult to accomplish and as a result has proven less effective for erosion control, so it is seldom recommended. Hydromulch is generally not recommended where there is more than 25 percent surface rock cover, in areas where there is appreciable needle-cast, or where there is good potential for regrowth of vegetation within the first year after a fire.

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Straw Mulching Guidelines for Erosion Control Following a Wildfire

By Rich Casale, Assisting the Natural Resources Conservation Service

Most people know that "Hay is for Horses," and straw is for mulching. While hay (usually alfalfa, oats, and grasses) is cut when still green, straw is the leftover dead stalks after harvest, a byproduct that is generally less expensive. However, not all straw is created equal for erosion control.

Mulching is best used around homes and home sites, above water courses (but not on streambanks where it could wash into the water), and alongside roads. When done correctly, straw mulching – with the right product and care – can be one of the most effective measures to soften the impact of rain, and reduce runoff, erosion, and sedimentation following fire even without seeding.

Experts recommend loose barley or wheat straw because it lasts longer. Use straw mulch in "free form." Mulch in 6-10 foot strips along the contour and spaced at 50-100 foot intervals, depending on the steepness of the slope. This method helps break down long steep slopes to slow runoff and trap sediment. Where steep slope or wind is an issue, straw can be "tucked" or "tracked" in by hand or covered with netting to hold in place.

Whole bales of hay can act like brick walls, preventing sediment from filtering. Whole bale installation is only appropriate when planned by a certified erosion control specialist. Bales must be regularly maintained throughout the first rainy season following fire and then removed or replaced with a more permanent structure.

Depending on site conditions, wood chips also may be helpful. Very light application, like that seen here, is advised to avoid suppression of new growth. Photo by Don McEnhill, Russian River Keepers

Concerns with straw mulching:

"Weed free" mulch such as rice straw is not necessarily weed free. It all depends on the source, transport carrier, and the staging area of the mulch. All straw treatments require a long-term commitment to monitor and control weeds.

- Rice straw tends to be less expensive than barley and wheat straw. Some critics say it breaks down faster, but this straw does not need to last a long time; rice straw is sufficient for natives to recolonize. However, it can be difficult to spread because it's light and fluffy and has a tendency to stick together.
- Straw mulch that is not certified as weed free will often contain seeds from yellow star thistle (*Centaurea solstitialis*), flammable grasses, and other weeds.
- Mulching will not prevent invasive plants from taking hold. In fact, studies show that mulching can actually help weeds invade by retaining more moisture for longer periods than in areas not mulched.
- If mulch is placed deeper than 2 to 3 inches, it can delay recovery time of existing seed bank in the soil and inhibit the success of seeding used in conjunction with mulching.
- Widespread mulching over the watershed by hand or by plane is not cost effec-tive and has not demonstrated significant benefits in the past. It may also contribute to establishment of invasive and weedy plants.
- Mulch can be a fire hazard if installed when fire is still a danger, especially in the interface of burned and unburned landscapes where many firebreaks are located. Make it less hazardous by spreading in discontinuous patterns and not near the base of living trees.
- Mulching is not needed in areas where tree leaf drop is heavy from heat damaged trees.

Introduction to wattles

Straw wattles may be used on slopes to shorten slope length. They are designed for short slopes or slopes flatter than 3:1 and low surface flows not to exceed 1 cubic foot per second for small areas.

Before installing wattles, you must know how much drainage area the most uphill wattle is receiving and accommodate for this drainage.

Loose straw mulch and straw wattles are among the methods used to prevent soil erosion and debris runoff at Kimball Reservoir following the Tubbs Fire. Photo from Calistoga Public Works Staff

(Note: Wattles improperly installed can cause further harm to the site.)

1. Prepare smooth slope before the wattling procedure is started. Shallow gullies should be smoothed as work progresses.
2. Dig a small trench across the slope on contour to hold the rolls. The trench should be deep enough to accommodate a third to half the thickness of the roll. Avoid extensive soil disturbance.
3. Rolls must be installed perpendicular to water movement to create terraces that are parallel to slope contour. Start building trenches and install the rolls from the bottom of the slope and work up.
4. Lay the roll along the trenches fitting it snugly against the soil. Make sure no gaps exist between the soil and the wattle.
5. Using a steak knife or Xacto knife, cut a small hole in the top of the wattle, insert a stake into the wattle, push it into the wattle until it makes contact with the ground and then pound the stake through the bottom side of the wattle. This creates a tight bind between wattle, stake and ground surface.
6. Install stakes at 4 feet max intervals.
7. Construct a compacted earthen berm along the uphill side of the roll to force sheet flow into the roll and prevent water from piping into the trench.
8. When more than one roll is placed in a row, the rolls should overlap, one in front of the other, by at least 1 foot and staked securely to prevent piping.
9. Wattles with plastic netting need to be removed after the wet season has ended.

For more information on proper wattle installation, go to https://ucanr.edu/sites/postfire/files/247999.pdf.

Typical fiber roll/wattle sediment barrier

Wattle spacing:
1,000/slope gradient or as project engineer dictates.

Example:
@20 percent slope wattle spacing =1,000/20=50 feet

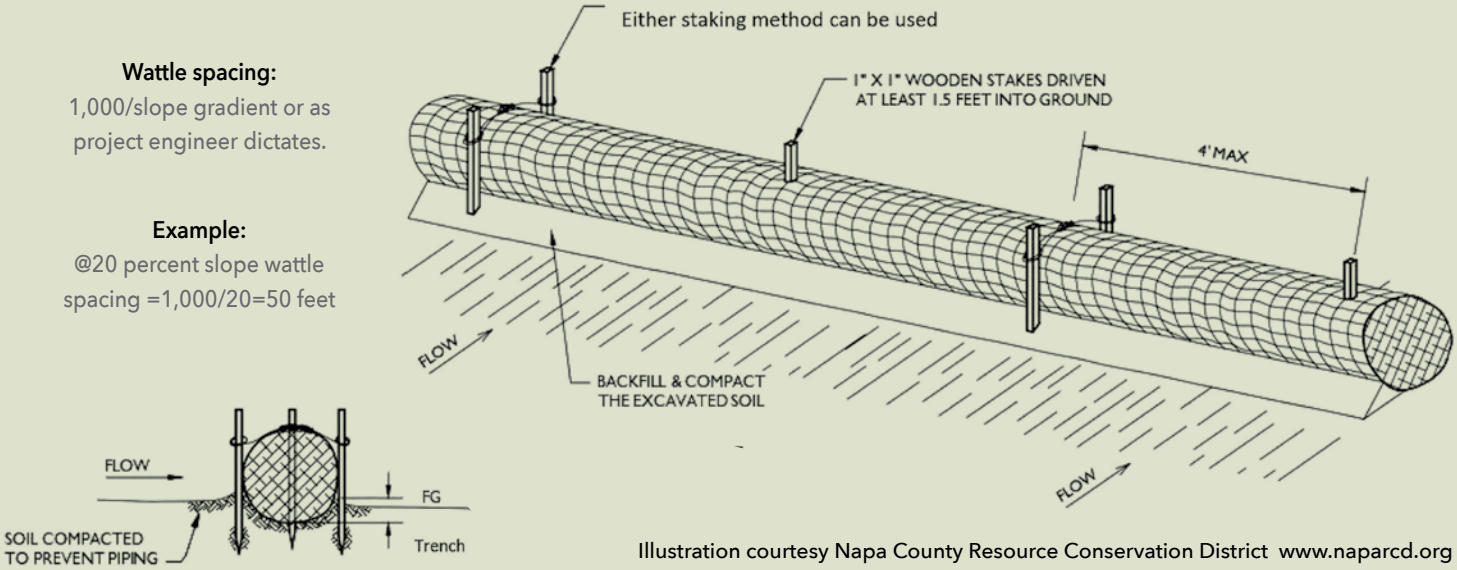
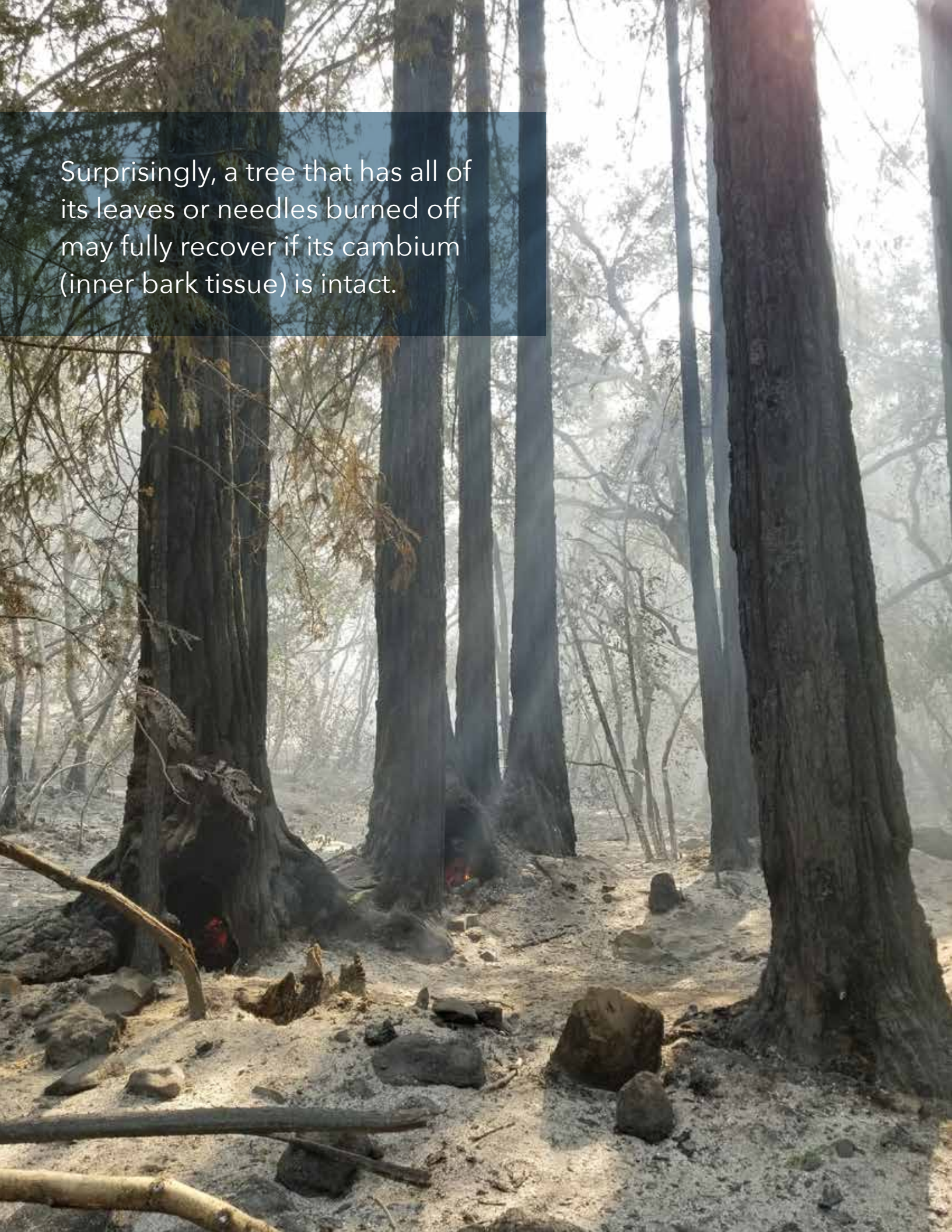


Illustration courtesy Napa County Resource Conservation District www.naparcd.org


Surprisingly, a tree that has all of its leaves or needles burned off may fully recover if its cambium (inner bark tissue) is intact.

Post-Fire Care and Recovery of Trees

California's severe and recent wildfires have burned thousands of acres of mixed conifer and broadleaf forests, as well as woodlands. Where fires burned intensely, some trees have been totally consumed. But in many places, trees remain standing and will survive.

How do I know if my trees are okay?

Let time tell. If the tree is not creating a hazardous situation, given one to two years, it may fully recover. After two years, the tree will likely not fully recover. But remember, if there's any doubt, consider how long it will take a replacement tree to grow that size and consider waiting a bit longer.

Do not cut trees down if:

- If they have lost all of their foliage, but their stem has only minor damage.
- They have spotty scorching around their bases, and at least 10 percent of their cambium (layer of plant tissue beneath the inner bark) is alive.
- They are more than 12 inches in diameter and are scorched all around their base, but there is no reduction in bark thickness.
- The base of the tree is intact without being hollowed out.
- Buttress roots (exposed roots supporting the tree) are not burned off or killed.
- The tree is structurally sound and poses a low risk. Wait one to three years after the fire to determine if the tree will not recover and needs to be removed, especially for larger, more valuable trees.

Please consult a professional forester or consulting arborist who is Tree Risk Assessment Qualified (TRAQ) to determine the level of tree injury.

See this great guide for more details: http://bit.ly/burnedoaks2011

Left: Redwood forest (*Sequoia sempervirens*) after the 2017 Nuns Fire at Bouverie Preserve. Photo by Audubon Canyon Ranch

Above Left: Acorn woodpecker. Photo by Lisa Hug

Above Right: The 2018 Camp Fire burns on the horizon. Photo by Jennifer Jewell, Cultivating Place

A photo taken after the 2018 Camp Fire along Little Butte Creek where large trees were able to survive thanks in part to selective and careful forest thinning by Cal Fire crews in 2013-14 as part of the Little Butte Creek Forest Health Project. Photo courtesy of Butte Fire Safe Council

Fire-killed conifer tree, being used by as a granary tree for acorn storage. Photo by Sherry Adams, Audubon Canyon Ranch

Should any trees be removed?

Some trees may need to be removed due to structural losses in the root system, root crown, and trunk. Where the wood at the base of the tree has been heavily charred, the tree may simply fall over on its own. Some compromised trees left standing may be unsafe, especially when close to people, homes, roads, and utility lines.

A professional forester or consulting arborist with TRAQ training can evaluate tree structure and identify trees posing an elevated risk to people and property. You can consult with a registered professional forester or certified arborist for specific advice on which trees to preserve or cut. (See Helpful Resources at the back of this guide for more information.)

Surprisingly, a tree that has all of its leaves burned off may fully recover if its cambium (inner bark tissue) is intact. Bark acts as insulation, and the thicker it is, the better it prevents heat damage. When a hot fire persists long enough, the cambium can be killed. If the cambium has been heated so severely that it has been killed all the way around the tree, then the tree is girdled and will die from a lack of moisture and nutrient transport. Sometimes it is difficult to tell if the cambium is fully killed by merely looking at the outside of the trunk. You can often determine the severity of damage by cutting into a small area of the bark to observe the cambium. Healthy cambium is white and moist, while dead cambium will become brown and dry.

Some tree species naturally have thicker bark, helping them to protect their cambium from injury, such as blue (*Quercus douglasii*), black (*Q. kelloggii*), and valley oaks (*Q. lobata*), and redwoods (*Sequoia sempervirens*). Larger trees have thicker bark, making them more resistant to fire injury than smaller trees. If possible, let at least one, and preferably three, growing seasons pass before deciding to cut down large, valuable trees whose crown survival is uncertain. Fire that has scorched the trunk and turned it black is not necessarily hot enough to kill the cambium, especially in larger diameter trees that have thicker bark (Plumb and Gomez 1983).

Even dead trees have value

Burned oak and conifer trees left in place provide wildlife habitat and contribute to biodiversity. For example, more than 80 species of birds rely on dead trees as important nesting sites and sources of food (primarily insects). Acorn woodpeckers establish large granaries in dead oaks and conifers, where a colony will "honeycomb" the tree with holes for acorn storage. Hundreds of species of insects and fungi also depend on old, dead wood. So, unless a standing dead tree presents a hazard, it can be left in place.

Considerations for Oak Trees

Oak woodlands provide food and habitat for more than 300 different types of wildlife.

Oaks (*Quercus* spp.) are integral to California's native ecosystems, making the health and survival of our native oak species particularly important. Fortunately, oaks have evolved mechanisms to survive periodic burning, since fire is a natural element of oak ecosystems. With low- and even moderate-intensity fires that scorch all the leaves on native oaks, little or no long-term damage typically occurs. When fires occur in the summer and fall, native oaks usually will not produce a set of new leaves until the following spring. Following such fires the trees may appear dead, since all the leaves are brown and brittle and the trunks may be blackened. Many of these trees will survive.

In northern California, frequent, low-intensity woodland burning may be used to create and maintain groups of large oak trees. Repeat burning can kill shrubs and small trees, allowing larger trees with thicker bark to continue growing. Repeat burning can promote more open savannah-like stands with widely spaced oaks and vegetation with relatively lower shrub cover. With longer periods of time between fires, growth of woody vegetation can occur, with an increase in tree density. Some open, savannah-like woodlands have changed over time to more heavily vegetated plant communities.

Trees with areas of killed cambium may need pruning to remain structurally sound. Another consideration: Dead trees provide remarkable habitat for a wide array of animal species. If the dead tree does not pose a hazard, it can be left alone to provide a key component to the woodland or forest community. If kept in place, even trees that are completely dead also help hold soil in place and prevent erosion. See more on this from Audubon California's Working Lands series: http://bit.ly/audubonsnags.

Oaks (*Quercus* sp.) resprouting post-fire at Sutro Ranch Preserve. Photo by Mike Palladini, Land Trust of Napa County

Above Left: More than 50 types of animals rely on acorns for food. Photo by Jennifer Buck-Diaz

Above Right: A coast live oak (*Quercus agrifolia*) sunset following the 2017 Tubbs Fire. Photo by Michelle Halbur

Coast live oak tree (*Quercus agrifolia*) resprouting from its upper branches. Photo by Wendy Trowbridge

Sprouting by oaks

Even if an oak has been girdled and the above ground portion of the tree has been killed, it can sprout from its base the following year. Sprouting initially produces many new shoots. These sprout clumps thin out over time, although even mature trees that started as sprouts usually have multiple trunks. In general, live oaks like coast (*Quercus agrifolia*), interior (*Q. wislizeni*), and canyon live oak (*Q. chrysolepis*) are more vigorous at sprouting than deciduous oaks like Oregon oak (*Q. garryana*) and blue oak (*Q. douglasii*), and smaller diameter trees are more likely to sprout than large diameter ones, although all California oak species can sprout.

Many of the oak trees in California today originated as resprouts following fires, and they are recognizable by having several main trunks. Sprout-origin trees generally grow faster than young seedlings starting from acorns because they have a massive root system compared to newly germinating acorns. Resprouted trees have access to greater amounts of water and nutrients to support top growth.

Planting oaks in areas where trees have been killed

While most oaks will sprout following fire, this is less likely in lower rainfall areas. In areas where a fire burned extremely hot, sprouting may not occur due to the roots and root crown being killed. In such instances, consider planting young oaks to replace trees that are killed.

Chances for success are also enhanced by choosing favorable microsites when planting. While difficult to identify, one can gain some insight by looking at nearby areas where oaks occur and by observing patterns where the trees have established naturally.

Identifying your oak trees and maintaining a natural forest

Various online resources are available to help you identify what oak species you have. For example: http://bit.ly/ucanroaks, as well as range maps and photos from Calflora. Also, the CNPS Manual of California Vegetation website contains management considerations of oak forests and woodlands: http://vegetation.cnps.org.

Black Oak
Quercus kelloggii
Photo by Neal Kramer

Blue Oak
Quercus douglasii
Photo by Keir Morse

Coast Live Oak
Quercus agrifolia
Photo by Neal Kramer

Oregon Oak
Quercus garryana
Photo by Keir Morse

Valley Oak
Quercus lobata
Photo by Neal Kramer

Planting of oak seedlings (*Quercus* sp.) with protective "tree shelters." Photos by Napa RCD

Re-Oak California

Join the effort to restore California's native oaks!

California's oaks are the powerhouses of our ecosystems, but disease and habitat destruction have put oak populations in serious decline. Now, Californians are coming together to restore this vital natural resource. With a few simple actions, you too can be part of the solution. Here's how you can help:

✓ Collect acorns

Since the devastating 2017 fires in wine country, thousands of Californians have gathered acorns for oak restoration efforts. It's a simple, fun way you can make a difference when acorns drop in the fall. Get instructions by signing up at cnps.org/acorns.

✓ Adopt an oak

Plant an oak (or a collection of oaks) on your property with locally appropriate oak species. Thanks to the many volunteers who've helped collect acorns, CNPS has been able to process and grow thousands of oak saplings. Contact CNPS to get free saplings for your property or learn about other oak resources.

✓ Attend or host a planting event

Community partners, schools, and neighborhoods are signing up to host oak planting events. Organize your own or find out about events near you.

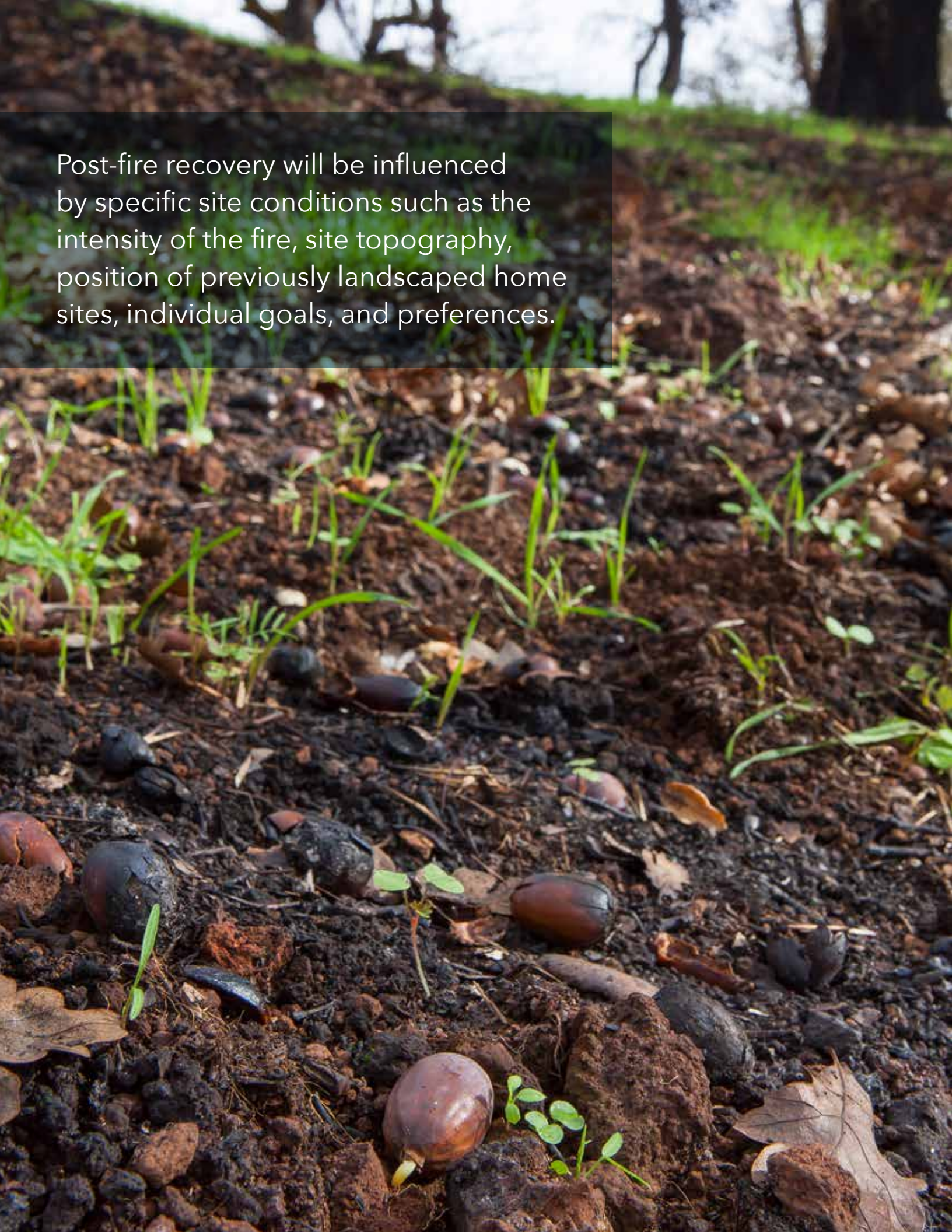
Go to cnps.org/reaoak to get involved!

Oaks and wildlife

Oak woodlands provide food and habitat for more than 300 different types of wildlife. These animals rely on woodland habitat for shelter, nesting, and reproduction. Acorns provide food for more than 50 different animals including mule deer, California ground squirrels, western gray squirrels, acorn woodpeckers, western scrub-jays, woodrats, many mice species, and various insects. In turn, many of these small animals are food for larger predators including bobcats, foxes, coyotes, and raptors (falcons, hawks, owls).

Right: Black bear's paw print found post-fire. Photo by Mike Palladini, Land Trust of Napa County

Right: Black-tailed deer, a subspecies of mule deer, photographed by motion-activated wildlife camera exploring its post-fire landscape. Photo by Pepperwood Preserve



Post-fire recovery will be influenced by specific site conditions such as the intensity of the fire, site topography, position of previously landscaped home sites, individual goals, and preferences.

Seeding vs. Natural Regeneration

Our human tendency is to fix what we perceive as a potential problem or as something "broken" or "untidy." Reseeding and planting can be important for erosion control or re-landscaping a home site. Yet natural regeneration is the best option in most other scenarios. This gives the land a chance to recover on its own from the existing soil seed bank, nearby seed sources, and the resprouting of surviving perennial plants.

Since various factors come into play when deciding if and/or when to re-seed/re-plant, we note some common questions and answers and include resources and tips below. However, post-fire recovery will be influenced by specific site conditions such as the intensity of the fire, site topography (slope steepness, stream drainages, etc.), position of previously landscaped home sites, and individual goals and preferences.

Common Questions

1. Should I add seed or allow the land to regenerate naturally?

The answer to this will vary by site, since fire is a natural process in most California ecosystems. Many plant communities and species are specifically adapted to periodic fires.

Seeding of previously burned wildlands can impair the recovery of native plant communities. In areas where fire intensity was low to moderate, seeds or perennials can be present in the soil or able to resprout, and the land will naturally regenerate. Thus, it is generally recommended to allow burned wildland areas to revegetate naturally.

Thankfully, most fire-prone landscapes include many native plants that are adapted to rapid regeneration after fire; seeding can inhibit the germination and survival of these native plants. For chaparral plant communities, high-intensity fire is the natural condition and allows for the most successful post-fire response. Moreover, high-intensity fire can help eliminate or reduce invasive weeds that may be present.

Left: Sprouting acorns and herbs within two months post-fire in Pepperwood Preserve. Photo by Saxon Holt

Above Left: Graceful Clarkia (*Clarkia gracilis*) blooming post-burn at Knoxville Recreation Area, Lake County. Photo by Evan Johnson

Above Right: Goldfields (*Lasthenia* sp.) and other herbs germinating in the spring after the 2015 Valley Fire. Photo by Lynn Houser

Above: An abundance of wildflowers, California poppy (*Eschscholzia californica*), following the Witch Creek Fire. Photo by Rick Halsey

Below: Resprouting of silk-tassel (*Garrya* sp.) and leather oak (*Quercus durata*) co-mingled with dense-flowered pedicularis (*Pedicularis densiflora*). Photo by Mike Palladini, Land Trust of Napa County

2. If I seed, where should I do it?

Seeding is no longer recommended in most burned areas, but it may be appropriate around home sites and in severely compromised areas left disturbed by fire-fighting or cleanup efforts. For example, fire lines, roads, helicopter landing pads, compacted soil areas, and other severely disturbed or previously landscaped areas may be unable to rapidly recover and revegetate following fire without some level of assistance.

Seeding with local native species may therefore be effective in reducing post-fire erosion from severely disturbed soils, or to "speed up" restoration using appropriate or desirable native plant species. When seeding or planting, consider fire-safe landscaping near home sites.

3. Where do I find native wildflower seed, and how do I select the species?

Because native seed is an important and expensive resource, it should be used judiciously and sown into appropriate areas. Seed provenance, or the origin of seed used for reseeding purposes, should be considered carefully when selecting seed for a project. When needed, seed should be sourced from as nearby as possible and sown into the site as soon as possible after a fire.

We recommend using a common sense ecologically-sound approach to determining appropriate seed provenance. The most stringent standard is to constrain seed provenance to the watershed where it will be sown. If a seed is dispersed by wind or animals, such as edible berries or seeds that adhere to animal fur, then it may be appropriate and reasonable to utilize seed from adjacent watersheds. It's important to know where not to source seed: We would never recommend seeding a site from material that was collected 30 miles away. Often, native seed companies may not have seed available for a particular desirable species. This can be a good time to reconsider whether seeding is necessary to site recovery. Always rely on expert opinion to help produce a responsible seeding palette.

4. Is seeding effective at stabilizing soil post fire?

The answer depends on timing, rain, and slope. For seeding to stabilize soil, seeds need to germinate early in the fall, and plants must develop sufficiently to provide cover and root mass before major winter storms. The first rains must bring sufficient water for germination, yet be gentle enough so as not to wash seeds and soils off slopes. When major storms occur early in the year following a fire and before seeded species are established, seeding has little or no beneficial effect on erosion or flooding.

Seeding is ineffective on steep slopes (>35 percent) because the steeper the slope the less likely seeds are to stay in place and germinate successfully. As a result, a flush of green grass is often observed at the base of steep slopes with few seeded species present on the slopes themselves.

5. Will seeding help the recovery of natural vegetation?

Introduced seeds can compromise natural vegetative recovery; the existing native seed bank must now compete with the additional seed input. Several studies have shown statistically significant reduction in abundance of native seedlings when seeded grasses were established successfully.

Seeding can open up previously resistant plant communities to invasions by weedy plants and other pest species, thus decreasing native biological diversity and potentially impairing function of ecosystem processes. For example, a US Forest Service study by Conard and Beyers (1993) showed that significantly more invasive mustard (*Brassica* spp.) was found in plots seeded with Italian rye grass (*Festuca perennis*) than in those allowed to revegetate naturally.

Refer to page 42, "Important Notes about Seeding Grasses following Wildfire" for more details on potential positive and negative effects of seeding.

Naturally, native fire-following annuals and geophytes often lie dormant in the soil between fires and only complete their life cycle in the first two years after fires. Seeds of these specialized plants are diminished or eliminated from the soil seed bank if they repeatedly have to compete with added/introduced seeds. This burst of growth by fire-following plants helps to retain nutrients on burned sites (Keeley 1994, 1995).

Chamise (*Adenostoma fasciculatum*) regenerating from adventitious buds on the underground lignotuber that survived the heat of the fire. Many chaparral plants utilize lignotubers for resprouting after fire. Photo by Lech Naumovich

A bouquet of wildflowers including canyon larkspur (*Delphinium nudicaule*), buttercups (*Ranunculus californicus*), and Fernald's iris (*Iris fernaldii*), among others all regenerating vigorously the spring after the fire. These plants are benefiting from the nutrient flush provided by the fresh ash. Photo by Lech Naumovich

Invasive Plants

Invasive plants are those species that spread rapidly and grow so dominant that they change the local landscape, damaging the ecosystem at great cost to waterways, wildlife, agriculture, the local economy, and human health. In altering the natural plant communities in California, they are altering the pattern, frequency, and intensity of wildfires as well.

Eucalyptus trees have long been known as a fire hazard, and when not well maintained, these trees often form dense stands with leaves, bark, and limbs that slough off in the understory, creating flammable fuel for wildfire.

Why are invasive plants of concern?

Invasive plants threaten natural areas by their ability to aggressively reproduce, spread, and out-compete native plants. Many of these species are well-adapted to disturbance and come from fire-adapted climates elsewhere in the world. They are often able to survive and proliferate after fire which can then lead to an increase in fire frequency and severity. (See Lambert and Landis in the references at the back of this guide for CNPS summaries of invasive plants of greatest concern statewide.)

Invasive plants interact with wildfires in three main ways:

1) Some invasive species facilitate the ignition, spread, and/or severity of wildfire.

Many of our native plant communities are relatively fire-resistant, yet where they are invaded by invasive species such as annual and perennial grasses, giant reed (*Arundo donax*), tamarisk (*Tamarix* spp.), or French broom (*Genista monspessulana*), they become much more vulnerable to fire. A fire that ignites along a weedy roadside or invaded disturbed area can easily get big enough to sweep into the adjacent native forest, shrublands, riparian areas and/or home sites. Invaders that increase the woody fuel load can increase fire intensity.

Grasslands or understories dominated by invasive herbaceous plants contain high fuel loads from annual and perennial grasses, such as Harding grass (*Phalaris aquatica*), medusahead (*Elymus caput-medusae*), wild oats and bromes (*Avena* spp. and *Bromus* spp.), ryegrass (*Festuca perennis*), and invasive thistles (*Carduus* spp., *Cirsium* spp., *Silybum marianum*). Since invasive herbaceous plants act as flashy fuels, they facilitate the spread of fire into unburned areas and in grassy understories below woodlands and shrublands. They also can increase the frequency of fire and length of the fire season in the future.

Climbing and invasive vining plants like Himalayan blackberry (*Rubus armeniacus*) also contribute to fire. The blackberry's canes can reach far into a tree canopy, spreading fire from the ground up.

Invading plants with high flammability can ignite easily and burn intensely. For example, eucalyptus trees have leaves with flammable resins, and produce abundant sloughing bark and small dead branches that make the trees highly flammable. The long dangling streamers of bark easily carry fire high into the canopy, so even a small ground fire becomes a devastating crown fire. The resin can cause the trees to literally explode when heated, so eucalyptus fires can spread especially fast.

French broom (*Genista monspessulana*) has invaded this oak woodland, posing higher fire risk, because fires can easily jump from the broom into the tree canopy, creating a dangerous crown fire. Photo by Marin Municipal Water District

Above Left: Yankee Hill in Butte County 2006. After the 1994 Ralston Fire burned the forest, the forest converted to chaparral.

Above Right: Dec. 2018: 24 years after The Ralston Fire, the brush field reburned with high intensity. The surviving ponderosa pines (*Pinus ponderosa*) had been planted as a school project in 1994. Photos courtesy of Butte County Fire Safe Council

2) Invasive species can take advantage of disturbances caused by fire and can become established in new areas

A number of unwanted, highly invasive plant species can take advantage of the disturbance created by wildfire to spread across larger areas and in higher densities. What might have been a small patch of star thistle (*Centaurea* spp.) before the fire can spread now that there is more sunlight, less thatch, and fewer competitors. Some plants like cheat grass (*Bromus tectorum*) and red brome (*Bromus madritensis* subsp. *rubens*) can both facilitate fire and take advantage of it by spreading more once it has occurred. These are particularly problematic species that can alter whole ecosystems by changing fire regimes.

Some plant communities are particularly susceptible to weed invasion after fire, such as native shrublands of chaparral and coastal scrub. Repeat burning at too frequent of fire return intervals can accelerate weed invasion, and can cause a feedback loop that further favors high fire frequency. This can ultimately result in type conversion of diverse native shrublands to more flammable annual grassland vegetation.

3) Fire can present a positive opportunity and powerful tool to control certain invasive species.

Alternatively, fire represents an opportunity. While fires don't usually destroy the seed bank of weeds, high-intensity fire can reduce invasive species seeds in some chaparral communities. Also, fires can burn off accumulated plant biomass and make it easier to control the young seedlings that do sprout. For example, in areas with strong dominance of invasive shrub species in the understory or in the open (e.g., French broom in the understory or along open road cuts), land owners and managers now have the opportunity to focus on the seedlings and resprouts while they are small and accessible.

Grasslands and oak woodlands may benefit from fire's removal of invasive annual grass thatch. Fire-adapted natives will sprout, if present in the seed bank, and manually removing invasive plants will give them space to grow.

While fires don't usually destroy the seed bank of weeds, high-intensity fire can reduce invasive species seeds in some chaparral communities.

Common post-fire invaders

- barbed goatgrass (*Aegilops triuncialis*)
- cheat grass (*Bromus tectorum*)
- filaree (*Erodium* spp.)
- French broom (*Genista monspessulana*)
- Italian thistle (*Carduus pycnocephalus*)
- medusahead (*Elymus caput-medusae*)
- mullein (*Verbascum* spp.)
- mustards (*Brassica nigra*, *Hirschfeldia incana*)
- red brome (*Bromus madritensis* subsp. *rubens*)
- star thistle (*Centaurea solstitialis*)
- stinkwort (*Dittrichia graveolens*)

SEEDING VS. NATURAL REGENERATION

Tocalote (*Centaurea melitensis*) Photo by Neal Kramer

Below: Thousands of French broom (*Genista monspessulana*) seedlings sprouting post-fire in the fall of 2017, under an oak woodland. Photo by Wendy Trowbridge

Some recently burned areas have been previously colonized by invasive plants and may lack a native seed bank to rebound after fire, especially in areas where fires have occurred too frequently and invasive weeds are abundant. Where resources exist, land managers may consider restoration. Restoration planning is often not black-and-white, and it requires knowledge of the site history. Reseeding an invaded area can help convert it back to native habitat if done correctly.

What can land owners and managers do?

Invasive plants can gain dominance or spread following fire, so remaining vigilant is key. This is a limited-time opportunity, because a fine line exists between a species that can take advantage of fire and an opening for invasive species management. Where intervention is necessary, we highly recommend investing half to two-thirds of your resource budget on managing the post-burn site in the first 12 months. The first year of growth is critical to determining the ecological trajectory of the burned landscape.

If the seedlings or resprouts of invasive weeds are not controlled in the first couple of years after the fire, the problem could pose worse risks than before the fire. Ultimately, invasive weeds once established can lengthen the fire season, facilitate more ignitions, increase fire extent, and increase fire severity.

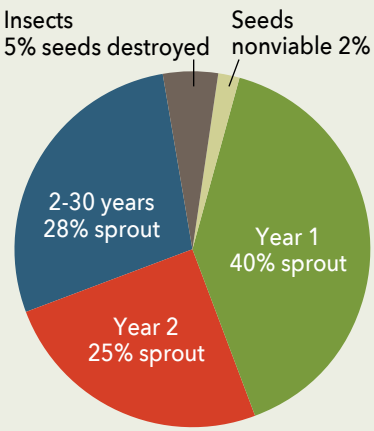
Please work to identify new weed infestation areas and manage previously infested areas to provide some defense towards reducing the intensity and severity of the next wildfire, while allowing for native plants to reclaim the habitat. Mechanical removal of invasive plants on your own home site is an important step. This might include hand weeding, digging, hoeing, cutting, and/or raking away unwanted plants.

Special considerations for broom management

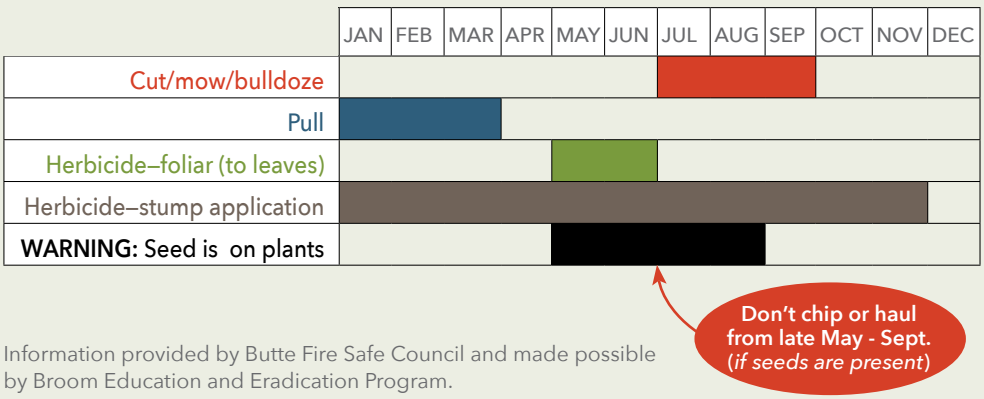
Introduced as an ornamental plant around 1850, French broom has shown an extraordinary ability to increase in abundance and cover following fire, quickly overwhelming neighborhood lots and byways. The results is type conversion of native habitat and extra fuel for future high intensity fires. Knowing when and how to manage broom is essential.

Get rid of these broom seeds in the soil:

Keep at it, even after the first year; those seeds are tough and will germinate for years to come. Here's what happens to seeds:



Doom the broom at the right time:



Information provided by Butte Fire Safe Council and made possible by Broom Education and Eradication Program.

More comprehensive mechanical and cultural techniques also may be necessary including mowing, carefully timed grazing, and perennial native plant seeding. If more intensive management of invasive, noxious weeds is needed, this will likely require developing a longer-term plan across a group of homeowners, an HOA, or other similar group that incorporates materials and programs for weed prevention and removal with a sustainable multi-year integrated approach. Local weed management agencies and/or watershed groups are great resources, depending on your concerns and needs.

Invasive species can gain dominance or spread in areas following fire, so remaining vigilant is key.

General approaches to reduce invasive plant infestations:

1) Prevent the introduction and spread of invasive plant seeds and/or their rooting bodies in both the fire areas and along roads or other corridors.
2) Where invasive weeds have established in burn areas, remove them carefully to allow for recovery of native plants.
3) Avoid disturbing the soil as much as possible, as many invasive species thrive in disturbed environments.

Every area will need to be assessed individually for its invasive plant risks; different habitats and the same habitat in different regions will need varied approaches to manage invasive plant threats. A brief summary of guidelines developed from Brooks and Lusk (2009), can help with developing your strategy.

Prescriptive fire in May 2016 at Bouverie Preserve to reduce areas with invasive plants. The 2017 Nuns fire lightly impacted these areas. Photos by Audubon Canyon Ranch

As a general guideline, we do not recommend this practice, unless specific erosion control and natural regeneration issues necessitate use of native perennial grass seeds and/or mulch without weed seed.

Important Notes on Seeding Grasses Following Wildfire

The research community agrees on two important points regarding seeding grasses following wildfire:

1) This management practice is usually not cost-effective.

2) It appears to create more problems than it solves.

Potential negative effects

- Seeds of invasive annual grasses like wild oats (*Avena* spp.), bromes (*Bromus* spp.), ryegrass (*Festuca perennis*) develop shallow root systems that have little to no effect on slope stability.
- These grasses can increase infiltration, which can negatively affect steeper slopes prone to sliding. Seeding, especially on slide prone slopes, can increase the likelihood of slope saturation and debris flows.
- Seeding competes with and/or slows down regeneration of pre-existing native vegetation.
- Seeding uses up more ground moisture and reduces regrowth of native plants that regenerate from resident seed bank in the soil.
- Seeded grasses can also compete with pioneering, native grasses and forbs.
- Seeding provides marginal effects/results in the first year following fire or not at all, and no significant effect when slower native perennials are the plant of choice in the first year.
- Native grass seeding may harm resident native grasses especially if the grasses sowed are collected from far away and so maladapted to local conditions.
- Seeding may have long-term negative effects on the ecosystem by changing plant community composition over time.
- Seeding can attract or increase pocket gopher activity, leading to soil piping, a situation in which runoff and/or water-saturated soil enters gopher holes and erodes the soil below the ground. This condition can lead to future ground collapse and surface gullying.
- Seeding can give property owners a false sense of security.
- Seeding that is successful – especially on the unburned wildland interface – can become a fire hazard in the following fire season.
- Seedbed preparation can cause disturbance to slopes, soil, pre-existing vegetation, native seedbank, etc.
- Often, the natural regeneration in the first growing season on unseeded sites equals or exceeds that of seeded sites.

Potential positive effects

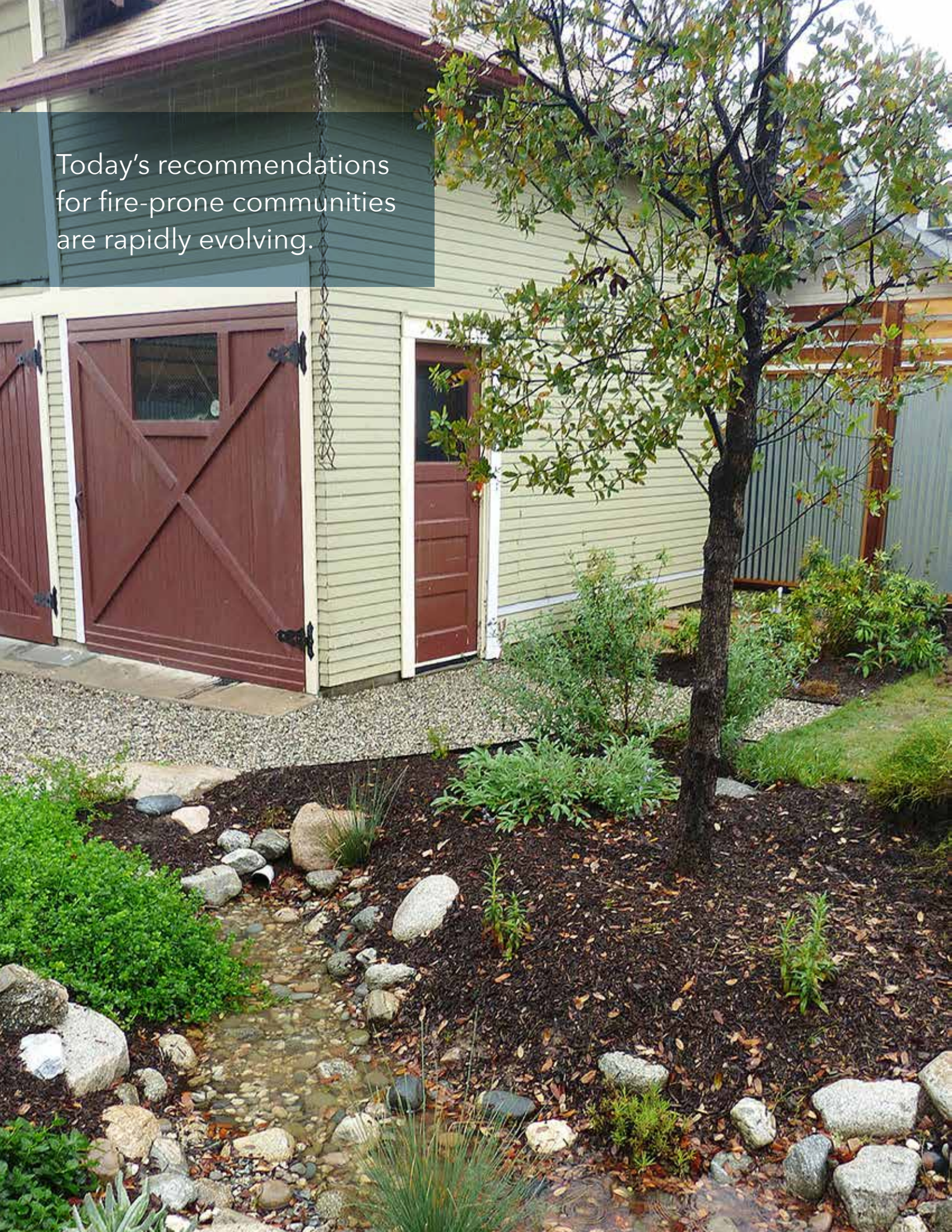
- In cases where natural regeneration processes are severely compromised (e.g., road cuts and mines) and/or where ecosystems are threatened by harmful invasive plants, seeding of native grasses and perennials may be justifiable.

- Seeding grasses like sterile barley and wheat or perennial native grasses at low densities can reduce invasive weed encroachment.

As a general guideline, however, we do not recommend this practice, unless specific erosion control and natural regeneration issues necessitate use of native perennial grass seeds and/or mulch without weed seed.

Bigberry manzanita (*Arcostaphylos glauca*) seedling recruitment following the 2007 Witch Fire in San Diego County. Photo by Rick Halsey

Natural chaparral recovery amid a bloom of sky lupine (*Lupinus nanus*) in spring 2013 after the 2012 North Fire in Mendocino County. Photo by Kerry Heise


Today's recommendations
for fire-prone communities
are rapidly evolving.

Defensible Space and Landscaping

From the House Out

Today's fire experts are clear: The most effective and efficient way to protect lives and property is from "the house out" rather than from the wildlands in. This means addressing the potential flammability of homes, around homes, and communities first.

Following the 2018 Camp Fire, retiring Cal Fire Chief Ken Pimlott urged California's leaders to "raise the bar" on what we're doing to protect communities and life at the wildland urban interface. His suggestions and others' range from building code updates and high tech wildfire warning systems to stricter requirements for approving new developments in known high fire risk areas. Today's recommendations for fire-prone communities are rapidly evolving, but general guidelines consistently include those featured in the following sections.

Community planning and building requirements

1. Fire corridors and evacuation routes must be properly considered in the planning process before additional developments can be permitted.

2. New developments within two miles of wildlands must have fire safe construction (e.g., ember resistant vents, non-flammable roofing, minimal wood exposure, metal framed double pane windows, external sprinklers.). Please refer to Cal Fire's readyforwildfire.org for California code specifics and FireWise USA at http://bit.ly/nfpawildfireprep for recommendations based on the latest science. Additional resources are listed at the back of this guide.

3. Decision-makers should provide economic opportunities and assistance for older communities within two miles of wildlands to help residents retrofit structures with critical fire-safe features.

4. The creation and maintenance of properly thinned, 100 foot (33m) buffers around communities in high fire hazard zones should be considered.

5. Consider the creation of limited, strategic fuel breaks near communities for fire-fighter safety and fire suppression opportunities.

Left: New guidelines call for a 5-foot no-fuel zone around homes and structures and breaks between flammable material, as seen above in this Los Angeles Area garden. Photo courtesy of Theodore Payne Foundation

Above Left: A success story in Butte County demonstrates how proper vegetation thinning helped preserve large trees and the POA Village during the recent Camp Fire. (Photo taken after fire in late Nov. 2018.) Courtesy of Butte Fire Safe Council

Above Right: Creating space between and under trees prevents fires from spreading along tree canopies or laddering from ground plants up trees. Photo courtesy of Theodore Payne Foundation

Defensible space can help reduce fire danger around your home by addressing three primary areas:

Layout – Space between plants and other fuel

Plants – High moisture / low flammability / low fire energy release plants

Maintenance – A well-kept and monitored property

Zone 1: Within 0 - 30 feet of your home.
Make this area and your evacuation route "lean, clean, and green."

- Create a 5-foot no-fuel zone around your house to deter fire under the eaves of your home. (Relocate wood piles, garbage cans, mulch, wooden fences, and flammable plant material.)
- Prevent trees and large shrubs from touching each other or hanging over structures. (Cal Fire currently instructs spacing of at least 10 feet.)
- Remove "laddering" plants that can spread a ground fire up to a tree's crowns.
- Remove loose plant debris from gutters, roofs, and other structures.
- Remove dead or dying trees. (*Note: Make sure a tree is actually dead.* *See page 29.*)
- Break up continuous, flammable ground cover (e.g., grasses, mulch) with hardscaping and other fire-resistant features.
- Provide good access to water within 30 feet of your home.

Why homes burn

The reasons wildfire destroys some homes and not others are complex. But we trend toward a common denominator in California: Most homes burn when they are in the path of wind-driven wildfires like last year's 2018 Camp Fire or the frequent southern California fires generated by Santa Ana and Diablo winds. In these conditions, air-borne flying embers and firebrands can ignite anything flammable on or near homes, including leaf-filled gutters, debris piles, trash cans, welcome mats, wood or plastic mulch, and plants. That's why new standards now advise starting from the house out with a focus on home hardening,careful maintenance, and breaks in any contiguous fuel in your landscaping.

Some property owners think an ice plant landscape will protect their homes. But not only does ice plant have a woody thatch that burns, it also can't protect a home from flying embers. Photo by Rick Halsey

Landscaping around home sites with fire-wise design

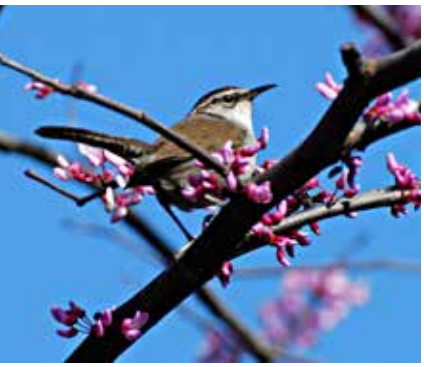
Experts now advise a 5-foot no-fuel zone immediately around structures and regular maintenance on and around your home.

Left: Reproduced with permission from the National Fire Protection Association, copyright © 2019, NFPA, Quincy, MA. All rights reserved. For more information on the referenced subject, please go to www.nfpa.org.

Zone 2: Within 30 - 100 feet of your home, reduce fuels.

- Keep your yard clear of trash, natural debris, and dried grasses.
- Mow grasses before 10 a.m. and avoid mowing on hot, windy days.
- Use low-maintenance plants that require low water and pruning.
- Clear dead and diseased plants. (*See page 29 for post-fire care of trees.*)
- Create both horizontal and vertical spacing between plants. Avoid laddering understory plants; space trees and shrubs at one or two times their mature height.
- Periodically re-open gaps between plants as plants grow closer together.
- Consider expanding this zone up to 300 feet for steep slopes with flammable shrubs.

Right: View of native plant garden that essentially served as a fire break protecting Pepperwood Preserve's Dwight Center. Photo by Lisa Micheli



Landscaping with native plants have many benefits, including providing habitat for wildlife; here, western redbud (*Cercis occidentalis*) with a Bewick's wren. Photo by Bob Watkins

Supporting Your Local Ecology with Native Plant Gardening

Whether you're recovering from wildfire or rethinking your home landscape for greater fire resilience, we encourage you to consider native plants in your planning process. Many people who live in fire prone areas are located at the wildland urban interface (WUI), where natural ecosystems are present and also threatened. By incorporating native plants into your landscapes, you can help extend habitat for nearby wildlife and conserve the beauty that likely brought you to the area in the first place.

Restoration vs. landscaping

Ecological restoration is a term of art for rewilding a site via planting, weeding, and other actions. Restoration professionals work to restore as much of the ecosystem as possible, including pollinators, wildlife, and other creatures. Because the co-evolved relationships between plants and other organisms have developed over millennia, only local plants will do. Local insects may even be unable to live on non-local plants, even if those plants are the same species. Thus, restoration uses plants that are hyperlocal, grown from seeds or cuttings collected onsite or very close to the site to be restored.

Restoration requires more care than gardening, but is also much more valuable, and so restoration is considered the "gold standard" for planting plants. Whenever possible, CNPS and others prefer to protect intact wildlands, rather than lose them and attempt to restore later; even the most successful restoration project can never replace what nature grew over centuries.

Ecological restoration is at one end of a spectrum of native plant landscaping. Some native plant gardeners come very close to restoration quality landscapes, consulting local experts and tools like Calscape.org to guide their planting decisions. Many more of us start by experimenting with a few commonly known native plants and go from there. That is fine too!

Starting over

In the case of fire, you may find yourself in the position of re-thinking your entire property. For that, we offer the following suggestions.

If your landscape has burned

1. First consult the Post-Fire Checklist (page 15) and consult a professional for advice regarding erosion, dead trees, drainage systems and waterways, or other potential hazards.

Below: Before and after: a striking view of chaparral (*Arctostaphylos glandulosa*) recovery at Foote Botanical Preserve. The photo on the left was taken in November 2017, immediately after fire; the photo on the right is the same spot just five months later. Mike Palladini, Land Trust of Napa County

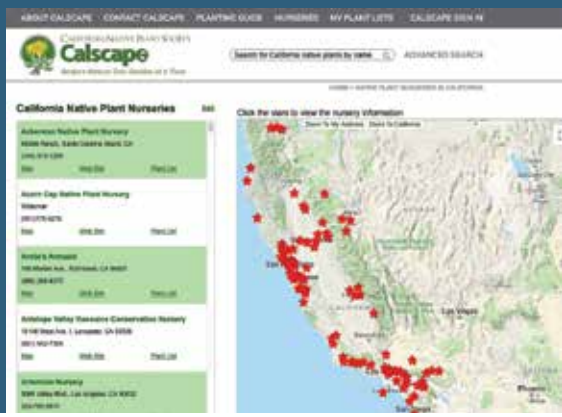
2. Avoid scraping or disturbing the blackened ground, as it can damage the existing seed bank and biological soil crusts that stabilize soils.
3. Be patient and watch what returns. See how burned trunks resprout, observe what is germinating. Consult your local CNPS chapter (www.cnps.org/chapters) or the local resources listed at the back of this guide to get to know the plants.
4. Remove and manage known invasive weeds which can be especially aggressive following fire and contribute to further fires. (UC has helpful guidelines at ipm.ucanr.edu.)
5. Using the zone recommendations on pages 46-47, plan your new native garden, incorporating local native plants already present on your property or introducing local plants. Go to calscape.org and enter your address or zip code to start discovering plants, or even use the advanced search to enter more detailed criteria. Note: Don't dig up plants from the wild, visit a local nursery instead.

If your landscape is intact but you're considering changes

1. Focus on maintenance and zones (*see pages 46-47*). Think like a fire expert and look for ways to break up contiguous flammable material with hardscapes and non-flammable products like decomposed granite.
2. Transition to a native plant palette. Find local plants that meet your needs at Calscape.org, and see our recommend reading list below.
3. Observe the way plants grow in the wild. What types of plants grow together (e.g., redwoods and ferns)? Mimic your local plant communities in your home landscape.
4. Avoid planting invasive species that are likely to spread from your garden. Learn more at http://www.cal-ipc.org/plants/inventory.
5. Look out for native vegetation growing nearby and prevent irrigation runoff, and fertilizer or pesticide overspray into wildlands.
6. Remember that starting small is fine! Even adding a few local species to your landscaping makes a big difference. Ask your local CNPS chapter for help selecting your first plants.

Where can I buy local seed and native plants?

Visit **calscape.org** to look up native plant nurseries and seed providers near you. You can also use Calscape to discover which native plants are local to your area.



Above and left: Blue-eyed grass (*Sisyrinchium bellum*), and California wild rose (*Rosa californica*). Photos by CNPS Calscape, www.Calscape.org

Recommended reading

California Native Plants for the Garden by Carol Bonstein, David Fross, and Bart O'Brien
https://store.cnps.org/collections/books/products/california-native-plants-for-the-garden

Designing California Native Gardens by Glenn Keator and Alrie Middlebrook
https://www.ucpress.edu/book/9780520251106/designing-california-native-gardens

The California Native Landscape by Greg Rubin and Lucy Warren
https://www.goodreads.com/en/book/show/15079653-the-california-native-landscape

Home Landscaping in Fire Country: A Southern California "Case Study"

Note: *The following is an excerpt from an article by native landscaping expert Greg Rubin. Rubin serves as a member of the CNPS Expert Horticulture Committee and is active in the CNPS San Diego Chapter. Although Rubin's observations are from San Diego County, his discussion here provides insight into real-life application of defensible space principles. The science is still out, but CNPS and partners are actively monitoring and participating in studies to better understand the potential benefits and utility of native landscaping in fire prone areas.*

Story and photos by Greg Rubin

The great San Diego wildfires of 2003 and 2007 taught us a number of surprising lessons. Contrary to popular belief, none of our installation clients lost their homes. This was despite being surrounded by native plants, despite being in the middle of these firestorms, and unfortunately, despite neighbors with conventional landscapes burning to the ground. So why did these native landscapes survive?

Overhead watering

All of the plants in our native installations are hydrated with overhead irrigation throughout the warm months, from early June to mid-October. The amount of moisture delivered is slight, however, approximately a quarter inch of equivalent precipitation per watering. Here in the San Diego area, that would equate to about 40 minutes on a Hunter MP-Rotator type system. The watering interval on an established landscape is once every 10-14 days, depending on location and exposure. Steep inland slopes may be watered as frequently as every 7-10 days, again depending on exposure. Each watering is meant to mimic a summer thunderstorm or fog drip-well within the tolerance range of most natives. Since native plants are better adapted to our climate, some may also prove to be better at retaining water when irrigated than non-native plants.

Figure 1: Completely clearing all vegetation (healthy chaparral) for hundreds of feet did nothing to save this home; in fact, it may have made the situation worse. Notice the palms are still standing and alive.

Thinning over clearing

In the panic that followed our great San Diego firestorm of 2003, many agencies and insurance carriers required that surrounding property be cleared 100, 200, even 300 feet or more. This meant environmental devastation for huge swaths of land, horrible erosion problems and the establishment of invasive annual grasses and weeds which become flashy fuels by August. Worse still, many homes that had cleared to bare mineral soil for hundreds of feet still burned to the ground, sometimes surrounded by green lawn and palm trees (see Figure 1). As chaparral-ecologist Richard Halsey explains it, by clearing all vegetation "you have created the perfect bowling alley for embers." On the other hand, hardscaping coupled with low growing, hydrated groundcovers and shrubs can disturb

and cool the otherwise uninterrupted flow. Leaving some vegetation while planting other irrigated areas may in fact help prevent structures from igniting.

Zoning and defensible space

Your first 30 feet of defensible space is the most critical (see details on page 46). These first zones are where you want to have a considerable amount of hardscape – flagstone, boulders, pavers, cement, gravel, etc. Plantings should be low in fuel volume and hydrated with once per week watering in my area. Figure 2 shows a home surrounded completely by an 8-foot-wide decomposed granite apron. The plantings immediately outside this zone and for the first 30 feet are hydrated, low growing, and well-spaced. This home survived both the 2003 and 2007 fires.

Figure 2: The 8 foot decomposed granite apron around this house has helped it withstand two major fire events in 2003 and 2007.

Figure 3 shows another view of the same house where the first 30 feet of well-watered plantings are enclosed by a low rock wall. Outside of that perimeter native groundcovers are being irrigated about every 10 days in summer. Note also that in this particular case, a road was constructed around the house approximately 100 feet away. This "country lane" actually doubles as a fire-break which gives access to the fire-fighters. Note also the use of metal roofing to prevent embers from igniting the structure.

With existing chaparral growing in this extended space, we've thinned it by about 50 percent. (Figure 6 and 7 show before and after pictures of this process.) I like to prune up and open their structure when possible. All trimmings are mulched and placed back on the areas that have now been opened up, to help suppress weeds. This is also an opportunity to lace the area with 4-to 5-foot wide paths that further open up the vegetation. One can bring in benches, bird baths, low fuel-volume perennials, signage, and other features to transform once impenetrable chaparral into an inviting, mature native landscape. Figure 6 illustrates this concept. Clearly, the environment does not have to be destroyed in the name of fire safety.

Clearly, the environment does not have to be destroyed in the name of fire safety.

Figure 3: Most of the landscape within 30 or so feet of this home is hardscape and hydrated plantings, which are protected by a wall. The next 30-100 feet are landscaped in hydrated natives, and then a road was constructed around this perimeter that doubles as a firebreak. Note the metal roof.

**Note from the editor: Defensible space experts indicate this excellent property could be improved even further by replacing wood mulch with decomposed granite to further break up contiguous fuel in the 5-30 foot zone.*

Figures 4 and 5: Before and after photos of properly thinned chaparral. The canopy is reduced by about 50 percent, which also removes about 70 percent of the fuel volume. The trimmings are chipped and placed right back as a mulch, which helps discourage weeds from forming.

Good maintenance

Site hygiene is everything when it comes to fire safety.

Site hygiene is everything when it comes to fire safety. Invasive weeds are typically annuals and perennials that are dead or dormant by August. Unlike native chaparral that tolerates intense but infrequent fires, these invaders welcome and promote frequent burning, making it essential to control and remove them.

Controlling annual weeds can be a challenge. Certainly the re-deposition of the mulched tree trimmings helps. Hand pulling may be enough when the weed loading is low enough to permit it. However, with a typical seed bank of 10 to 100 thousand seeds per cubic foot, post and/or pre-emergent chemical treatment may be required. Whatever method is chosen, it is essential that the site be maintained in a clean condition once it has been opened up.

Another important maintenance step is to keep the site at around 50 percent coverage. Trees should be pruned up 6 feet wherever possible. Lower perennials and shrubs should be held to 18 inches when practical. A good rule of thumb is to provide clearance between tree limbs and groundcover that is a minimum of three times the height of the lower plants. All dead wood needs to be removed. In my experience, "stumped" plants can be left to re-grow for up to one year, but they may need to be re-stumped once newer growth starts to become woody.

If your extended zone is devoid of naturally occurring vegetation and is instead planted in irrigated natives, the maintenance should be fairly straightforward. The plants should mostly be lower growing (under 18 inches) and spaced for final size. This prevents plants growing on top of each other and forming a woody thatch.

Firewise planning and planting for home landscaping (5-30 feet from your home)

A number of native plants will tolerate the overhead watering I've discussed in this article. Here in San Diego County, some nice evergreen landscaping shrubs include lower growing manzanitas like the cultivars 'Carmel Sur,' 'Radiant,' 'Emerald Carpet,' and 'Pacific Mist,' as well as medium-sized manzanitas like 'Sunset,' and 'Howard McMinn.' I also like to include lower growing garden tolerant wild lilacs like blueblossom (*Ceanothus thyrsiflorus* var. *repens*), and the cultivars 'Anchor Bay,' and 'Heart's Desire.' Native perennials I enjoy include Wayne Roderick seaside daisy (*Erigeron* 'WR'), Matole river fuchsia (*Epilobium septentrionale* 'Select Mattole') and goldenrod (*Solidago* spp.). Bush monkey flower (*Diplacus aurantiacus*) may be shorter lived under these conditions but will certainly put on a show for the two to five years it survives (just get a new one if it dies). Rocks or well-consolidated "gorilla hair" can be used for mulch, but any bark must be watered down and consolidated immediately after planting.

Your extended zone will ideally consist of either thinned chaparral or lightly hydrated native plantings. I find *Baccharis* 'Pigeon Point,' *Ceanothus* 'Yankee Point,' *Arctostaphylos* 'John Dourley,' and San Diego marsh-elder (*Iva hayesiana*) to be excellent choices if this area is to be planted. A smattering of larger shrubs, like *Ceanothus* 'Blue Jeans' and 'Concha,' the coffeeberry (*Frangula californica*) cultivars, 'Eve Case' and 'Mound San Bruno,' and toyon (*Heteromeles arbutifolia*) are all fine as long as they are situated in groups of three or fewer with about 10 feet between groups. I like to incorporate lots of trails in this area of at least 4 feet in width. Fully established Zone 2 plantings must be irrigated about once every 8-14 days during the warm months with overhead irrigation in order to promote adequate hydration. The possibility of lightly irrigating existing chaparral in Zone 2 (wetting leaves and mulch, not to saturation) is being investigated.

Figure 6: A mature native landscape carved from impenetrable chaparral. Adding bird baths, benches, and other features enhances the experience, and the path creates breaks in fuel.

Not in southern California? Go to Calscape.org to discover native plants best suited to your location.

Recent fires offer unique opportunities to better document California's post-fire flora.

Rare Plants and Fire: Opportunities for Better Understanding

California is one of 36 global biodiversity hotspots, with more types of plants than any other state in the U.S. and more rare taxa than most states have species! Each of our more than 2,300 rare plant species and subspecies is special, and each presents a unique response to fire.

A number of rare plants are able to tolerate and even thrive with wildfires. For example, bulbs such as St. Helena Fawn Lily (*Erythronium helenae*) are generally buried deep enough in the soil to be insulated from the intense heat during a wildfire, and then sprout when the land cools and the rains arrive. In the spring following the devastating Thomas Fire, scientists found populations with thousands of Catalina mariposa lily (*Calochortus catalinae*), far more flowering plants of this sensitive species than seen prior to the fire.

Other rare plants increase in abundance after fires. Some are "fire followers" such as the rare Brewer's calandrinia (*Calandrinia breweri*), a small annual plant that spends most of its life cycle as a tiny seed in the soil seed bank, waiting for the favorable conditions created by fire to promote germination, flowering, and seed dispersal. As habitat conditions change in the years after a fire (e.g., dense chaparral habitat is reestablished), the seeds return again to their secret life in the soil seed bank. Amazingly, plants with tiny seeds like Brewer's calandrinia can be alive and dormant in the seed bank for 80 years or more, a testament to the evolutionary relationship between some plant species and fire. California also is home to an incredible diversity of rare conifer species, such as bishop pine (*Pinus muricata*), Monterey pine (*Pinus radiata*), and Tecate cypress (*Hesperocyparis forbesii*), that actually require fire to melt their sap-sealed cones: Once the glue is melted and cones open, their seeds are released to germinate in the nutrient-rich ash of their burned-out mother tree.

While many rare plants may tolerate or benefit from natural wildfires, even these plants can get too much of a good thing. After fire, plants need a period of recovery: Stems must have time to resprout and recover, underground storage bulbs and tubers must replenish, and parent plants must have time to make seeds to renew the soil seed bank. Should another fire sweep through a site too soon, before populations have rebuilt their natural fire "insurance policies," these rare plants may not recover and populations could be diminished or even extirpated. Thus, while a natural fire regime can benefit rare plants, and prescribed burns may at times be an essential part of the strategy for conserving rare plants, inappropriately-timed and too-frequent fires are threats to persistence of California's rare plants and habitats.

Left: St. Helena fawn lily (*Erythronium helenae*), California Rare Plant Rank 4.2, prolifically blooming post-fire. Photo by Mike Palladini, Land Trust of Napa County

Above Left: Catalina mariposa lily (*Calochortus catalinae*) is a rare southern California endemic bulb seen here in the Ventura Hills following the Thomas Fire of 2017. Its rarity ranking is 4.2, with many of its historic populations in Los Angeles and Orange Counties extirpated by urban development. Photo by Robert Potts, CAS

Above Right: Brewer's Calandrinia (*Calandrinia breweri*), California Rare Plant Rank 4.2, is a widespread but rare post-fire herb. Photo by Nomad Ecology

Mount Piños onion (*Allium howellii* var. *clokeyi*), California Rare Plant Rank 1B.3, found at the same location in northern Ventura County after the Day Fire. Photo by John Game

As climate change alters the environment, and as invasive species and changing fire regimes further stress rare plant populations, we must explore questions like these to better understand, appreciate, and protect these rare and special creatures.

Many questions still need to be answered with regard to California's rare plants and fire, including:

- How does fire severity affect rare species?
- How does fire influence the life spans of seeds in the soil seed bank?
- How does variability in rainfall during the years following a fire affect secondary germination events of these fire followers?

Overall, we know too little about how most rare plant species interact with fire. The randomness of fire, combined with the rarity of these species, means that little is known about rare plant species not directly related to fire-adapted ecosystems. As climate change alters the environment, and as invasive species and changing fire regimes further stress rare plant populations, we must explore questions like these to better understand and protect these rare and special creatures.

What can be done to monitor for rare plants post-fire?

Recent fires offer unique opportunities to better document California's post-fire flora. Particularly, we lack baseline information on post-fire floras in northern California, yet it is clear that these plants represent an important piece of diversity that needs to be considered when managing ecosystems both before and after fire.

There are two major reasons that this is a special opportunity to advance our understanding. First, fires have provided access to land that was previously too overgrown, especially in habitats dominated by chaparral. Second, fires stimulate the germination and growth of plants that may not be abundant in habitats that have not burned. Consequently, the window for learning more is brief and precious. Of course, the fires have also shown all of us the need to care for these natural systems, and generated widespread interest in contributing to the effort, representing another important reason to work now to help landowners in their ongoing effort to more fully understand the lands they steward.

Stinkbells (*Fritillaria agrestis*) and coast iris (*Iris longipetala*) are threatened geophytes, California Rare Plant Rank 4.2, found in limited populations in California. Photo above by Kelly Bougher; right by Debra Cook

CNPS Rare Plant Treasure Hunt (RPTH)

Treasure hunt in post-burn chaparral along Mount Diablo. Photo by Nomad Ecology

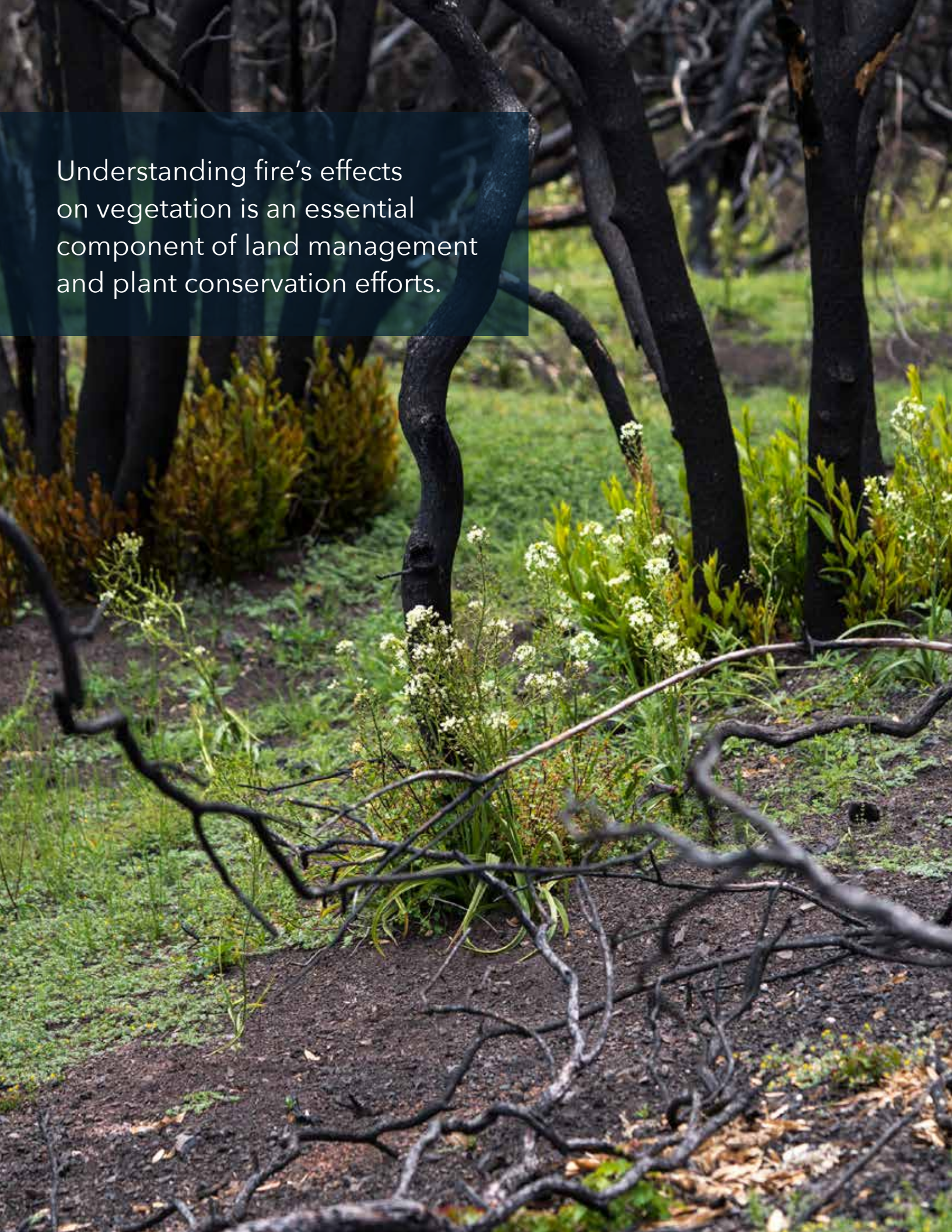
The CNPS Rare Plant Treasure Hunt (RPTH) project is an ambitious initiative that pairs knowledgeable botanists with interested volunteers and community members to go on hunts that last anywhere from an afternoon to a few days. This citizen science effort is a fun and engaging way to learn about local, rare plants, while collecting data and specimens that make a tremendous scientific contribution.

Many CNPS treasure hunts are focusing on burned areas, where special rare plants can be found. Some are only visible in the years immediately following wildland fire, and so will be a valuable opportunity for landowners to discover the special plants they are fortunate to have on their lands. CNPS is providing Rare Plant Treasure Hunts to a limited number of landowners and seeking funding to offer this service to as many as possible. Scientists and volunteers will make a special commitment to serving areas affected by recent fires to gather much needed data on post-fire response of rare plants and to help landowners in their recovery efforts. In addition to mapping rare plants and collecting data, volunteers may also help with the important task of collecting seeds from rare species for the National Laboratory for Genetic Resources Preservation in Colorado, in support of our California Plant Rescue (CaPR) effort to collect and save seeds from every rare plant in California.

Many CNPS Treasure Hunts are focusing on burn areas to gather much needed data on post-fire response of rare plants and to help landowners in their recovery efforts.

If you are interested in hosting a RPTH in your community or would like to apply to host a RPTH team on your land, please contact the CNPS RPTH Coordinator at treasurehunt@cnps.org. CNPS also will train motivated volunteers and conservation groups wishing to adopt a rare plant (or adopt an area where rare plants grow), or wishing to lead their own hunts on an ongoing basis.

Mt. Saint Helena morning glory (*Calystegia collina* subsp. *oxyphylla*), California Rare Plant Rank 4.2. Photo by Robert Sikora



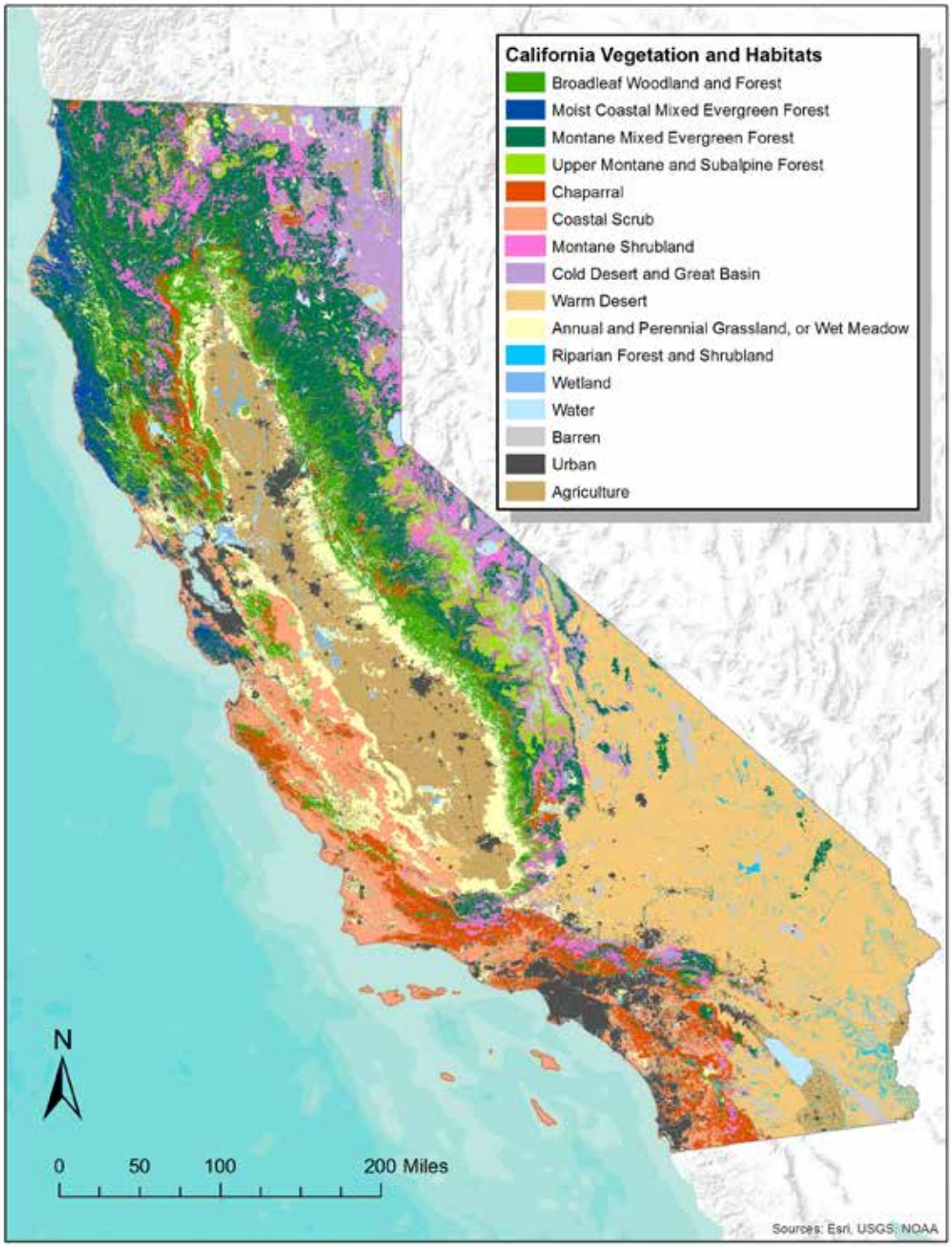
Understanding fire's effects on vegetation is an essential component of land management and plant conservation efforts.

Considerations for California's Habitats

California is one of the most biodiverse places on Earth, home to a range of ecosystems and habitats. Understanding your local habitat and fire's effect on the vegetation is key to land management and plant conservation, particularly in the face of climate change, increased human activity, and newly emerging data. The following pages provide brief overviews of the California habitat types where wildfire occurs. For more information about your location, please contact the local references listed at the back of this guide.

Left: Characteristic resprouting of shrubs after fire. Notice both the resprouting and dark soil rich with seedlings whose germination has been triggered by this fire. Note that these areas have not been seeded; this is all natural recovery. Photo by Lech Naumovich

Right: Data sourced from California Department of Forestry and Fire Protection (CAL FIRE) Fire and Resource Assessment Program (FRAP) Statewide Vegetation with WHR types GIS Data. 2015. Available http://frap.fire.ca.gov/data/frapgisdata-sw-fveg_download



Broadleaf Woodlands & Forests

Above: A view of foothill pine (*Pinus sabiniana*) on the upper, rocky slopes and blue oaks (*Quercus douglasii*) on the deeper, more nutrient rich soils below. Photo by Julie Evens

Right: A blue oak (*Quercus douglasii*) woodland at Peoria Wildlife Area, Tuolumne County. Photo by Julie Evens

Far Right: Burned oak woodland immediately after the 2017 Tubbs Fire in Sonoma County. Photo courtesy of Pepperwood Preserve

Broadleaf Woodlands & Forests

From the Coast Ranges to the Sierra Nevada, Cascade and Klamath Ranges, broadleaf woodlands and forests are found across California. Trees of this ecosystem are typically hardwoods (broadleaved, flowering trees instead of cone-bearing conifers) and include both deciduous and evergreen trees. These woodlands and forests are threatened as increasing human population, development and agriculture make ever more use of wildlands.

Top: An oak *(Quercus douglasii)* tree "stump sprouting" from its base shortly following the 2017 Tubbs Fire in Sonoma County. Photo courtesy of Pepperwood Preserve

Above: Fall colors in a post-fire mixed broadleaf forest with bigleaf maple (*Acer macrophyllum*) and Pacific dogwood (*Cornus nuttallii*), along the South Fork of the American River on a moist-north facing slope. Photo by Jeff Bisbee

Characteristics

- The composition of broadleaf tree communities varies based on proximity to coast, precipitation, elevation, temperature, topography, fire, and other disturbances. Small patches of grasslands or shrublands often occur in a mosaic with this habitat.
- The most common plant communities are oak woodlands. Stands of coast live oak, island oak, Catalina ironwood, and Engelmann oak dominate coastal hills and ranges; interior live oak and blue oak are more common in the interior. Moister, colder areas have black oak, Oregon white oak, canyon live oak, maple, and dogwood. Valley oak grows on alluvial plains.
- Other dominant trees include California buckeye, California bay, foothill pine, tanoak, and madrone.
- Oaks and other broadleaf trees provide valuable habitat for more than 300 wildlife species and at least 5,000 insect species.

Relationship with fire

California's broadleaf forests and woodlands have evolved to survive periodic fires.

- Fires may be frequent with low-intensity, particularly in oak savannah habitats. The burns minimize competition and promote a more open landscape with widely spaced oaks.
- Following fires, many trees go dormant if the canopy has been burned. Minimize removal or impacts to standing trees, as their roots stabilize the surrounding soil.
- Trees can regrow after fire, sending out new leaves when ready. Many trees and shrubs "stump sprout," meaning the tree stump can send out new shoots or branches to renew its life cycle, even if the entire tree was burned.
- Periodic fires are beneficial for oak regeneration. Acorns germinate most successfully where there is litter on the soil surface.
- Oaks, tanoak, and several other hardwood species are at risk of Sudden Oak Death Syndrome (SODS), which may have a complicating effect with fire.
- Native Californians set small, intentional fires in oak woodlands to help suppress insect pests that infest acorns, clear out duff and brush, and promote the cover of edible grasses and other useful understory plants.

Lower-Elevation Chaparral

Above: A California endemic, fire poppy (*Papaver californicum*), and phacelia (*Phacelia* spp.) grow alongside resprouting oaks (*Quercus* sp.) a year after the 2016 Loma Fire in Santa Clara County. Photo by Jake Schweitzer

Above Insert: A fire poppy (*Papaver californicum*) in bloom after the 2013 Morgan Fire in Contra Costa County. Photo by Heath Bartosh

Right: A characteristic resident of chaparral, the California thrasher, is found only in California and northern Baja California. Photo by Brad Schram

Far Right: Whiteleaf manzanita (*Arctostaphylos viscida*), chamise (*Adenostoma fasciculatum*) and wedge leaf ceanothus (*Ceanothus cuneatus*) are the most common chaparral types in the Sierra Nevada foothills. Photo by Julie Evens

Lower-Elevation Chaparral

Chaparral is a general term to describe woody, drought-adapted evergreen shrubs, typically with small, leathery leaves. Chaparral covers approximately 5 percent of California and mostly occupies the lower elevation mountains of California. A rare variety of chaparral occurs only along the coasts and is referred to as maritime chaparral.

Top: Whispering bells (*Emmenanthe penduliflora*) is one of California's most common and prolific fire followers. Photo by Heath Bartosh

Above: Chaparral in recovery after burning in the 2009 Station Fire, Los Angeles County. Photo Carole Scurlock

Characteristics

- Chaparral contains a great richness of shrubs, such as chamise, various shrubby oaks (scrub oak, interior live oak, canyon live oak), manzanita, lilac bush, lemonade berry, toyon, black sage, and birch leaf mountain mahogany among many others.
- Various species assemblages with slightly different ecological niches sort based on proximity to coast, precipitation, topography, geology, and geography.
- Chaparral forms relatively open to very dense stands usually along slopes and ridges, especially on nutrient poor soils.

Relationship with fire

The natural fire return interval in chaparral is about 30 to 100+ years, and plants are adapted to recover from infrequent fires (>30 years). Fire frequency has a profound effect on the species composition and geographic extent of this vegetation type.

- Chaparral is one of the most fire adapted plant communities in North America. Closed canopy stands are flammable and can burn at high intensities, especially if ignited during late summer or early fall when hot, dry Santa Ana or Diablo winds spread fires quickly.
- A dynamic post-fire relationship occurs where annual and herbaceous "fire followers" emerge from the soil after the chaparral canopy has been burned away. Their seeds can lie dormant in the soil for decades (even a century), and germinate when prompted by fires – either through heat or chemical changes. Several short-lived, opportunistic plants are locally rare and are only seen the first few years after a fire.
- Unfortunately, invasive annual grasses can also colonize chaparral stands after fires, especially if the fire return interval in a stand is less than 30 years.
- Certain chaparral shrubs can resprout from underground ligno tubers or "burls" after fire, while others are obligate seeders, meaning they reproduce by seeds only.
- Statewide, we are tragically losing chaparral because urbanization and human activity have increased ignition events in and near wildlands.
- With repeated, frequent fires (around every 15 years or less), chaparral habitat will shift to other, more fire-prone weedy species. This is because resprouting shrubs use up their energy reserves, while seeding shrubs don't reach reproductive age and are unable replenish their seed sources.

Coastal Scrub

Above: Coastal scrub near the ocean, here along the Monterey coast, includes seaside woolly sunflower (*Eriophyllum* spp.), buckwheats (*Artemisia californica*), California sagebrush (*Artemisia californica*), and many others. Photo by Julie Evens

Right: Allen's hummingbirds breed in a narrow strip of coastal scrub and chaparral along the Pacific Coast in California and southern Oregon. Photo by Brad Schram

Far Right: San Diego golden eye and nonnative red brome (*Bromus madritensis* subsp. *rubens*) in post-burn coastal scrub. Photo by Todd Keeler-Wolf

Coastal Scrub

Coastal scrub occurs prolifically along California's coastlines and extends inland along corridors of maritime climate influence. A diversity of shrubs exist in different combinations depending on variations in precipitation, exposure, proximity to the ocean, soil texture and disturbance. Coastal scrub is often interspersed with other coastal vegetation types including coastal prairies, maritime and inland chaparral, estuaries, dunes, beaches, and conifer stands.

Top: California sagebrush (*Artemisia californica*) and California buckwheat (*Eriogonum fasciculatum*) are two common drought-deciduous shrubs, co-occurring on south facing slopes in southern California. Photo by Todd Keeler-Wolf

Above: Wildflowers after a fire. Many of these species require a fire to germinate. Photo by Allan Schoenherr

Characteristics

- Coastal scrub plants are well adapted to California's Mediterranean climate. Many species can tolerate high winds and salty air from ocean spray. Some species are drought-deciduous and can drop their leaves in the summer to avoid drying out.
- Dominant or co-dominant shrub species include California sagebrush, coyote bush, coffee berry, blue blossom and poison oak. Additionally, California buckwheat, white sage, black sage, mock heather, chamise, bush monkeyflower, golden yarrow and yellow bush lupine are common as well.
- Coastal scrub is one of the most diverse groupings of plant communities in central and southern California, providing habitat for rare and uncommon plants and animals.

Relationship with fire

Along the coast, the influence of summer fog serves to mitigate summer heat. Nonetheless, fires are an important natural factor influencing the nature of coastal scrub, and most species have evolved to survive fire. Fire return intervals vary greatly (15 to 50+ years) between sites along the coast, or even among sites within a single location.

- Coastal scrub response to fire is highly variable. In some sites, lack of fire results in conversion to forest; in other sites, coastal scrub persists unchanged without fire. In other cases, fire converts natural shrubland into weed-dominated grassland.
- Some coastal scrub plants, such as California sagebrush, can weakly resprout after fires, but most regenerate through seed germination from the seed bank.
- Stands usually recover after low intensity / low frequency fires, but increased frequency or severity will eliminate native shrubs. With frequent fires, diverse coastal scrub is replaced by invasive annual grasses or forbs, providing biomass to fuel future fires.
- In natural fire cycles, short-lived annual wildflowers can dominate the landscape, and geophytes (plants with underground bulbs or reserves) reappear in great numbers after a fire. Short-lived perennial shrubs will germinate from seeds and dominate the landscape for a few years.
- Human development, increased nitrogen-deposition from human pollution, and proliferation of non-native invasive grasses are great threats to coastal scrub habitat.

Cold Deserts including Great Basin Shrublands

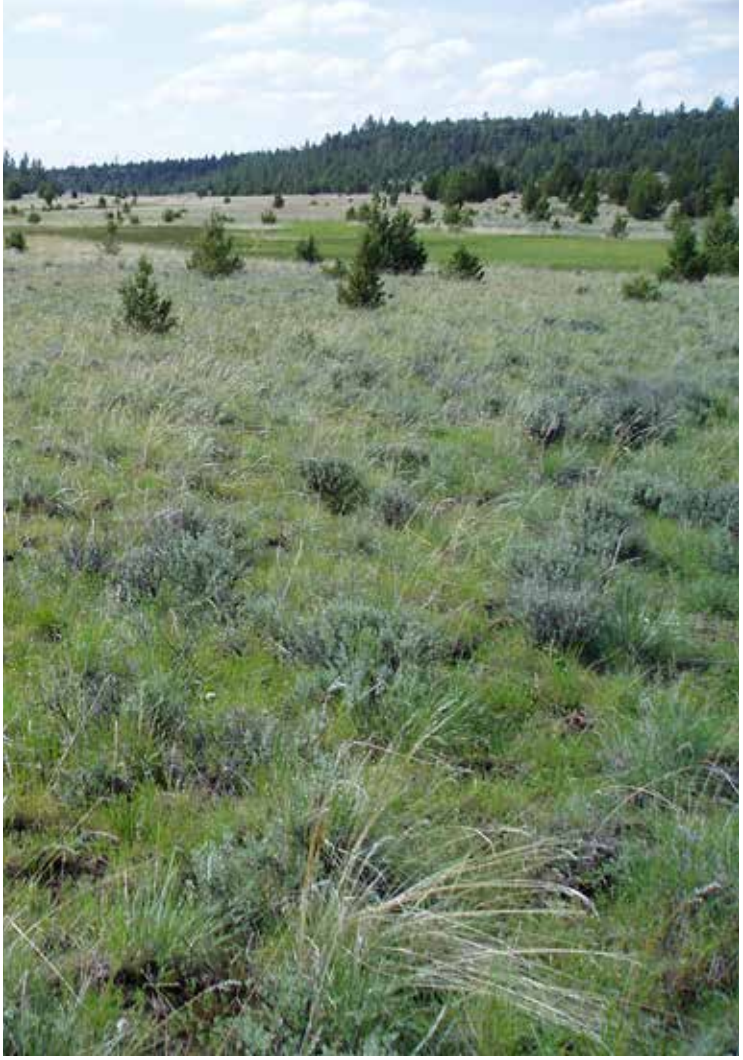
Above: Western juniper (*Juniperus occidentalis*) and curl leaf mountain mahogany (*Cercocarpus ledifolius*) above Eagle Lake near Fredonyer Peak on the Modoc Plateau. Photo by Robert Wick

Right: The greater sage-grouse is completely dependent on sagebrush steppe vegetation for foraging and nesting. Populations have sharply declined as a result of habitat degradation. Today, greater sage-grouse is the focus of sagebrush (*Artemisia tridentata*) habitat restoration across the West. Photo by Robert Wick

Far Right: Cheatgrass (*Bromus tectorum*) invasion promotes frequent fires that eliminate woody shrub species. Photo by Peter Weisberg

Cold Deserts including Great Basin Shrublands

The cold desert regions of California are predominately in the eastern and northeastern parts of the state and include portions of the southern Great Basin and Modoc Plateau. The term cold desert means that most precipitation falls in the form of snow. Although dry, these areas support a wide diversity of vegetation types and are most broadly characterized by bitterbrush and sagebrush steppe, alkaline lakebeds, and conifer woodlands.



Top: Encroachment of western juniper trees (*Juniperus occidentalis*) in sagebrush steppe with curly blue grass (*Poa secunda*) and Idaho fescue (*Festuca idahoensis*). The western juniper trees seen here in the Fitzhugh Creek Wildlife Area are all less than 15 years old. Photo by Todd Keeler-Wolf

Above: Alkaline lakeshores along Mono Lake include bulrushes (*Schoenoplectus* spp.), rushes (*Juncus* spp.), saltgrass (*Distichlis spicata*), Nuttall's alkali grass (*Puccinellia nuttalliana*), greasewood (*Sarcobatus vermiculatus*), rabbitbrushes (*Ericameria* spp.), to name a few. Photo by Jeff Bisbee

Characteristics

- The dominant vegetation type of cold deserts, bitterbrush and sagebrush steppe, is a complex of multiple plant communities, including various sagebrush species and subspecies, often with combinations of other shrubs, grasses, and forbs.
- Steppe communities support drought-adapted native bunchgrasses like Idaho fescue, squirreltail, Indian ricegrass, and ashy ryegrass along with numerous wildflower species, including fleabane, desert parsley, balsam root, buckwheats, and clover.
- At mid elevation, conifer woodlands include Utah juniper, western juniper, and single leaf pinyon pine. At higher elevations white fir, Jeffrey pine, and Washoe pine are common.
- Alkaline lakebeds and riparian areas host assemblages of sedges, rushes, willows, saltgrass, mat muhly, curly blue grass, and forb species.
- Although this habitat is largely undeveloped, many of its plant communities have been altered or degraded by livestock, feral horses, invasive plants, western juniper expansion and altered fire regimes. Overgrazing can greatly reduce the abundance of native perennial grasses.
- One of the most serious threats to sagebrush steppe is the invasion of cheatgrass, medusa head grass, and other harmful and noxious species.
- Western juniper has greatly expanded since the mid-1800s due to grazing, fire exclusion, and climate change. This expansion can result in lower cover and diversity of native shrubs and herbs and may reduce forage for wildlife and livestock.

Relationship with fire

The invasion of cheatgrass and medusa head grass have changed this habitat's historic fire regime by creating continuous fuels that encourage more frequent, higher severity fires. This has drastic effects on bitterbrush and sagebrush steppe and other vegetation.

- Pinyon pine, sagebrush, and other shrubs like bitterbrush and curl leaf mountain mahogany are slow to recolonize after fires. Frequent fires cause shrublands and woodlands to convert into invasive annual grasslands, reducing the biodiversity of cold deserts.
- Over time, western juniper trees in northeastern California become dense, closed stands with virtually no understory. These stands are especially prone to high severity, stand replacing fires.

Annual & Perennial Grasslands, Vernal Pools and other Meadows

Above: At the Arena Plains Unit of Merced National Wildlife Refuge, tidy tips (*Layia* spp.) and various other forbs form swathes in shallow vernal pools. Photo by © Gary R. Zahm

Right: Kangaroo rats rely on grasslands for the grass and forb seeds that make up their diets, shown here at Lokern Ecological Reserve in Kern County. Photo by Christine Van Horn Job

Far Right: Grasses regenerating shortly after the 2017 Tubbs Fire, Sonoma County. Photo courtesy of Pepperwood Preserve

Annual & Perennial Grasslands, Vernal Pools and other Meadows

Annual and perennial grasslands are economically and ecologically important areas of California. Grasslands can be any association of perennial, annual, native, and invasive grasses mixed with other herbaceous plants. Broadly, coastal prairies, upland grasslands, and meadows occur along terraces, hills, slopes, and flats, while vernal pools and wet meadows occur in low-lying areas that collect water.

Top: Coastal prairie with tufted hair grass (*Deschampsia cespitosa*) and Douglas iris (*Iris douglasiana*) in Marin County. Photo by Todd Keeler-Wolf

Middle: The barn meadow at Pepperwood Preserve was filled with California poppies (*Eschscholzia californica*), cream cups (*Platystemon californicus*), and soap plant (*Chlorogalum pomeridianum*) only a few months after the 2017 Tubbs Fire. Photo courtesy of Pepperwood Preserve

Bottom: A grassland of invasive ripgut brome (*Bromus diandrus*) and purple false brome (*Brachypodium distachyon*) creates a vegetation mosaic with blue oak (*Quercus douglasii*) woodlands in Napa County. Photo by Todd Keeler-Wolf

Characteristics

- California's grasslands are often thought to be dominated by invasive plants, but the relative cover changes during the growing season and over time.
- Grasslands harbor a tremendous richness of native grasses and forbs, such as needlegrasses, creeping rye grass, wild-ryes, bromes, fiddlenecks, poppies, buckwheats, goldfields, and popcorn flowers to name a few.
- Coastal prairies are grasslands on coastal terraces featuring California oat grass, fescues, tufted hair grass, and forbs like Douglas iris, California buttercup, suncups, and wavyleaf soap plant. Moist and wet meadows at higher elevations host related or similar species to coastal prairies.
- Prairies with perennial grasses often occur where soils are deep and well-drained. Annual grasslands vary floristically depending on soil depth, texture, and substrate.
- Vernal pools are seasonal wetlands of plants adapted to different lengths of water inundation. Plants flower sequentially as pools dry in the spring. An estimated 80-90 percent of vernal pool habitat in California has been lost due to hydrologic alterations, agricultural conversion, or development. Several vernal pool species are federally endangered.

Relationship with fire

Grasslands and meadows are productive habitats, often with thatch from previous years providing fuel for wildfires. Fires generally pass quickly through these communities and can cover large areas but with low intensity.

- Native grasses can respond favorably to nutrients added to the soil by fire, especially following winter rains. Native perennial grasses are often the earliest species to start growing again.
- Wildflowers and geophytes (plants with bulbs or other belowground storage) bloom prolifically after fires, including many species of poppy, larkspur, lupine, paintbrush, goldfields, wild hyacinth, and mariposa lily.
- Native Americans historically burned grasslands to encourage plants used for food and materials, discourage brush or tree encroachment, and increase forage for game animals.
- Unfortunately, the same nutrients that enhance native grasses also provide an advantage to fast-growing, weedy plants. In some cases, they can outcompete native plants after fires and reduce biodiversity, wildlife habitat, and wildflower displays.

Coastal, Moist Mixed Evergreen Forests and Closed-Cone Forests

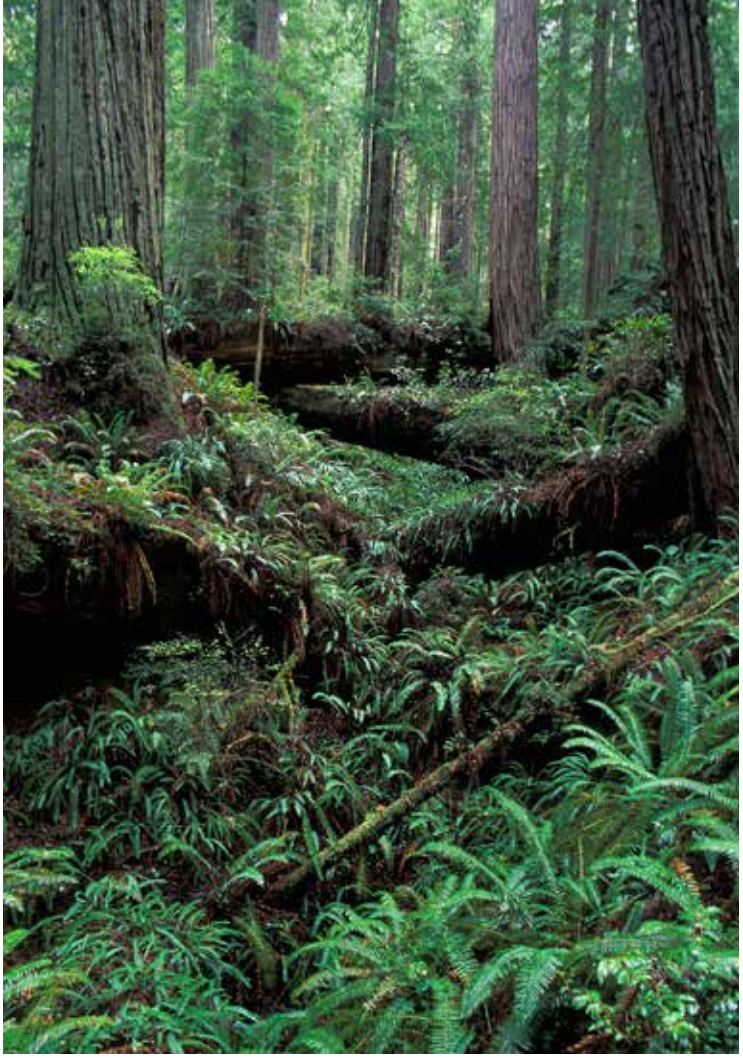
Above: An extensive Douglas-fir (*Psuedotsuga menziesii*) and tanoak (*Notholithocarpus densiflorus*) forest along the North Coast. Photo by Robert Wick

Right: Female northern spotted owl near Korbel, Humboldt County. Photo by Mark Herse

Far Right: Madrone (*Arbutus menziesii*) resprouting after the Martin Fire at Bonny Doon Ecological Reserve, Santa Cruz County. Photo by Neal Kramer

Coastal, Moist Mixed Evergreen Forests and Closed-Cone Forests

Moist forests along the northern and central California Coasts are often dominated by evergreen, conifer trees with mixed hardwood trees and variable understories. Like most habitats in California, the species composition and density depends on available moisture, topography, and time since disturbance. Fire suppression, human development, logging, and resource extraction have put these forests at risk.



Top: Moist, redwood (*Sequoia sempervirens*) forests occur on ridges, slopes, and alluvial flood plains. Photo by Robert Wick

Above: An even-aged bishop pine (*Pinus muricata*) forest in the natural area at the Mendocino Coast Botanical Gardens. Photo by Teresa Sholars

Characteristics

- Iconic trees like coast redwoods and Douglas-fir are evergreen conifers. (They retain their leaves year-round and bear seeds in cones.) Mature forests can be dense and multi-layered with hardwoods like tanoak, live oaks, California bay, dogwood, hazelnut, and madrones in the mid-stories.
- Closed-cone pine and cypress forests occur in pockets of low-nutrient soils along the coast of California. Species include Bishop pine, knobcone pine, Mendocino cypress, Monterey pine and cypress, Santa Cruz cypress, Sargent cypress, McNab cypress, and Torrey pine.
- Much of the available moisture in these areas comes in the form of fog. Trees comb water out of the air that coalesces into larger droplets and falls to the ground. In redwood forests, this phenomenon is known as fog drip and can account for up to 30 percent of annual moisture.

Relationship with fire

Fire is the primary disturbance in moist, coastal forests; however, fire interval and severity are highly variable depending on environmental site conditions. Although many trees have evolved adaptations to fire, high severity fires can shift forest composition and structure.

- Redwoods are fire resistant: They can resprout from trunks, branches, stumps or roots. As trees grow older, thick bark protects them from serious fire damage. In old-growth forests, as found in Armstrong Redwood State Reserve or Redwood National and State Parks, fire scars from historic fires are often visible on mature trees.
- Other common trees like tanoak and madrone are also adapted to resprout after fires.
- Closed-cone pine and cypress forests require fire to regenerate. Many of these trees hold their seeds in cones in the tree canopy, and the seeds are released under certain conditions. For example, high temperatures during a fire will break down the resin that binds cones shut. Only then do the seeds fall to the ground where they can grow in open soil. Likewise, closed-cone pine and cypress forests are typically single-aged because the trees germinate and grow following the same event.
- Sites where invasive woody shrubs like French broom have invaded pose a greater risk of fire due to the added fuels. Fires often burn these areas with high intensity and can result in high tree mortality.

Montane Shrublands

Above: Mountain whitethorn (*Ceanothus cordulatus*) chaparral as a late successional community in Placer County. Photo by Jeff Bisbee

Right: Tobacco brush (*Ceanothus velutinus*) and other montane chaparral shrubs in Mono County. Photo by Jeff Bisbee

Far Right: Post-burn deer brush (*Ceanothus integerrimus*) chaparral with emerging ponderosa pine (*Pinus ponderosa*), California black oak (*Quercus kelloggii*), and other trees above Highway 50 in El Dorado National Forest. Photo by Julie Evens

Montane Shrublands

Montane chaparral and shrublands are found on ridges and slopes of the Coast Ranges, Sierra Nevada, Southern Cascades and Klamath Mountains. Shrubs form stands in forest openings (caused by fires, logging or other disturbances) and on shallow soils or rocky outcrops. Montane shrublands can be a stable plant community, but it is often a transitional short-term stage after disturbance that eventually transitions back into montane or subalpine forest.

Top: Montane chaparral dominated by tobacco brush (*Ceanothus velutinus*) as an early successional community, where the overstory forest burned in Plumas National Forest. Photo by Julie Evens

Above: Huckleberry oak (*Quercus vacciniifolia*) chaparral covers huge swathes of the rocky, granite slopes below stands of Shasta fir (*Abies magnifica* var. *shastensis*) in the Trinity Alps Wilderness, Trinity County. Photo by John Sawyer

Characteristics

- In general, montane shrublands occurs where environmental conditions such as soil depth, slope, moisture, disturbance, and geology are unfavorable for forest vegetation.
- Common dominant montane shrublands shrubs include green leaf manzanita, pinemat manzanita, mountain whitethorn, deer brush, tobacco brush, bush chinquapin, bitter cherry, Brewer oak, and huckleberry oak. Many of these plants are also found as scattered, understory shrubs in forests.
- Nitrogen fixing chaparral shrubs such as lilacbush, alder, and lupine improve the soil for other plants.
- Manzanita berries are a valued food source for wildlife, while lilac bush is an important host plant for pollinators.

Relationship with fire

Montane shrublands were historically more widespread in the state, but no-burn policies of fire suppression during the 20th century decreased its extent. Now that widespread wildfires have burned thousands of acres of forest, many areas will regenerate as montane shrublands.

- After fires, most montane shrublands shrubs will regenerate rapidly (within weeks) from seeds or resprouting. Depending on the species, dense stands can develop in as little as five years.
- During long intervals without fire, conifers may replace the shrub community, but repeating high-severity fires will maintain chaparral shrublands.
- Stands of montane shrublands can ignite and damage nearby trees, or may act as ladder fuels bringing a ground-level fire up into the forest canopy.
- Ecologically, fire releases soil nutrients and creates openings in the forest. As trees begin to replace montane shrublands, they form a complex arrangement with shrubs and herbaceous plants that provides habitat for many birds, deer and other herbivores, rodents, and insects attracted to the post-burn landscape.

Montane Mixed Evergreen Forests

Above: At higher montane elevations in the Sierra Nevada, such as near Ebbetts Pass, open woodlands of Jeffrey pine (*Pinus jeffreyi*), incense cedar (*Calocedrus decurrens*), white fir (*Abies concolor*), and red fir (*Abies magnifica*). Photo by Julie Evens

Right: A young fisher, near Kings River in Fresno County. Fishers prefer dense, structurally diverse forests at lower elevations. Photo by Zane Miller

Far Right: A classic mixed conifer forest of white fir (*Abies concolor*), sugar pine (*Pinus lambertiana*), and incense cedar (*Calocedrus decurrens*) grow along the west side of Lake Tahoe. Photo by Jeff Bisbee

Montane Mixed Evergreen Forests

Between 1,000 to 3,000 meters (3,000 to 6,000 feet) above sea level, a suite of mixed conifers blanket the slopes and ridges of the Coast Ranges, Sierra Nevada, Southern Cascades, and Klamath Mountain ranges. Mixed means that stands vary in dominant tree species, and multiple species may be dominant in a given area.

Top: At lower montane elevations, incense cedar (*Calocedrus decurrens*), ponderosa pine (*Pinus ponderosa*), white fir (*Abies concolor*), and patches of shrubs form an open canopy mixed conifer forest, here in Yosemite National Park. This forest has a mixed fire regime and various aged trees; fire scars are visible on some of the mature trees. Photo by Jeff Bisbee

Above: The Rim Fire was a dynamic firestorm in Stanislaus National Forest that burned for a year, starting in the summer of 2013. Photo provided by the U.S. Department of Agriculture

Characteristics

- California's mixed conifer forests are characterized by six primary species: ponderosa pine, Douglas-fir, incense cedar, sugar pine, white fir, and giant sequoia. Giant sequoias are among the largest and longest-living organisms ever to exist Earth.
- Beneath the conifer canopy is an open sub-canopy of hardwoods like black oak and dogwood. Next is a layer of evergreen shrubs like green leaf manzanita, shrub chinquapin, and others. At the ground level, short shrubs like pinemat manzanita, mountain misery, and mahala mat mix with perennial grasses and forbs. These structurally complex forests provide habitat for a high diversity of birds, mammals, and other wildlife.
- Mixed conifer forests are expected to move up in elevation as a result of multi-year drought in combination with pest or insect damage and effects of climate change.

Relationship with fire

A century of fire suppression in California's mixed evergreen forests has displaced the natural fire regime of smaller, lower intensity fires (approximately every 25 years). Under a no-burn policy, these forests have been strongly and adversely affected.

- Historically, Native Californians regularly set small fires in forest understories manage brush, promote the growth of wildflowers and native grasses, and to make hunting and traveling easier.
- Over time, fuel and thickets of shrubs or small trees accumulate which create wildfire hazards. When dense forests ignite, fires can burn at high intensity and travel quickly.
- High intensity fires, which kill most adult trees, will result in areas of the fire footprint reverting to brush or shrubland. These areas are more susceptible to repeat fires.
- Mixed and moderate intensity fire can regenerate forest structure. For instance, heat from surface fires is required to open giant sequoia cones. Surface fires also remove litter, which allows seeds to grow.
- Fuel breaks, prescribed fires, selective clearing of brush and debris, and fire-wise building materials are a few strategies to discourage high intensity fires in forests.
- After a fire, dead, standing trees provide important habitat for wildlife; their roots stabilize the soil, decreasing the risk of erosion.

Riparian Forest & Shrubland

Above: The sun rises over classic riparian habitat at the Cosumnes River Preserve in Galt. Photo by Malcolm O'Keeffe

Right: Riparian vegetation and streams provide important habitat for native fish, such as this wild rainbow trout in the Yuba River. Photo by Roger Bloom

Far Right: The Colorado Desert supports incredible riparian - dry wash woodlands, including smoke tree (*Psorothamnus spinosus*) in a wash east of the Eagle Mountains. Photo by Julie Evens

Riparian Forest & Shrubland

Riparian communities include woodlands or shrublands along streams, rivers, or floodplains and are found in every region of California. Formerly, riparian habitats were extensive along rivers and streams, especially in the Great Valley, but human impacts from channelization, agriculture, urban development, livestock grazing, mining, and dams have drastically impacted their quality and extent. Today, riparian areas are sensitive communities since they are mostly restricted to narrow and fragmented channels. Related habitats include marshlands and herbaceous floodplains.

Top: Riparian vegetation often acts as a buffer to wildfire, as shown here where the south aspect burned to the creek edge. Photo by Sasha Berleman, Audubon Canyon Ranch

Middle: Along many streams of the Sacramento and San Joaquin Valleys, including here along Thomes Creek, Fremont cottonwood (*Populus fremontii*) forests line the steam banks. Photo by Todd Keeler-Wolf

Bottom: Red alder (*Alnus rubra*) forest with an understory of western sword fern (*Polystichum munitum*) and slough sedge (*Carex obnupta*) along Ossagon Creek, Redwood National and State Parks. Photo by Andrea Pickart

Characteristics

- The species composition of riparian vegetation is dependent on the amount and frequency of water flows, proximity to the coast, elevation, temperature, and topography.
- Riparian areas can be forests or woodlands in stable environments, while riparian shrublands are usually on stream banks or in the active floodplain.
- Cismontane riparian trees include cottonwood, sycamore, willows, buckeye, alder, aspen, and birch. Riparian shrublands include California grape, mule fat, poison oak, scalebroom, blackberry, wild rose, elderberry, and willow, among many others. Desert wash woodlands include blue palo verde, ironwood, desert-willow, smoke tree, mesquite, and catclaw acacia.
- Riparian areas are also home to a diversity of sedges, rushes, grasses, ferns, and herbs, including mugwort, elk's clover, coltsfoot, yerba mansa, columbines, and mustards.
- Invasive species like giant reed, perennial pepperweed, and tamarisk have a huge effect on riparian systems, invading waterways, altering flooding regimes, and changing water availability for native vegetation.
- Riparian areas are crucial for wildlife, including sensitive fish species like coho, chinook, and steelhead salmon. Other animals rely on this habitat for water, food, dwellings, and migration.

Relationship with fire

Due to its characteristic moisture, riparian habitat rarely burns severely, unless its been infested with weeds. Historical fire return intervals are moderate to long (15 to 70+ years) with flood rather than fire being the major disturbance.

- Various riparian trees, shrubs, and herbs can resprout after a fire or other disturbance.
- Invasive tamarisk in desert riparian areas adds surface fuels, increasing fire intensity and shortening fire intervals to 10 to 20 years.
- Giant reed also increase fuel and fire intensity, especially in southern California and the Central Valley. Shorter fire internals lead to continued post-fire dominance of giant reed.
- When fire removes vegetation from a watershed, erosion into streams and rivers can become a major threat for riparian areas. Sediments, ash, toxic chemicals, or other debris from upslope/upstream can have long-lasting consequences, particularly for fish and other aquatic wildlife.

Upper Montane & Subalpine Evergreen Forests

Above: Foxtail pine (*Pinus balfouriana*) in the subalpine zone, Inyo County. Photo by Jeff Bisbee

Right: Clark's nutcracker is the essential seed-disperser for limber pine (*Pinus flexilis*) and whitebark pine (*Pinus albicaulis*). The nutcracker caches seeds at the tree base, and when forgotten, the seeds grow up into tight clusters of several trees. Photo by Ron Wolf

Far Right: The upper montane zone accumulates more snow than any ecosystem in California. The yellow wolf lichen (*Letharia vulpina*) on these red firs (*Abies magnifica*) cannot survive below the average snowpack depth. Photo by Robert Wick

Upper Montane & Subalpine Evergreen Forests

Upper montane forests occur at elevations of roughly 6,500 to 8,500 feet (2,000 to 2,600 meters). In this zone, vegetation is usually a single canopy layer, and representative plants differ from lower montane, mixed evergreen forests. The subalpine zone is defined by elevations from 8,500 to almost 11,000 feet (2,600 to 3,300 meters), where scattered clumps of trees form open woodlands.

Top: Western mountain hemlock (*Tsuga mertensiana*) in subalpine northerly-facing slope of LeConte Canyon, Kings Canyon. Photo by Julie Evens

Above: Krummholz growth form of whitebark pine (*Pinus albicaulis*) on the Dana Plateau. Photo by Todd Keeler-Wolf

Characteristics

- Upper montane forests of the Sierra Nevada and Cascade ranges have the deepest and longest lasting snow packs of any place on the west coast of North America. The growing season here is only four to six months of the year.
- The most common upper montane tree species are red fir, lodgepole pine, western white pine, Jeffery pine and mountain juniper.
- In the subalpine zone, the growing season is only about three months long.
- Characteristic subalpine conifer trees include whitebark pine, foxtail pine, limber pine, and mountain hemlock.
- At the elevation limit for tree growth, trees become shorter and shorter until they grow into a low, hedge-like form due to heavy snow packs and intense winds. This form is known as "krummholz," from a German word that means "crooked wood." Whitebark pine is the most common krummholz conifer in California.
- Birds or small mammals cache seeds each season. If the cache is forgotten, the seeds will germinate and grow into dense clumps of several trees.
- Diseases such as white pine blister rust (caused by an invasive, introduced pathogen) and pests like (native) pine beetles threaten upper montane and subalpine forests.

Relationship with fire

Unlike lower elevation plant communities, upper montane and subalpine forests are not invigorated by surface fires. Fires are most commonly ignited by lightning strikes, but usually burn only small isolated patches because vegetation is often too sparse to carry fire.

- In upper montane forests, the fire return interval is long, typically 50+ years. This is approximately double that of the lower, montane mixed conifer forests.
- In subalpine forests, there is essentially no fire regime. However, when fires do occur the complexity and severity is variable.
- Tree mortality from insects, disease, and climate change has the potential to alter the fire regimes in these high elevation areas.

Warm Desert / Mojave, Sonoran, Coloradan Deserts

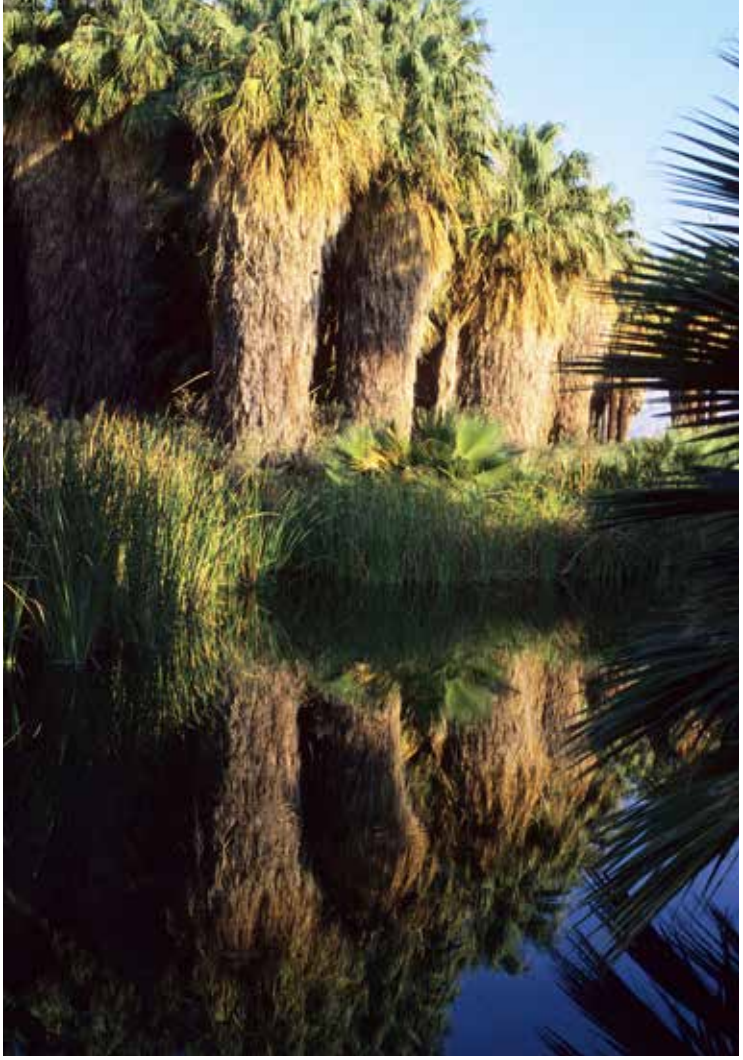
Above: Creosote bush (*Larrea tridentata*) and white bursage (*Ambrosia dumosa*) scrub is the most widespread vegetation type in the region. Photo by Julie Evens

Right: A federally threatened desert tortoise (California's state reptile) with native annual wildflowers: evening primrose (*Eremothera boothii*), desert dandelion (*Malacothrix glabrata*), and pincushion flower (*Chaenactis* sp.). Photo by Todd Keeler-Wolf

Far Right: Representative of the Mojave Desert are island-like mountains interrupting massive bajadas and alluvial fans with semi-desert vegetation, including creosote bush (*Larrea tridentata*), brittle bush (*Encelia farinosa*), and white bursage (*Ambrosia dumosa*). Photo by Julie Evens

Warm Desert / Mojave, Sonoran, Coloradan Deserts

The Sonoran-Colorado and Mojave deserts of southeastern California are comprised of broad alluvial fans that drain into dry lakes. These basins are separated by pronounced mountain ranges, which act as ecological islands. Complex geology and topography create great variations in elevation, temperature, and precipitation; these factors influence the diversity of desert plant life. Sparse creosote bush and white bursage scrub is the most ubiquitous vegetation type, but mesquite woodlands, saltbush scrub and shifting sand dunes are also common across the region.



Top: California fan palm (*Washingtonia filifera*) oasis. Photo by Allan Schoenherr

Above: Joshua tree woodlands (*Yucca brevifolia*), including this resprouting variety, can be found in mid elevations of the Mojave desert. Photo by Julie Evens

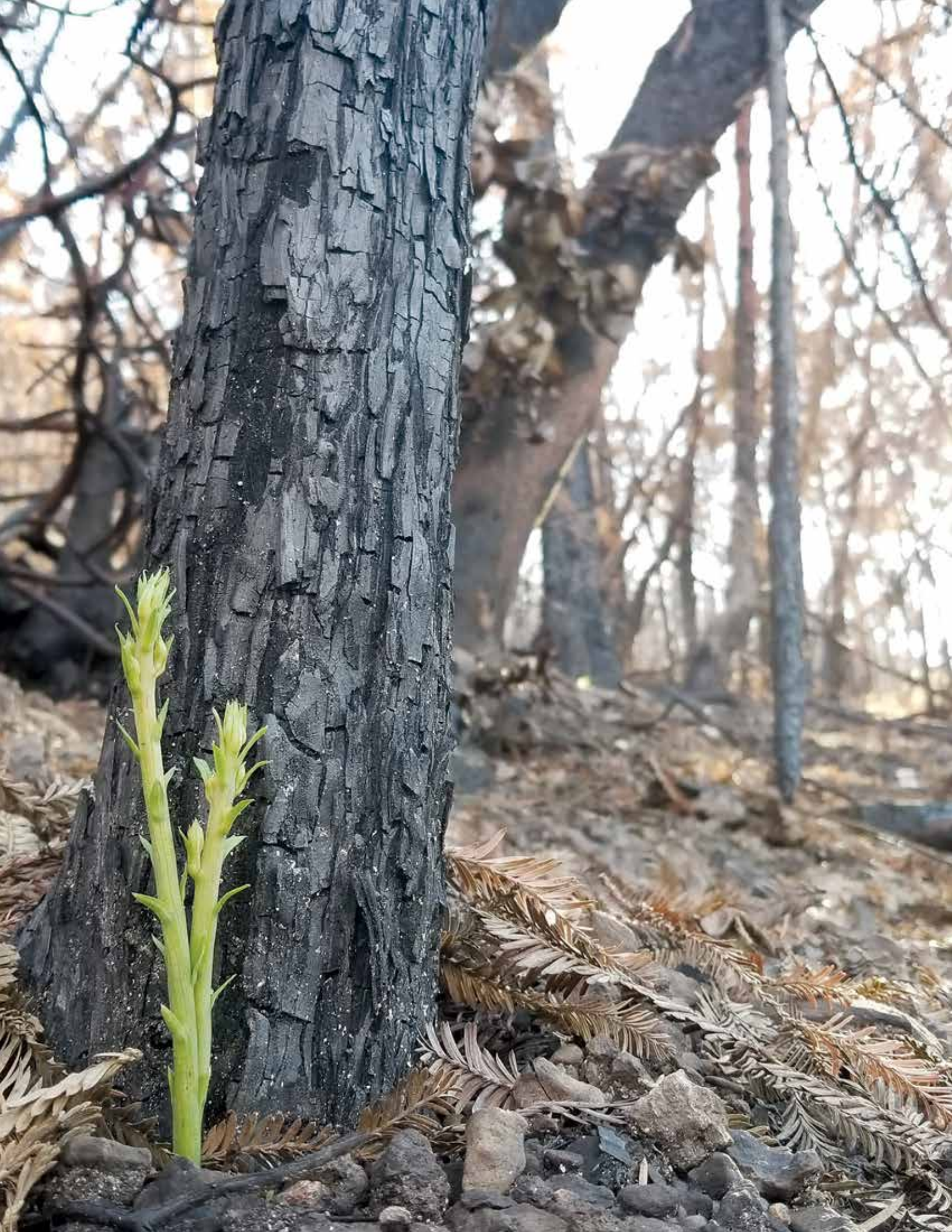
Characteristics

- The warm deserts of California have a high number of endemic species (native species that only occur in a specific area) compared to most ecoregions of the United States.
- The Colorado and Sonoran Deserts have well-developed wash woodland and shrubland vegetation, which include species such as blue palo verde, smoke tree, desert willow, and chuparosa. Invasive tamarisks outcompete these native species for water and threaten their sensitive habitats, sometimes referred to as microphyll woodlands.
- The Mojave region is a "semi-desert" with higher rainfall and more vegetation than true deserts and has predominantly shrubby vegetation of varying density.

Relationship with fire

Fires are relatively uncommon and isolated in California's warm deserts. However, introduced species can change the fire regime, thereby altering plant composition, density and distributions.

- California fan palm oases are one of the few desert habitats that are adapted to fire: Lightning strikes ignite small, localized fires that burn understory vegetation without killing mature trees. This process increases surface water and allows palm seedlings to establish without competition.
- Invasive annuals plants (e.g., Sahara mustard, red brome, Mediterranean grass), leave behind layers of thatch. If ignited, the thatch will carry fire over great distances.
- Fire can destroy sensitive, slow-growing plants such as blackbush scrub, pinyon pine and Joshua tree woodlands. Joshua trees and Mojave yucca can sprout from root-crowns and new seedlings will establish after fire. However, most desert shrubs are not adapted to fires and it may take 50+ years for desert scrub to recover after a burn.
- Increased fuel and increased fire frequency eventually will convert scrub and woodland vegetation types into invasive annual grasslands.
- Habitat fragmentation, degradation from intensive grazing, OHV activity, mining and military operations, solar and wind energy development, and urbanization are the greatest threats to the region.



References

Frequently Asked Questions

Ernst, A.W. 2017. Tubbs fire reminds locals of Hanley fire of '64. *Napa Valley Register,* http://napavalleyregister.com/calistogan/news/local/tubbs-fire-reminds-locals-of-hanley-fire-of/article_dce8464f-1557-5956-a508-04fffe8d7043.html [Accessed 04 Dec. 2017].

Keeley, J.E. 2002. Native American impacts on fire regimes of the California coastal ranges. *Journal of Biogeography*. 29: 303–320.

Keeley. J.E. 2005. Fire history of the San Francisco East Bay region and implications for landscape patterns. *International Journal of Wildland Fire*. 14:285–296.

LeBaron, G. 2014. Historic wildfires' catastrophic lessons. *The Press Democrat*, http://www.pressdemocrat.com/news/2377919-181/lebaron-historic-wildfires-catastrophic-lessons?artslide=0 [Accessed 04 Dec. 2017].

Soil Erosion Control

Busse, M.D., K.R. Hubbert, and E.E.Y. Moghaddas. 2014. Fuel reduction practices and their effects on soil quality. Gen. Tech. Rep. PSW GTR-241. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA.

California Native Plant Society. 2001. CNPS guidelines for landscaping to protect native vegetation from genetic degradation, https://www.cnps.org/wp-content/uploads/2018/04/landscaping.pdf.

Cal Fire 2017. Watershed Emergency Response Team (WERT) reports [Accessed Feb. 2018 - May 2019]:

Atlas http://www.fire.ca.gov/communications/downloads/Watershed_reports/20171115_AtlasFireWERT.pdf

Camp Fire (Paradise) http://cdfdata.fire.ca.gov/pub/cdf/images/incidentfile2277_4330.pdf

Carr http://cdfdata.fire.ca.gov/pub/cdf/images/incidentfile2164_4152.pdf

Nuns http://www.fire.ca.gov/communications/downloads/Watershed_reports/20171115_NunsWERT.pdf

Pocket http://www.fire.ca.gov/communications/downloads/Watershed_reports/20171115_PocketFireWERT.pdf

Redwood http://www.fire.ca.gov/communications/downloads/Watershed_reports/20171115_RedwoodWERT.pdf

Sulphur http://www.fire.ca.gov/communications/downloads/Watershed_reports/20171115_SulphurFireWERT.pdf

Tubbs http://www.fire.ca.gov/communications/downloads/Watershed_reports/20171115_TubbsWERT.pdf

Woolsey http://cdfdata.fire.ca.gov/pub/cdf/images/incidentfile2282_4328.pdf

Casale, R. 2016. After the fire: Post fire restoration on forestland. USDA Natural Resources Conservation Service,

Capitola, CA. Available: Mendocino County Resource Conservation Service

Casale. R. 2017. After the fire: Preparing for winter following fire. USDA Natural Resources Conservation Service, Capitola, CA. Available: Mendocino County Resource Conservation Service.

EBMUD. 2003. Firescape landscaping to reduce fire hazard. East Bay Municipal Utility District, Oakland, CA.

Keeler-Wolf, T. 1995. Post-fire emergency seeing and conservation in southern California shrublands. Pages 127–139 in J.E. Keeley and T. Scott (eds.). 1995. Brushfires in California: Ecology and Resource Management. International Association of Wildland Fire, Fairfield, WA.

Keeley, J.E., T. Scott (eds.). 1995. Brushfires in California Wildlands: Ecology and Resource Management. International Association of Wildland Fire, Fairfield, WA.

Kent, D. 2017. First aid for Sonoma County's fire-damaged soil. *The Press Democrat*. http://www.pressdemocrat.com/lifestyle/7531859-181/first-aid-for-fire-damaged?ref=menu

Left: Redwood (*Sequoia sempervirens*) tree resprouting.
Photo by Audubon Canyon Ranch

Post-Fire Care and Recovery of Trees: Considerations for Oak Trees

American National Standards Institute. 2017. American National Standard for Tree Care Operations – Tree, Shrub, and Other Woody Plant Management – Standard Practices (Tree Risk Assessment a. Tree Failure). ANSI A300 (Part 9)-2017 Tree Risk Assessment a. Tree Structure Assessment. American National Standards Institute, New York, NY.

Bush, L. and R. Thompson. 1989. Acorn to Oak: A Guide to Planting and Establishing Native Oaks. Circuit Rider Productions, Windsor, CA.

Costello, L.R., B.W. Hagen and K.S. Jones. 2011. Oaks in the Urban Landscape: Selection, Care and Preservation. Regents of the University of California, Agriculture and Natural Resources, Richmond, CA.

Matheny, N.P. and J.R. Clark. 1994. A Photographic Guide to the Evaluation of Hazard Trees in Urban Areas, 2nd edition. International Society of Arboriculture, Champaign, IL.

Mazurek, M.J. and W. J. Zielinkski. 2004. Individual legacy trees influence vertebrate wildlife diversity in commercial forests. Forest Ecology and Management 193: 321–334.

McCreary, D.D. 2004. Fire in California's Oak Woodlands. University of California Cooperative Extension. Browns Valley, CA.

McCreary, D.D. 2011. Living among the Oaks. Publication 21538. University of California Agriculture and Natural Resources, http://anrcatalog.ucanr.edu/pdf/21538.pdf.

McCreary, D.D., and G. Nader. 2011. Burned oaks: Which ones will survive? University of California, Agriculture and Natural Resources, Publication 8445, http//anrcatalog.ucdavis.edu.

Michel, A.K. and S. Winter. 2009. Tree microhabitat structures as indicators of biodiversity in Douglas-fir forests of different stand ages and management histories in the Pacific Northwest, U.S.A. Forest Ecology and Management 257:1453–1464.

Plumb, T.R., and A.P. Gomez. 1983. Five southern California oaks: identification and post-fire management. Pacific Southwest Forest and Range Experiment Station. General Technical Report PSW-71.

Sawyer, J.O., T. Keeler-Wolf, and J.M. Evens. A Manual of California Vegetation. California Native Plant Society, http://vegetation.cnps.org/ [Accessed 07 Dec. 2017 and March 2019].

Smiley, E.T., N. Matheny, and S. Lilly. 2011. Best Management Practices. Tree Risk Assessment. 2nd edition. 2017. Companion publication to the ANSI A300 Part 9: Tree, Shrub, and Other Woody Plant Management – Standard Practices (Tree Risk Assessment a. Tree Structure Assessment). International Society of Arboriculture, Champagne, IL.

Tietje, W., K. Purcell, and S. Drill. 2005. Oak woodlands as wildlife habitat. Pages 15–31 in G.A. Giusti, D.D. McCreary, and R.B. Standiford, (eds.). 2005. A Planner's Guide for Oak Woodlands, 2nd edition. Publication 3491. University of California, Agriculture and Natural Resources, Oakland, CA.

Other Web Resources [Accessed Dec. 2017 - Feb. 2018]

Help Us Restore Oaks to Wine Country: http://www.cnps.org/cnps/conservation/acorns/

Oak Identification: http://cemarin.ucanr.edu/Programs/Custom_Program97/Types_of_oaks/

Kocher, S., and K. Shive. Recovering from Wildfire: A Guide for California's Forest Landowners. UCANR Fire Resources and Information, http://anrcatalog.ucanr.edu/pdf/8386.pdf

Sonoma Ecology Center: https://www.sonomaecologycenter.org/watershed-protection/

Young, B. Turn an Acorn Into and Oak: http://www.cnps.org/cnps/conservation/acorns/acorn-to-oak.pdf

Seeding vs. Natural Regeneration

Barro, S.C. and S.G. Conard. 1987. Use of Ryegrass; Seeding as an Emergency Revegetation Measure in Chaparral Ecosystems. USDA Forest Service Pacific Southwest Forest and Range Experimental Station. Gen. Tech. Rep. PSW-102.

California Native Plant Society. 1995. Statement of Policy – Seeding after wildfire. https://www.cnps.org/conservation/policies.

California Native Plant Society. 2001. Guidelines for landscaping to protect native vegetation from genetic degradation. https://www.cnps.org/conservation/policies.

EBMUD. 2003. Firescape landscaping to reduce fire hazard. East Bay Municipal Utility District, Oakland, CA.

Keeley, J.E. 1995. Future of California Floristics and Systematics: Wildfire Threats to the California Flora. *Madroño* 42:175-179.

Keeley, J.E. 1994. To seed or not to seed. *Wildfire* 3:18.

Keeley, J.E., C.D. Allen, J. Betancourt, G.W. Chong, C.J. Fotheringham, and H.D. Safford. 2006. A 21st Century perspective on postfire seeding. *Journal of Forestry*. 104(1):1–2.

Kent, D. 2005. Firescaping: Creating fire-resistant landscapes, gardens, and properties in California's diverse environments. Wilderness Press, Berkeley, CA.

A south-facing steep slope of chaparral that burned intensely after the 2012 North Fire along Cow Mountain in Mendocino County, where shrubs are beginning to resprout. Photo by Kerry Heise

(Seeding vs. Natural Regeneration cont...)

Landis, B. 2010. How CNPS developed a policy on native plants and fire safety. *Fremontia* 38(2):7–15. California Native Plant Society, https://cnps.org/wp-content/uploads/2018/03/Fremontia_Vol38-No2-3.pdf [Accessed 07 Dec. 2017].

Schettler, S. 2010. Fire resistant landscaping: A general approach and Central Coast perspective. Fremontia 38(2): 46–50. California Native Plant Society, https://cnps.org/wp-content/uploads/2018/03/Fremontia_Vol38-No2-3.pdf [Accessed 07 Dec. 2017].

USDA/NRCS. 2017. Hydromulching Fact Sheet. http://sonomarcd.org/wp-content/uploads/2017/10/NRCS_hydromulching.pdf [Accessed 07 Dec. 2017].

Invasive Plants

Brooks, M. and M. Lusk. 2009. Fire Management and Invasive Plants: A Handbook. United States Fish and Wildlife Service. https://www.fws.gov/invasives/pdfs/USFWS_FireMgtAndInvasivesPlants_A_Handbook.pdf [Accessed 07 Dec. 2017].

DiTomaso, J.D. 2000. Invasive weeds in rangelands: Species, impacts, and management. Weed Science 48(2): 255–265.

Keeley. J.E. 2004. Invasive plants and fire management in California Mediterranean climate ecosystems. In Arianoutsou and Papanastasis (eds.), Proceedings of the 10th MEDECOS Conference, 25 April - 01 May 2004, Rhodes, Greece.

Keeley, J.E., J. Franklin, and C. D'Antonio. 2009. Fire and Invasive Plants on California Landscapes. Pages 193–221 In D. McKenzie, C. Miller, D.A. Falk (eds.). 2011. The Landscape Ecology of Fire. Springer, NY.

Keeley, J.E., H. Safford, C.J. Fotheringham, J. Franklin, and M. Moritz. 2009. The 2007 Southern California Wildfires: Lessons in Complexity. *Journal of Forestry* 107:287–296.

Lambert, A.M., C.M. D'Antonio, and T.L. Dudley. Invasive Species and Fire in California Ecosystems. *Fremontia* 38(2):29–36.

Landis, B. 2010. How CNPS developed a policy on native plants and fire safety. *Fremontia*. 38(2):7–15. California Native Plant Society, https://cnps.org/wp-content/uploads/2018/03/Fremontia_Vol38-No2-3.pdf [Accessed 07 Dec. 2017].

Defensible Space and Landscaping

Online resources and individual experts consulted Feb. - May 2019]

Cal Fire, http://www.readyforwildfire.org/.

Calscape, https://calscape.org/.

From the house outward. California Chaparral Institute, http://www.californiachaparral.com/images/From the House_Outward.pdf.

Preparing homes for wildfire. National Fire Protection Association, https://www.nfpa.org/Public-Education/Fire-causes-and-risks/Wildfire/Preparing-homes-for-wildfire.

University of California Cooperative Extension, https://ucanr.edu/sites/fire/.

Rare Plants and Fire

Keeley, J.E. and Fotheringham, C.J. 1998. Mechanism of smoke-induced seed germination in a post-fire chaparral annual. *Journal of Ecology*. 86(1):27–36.

Keeler-Wolf, T. 1995. Post-fire emergency seeding and conservation in southern California shrublands. Pages 127–139 in J.E. Keeley and T. Scott. 1995. Brushfires in California Wildlands: Ecology and Resource Management. International Association of Wildland Fire, Fairfield, WA.

Considerations for California's Habitats

Anderson, M.K. 2005. Tending the Wild: Native American Knowledge and the Management of California's Natural Resources. University of California Press, Berkeley, CA.

Armstrong, W.P. 2019. Ashes to wildflowers: a promise of renewal springs from destruction. https://www2.palomar.edu/users/warmstrong/ww0604.htm. [Accessed Feb. - May 2019]

Barbour, M.G., J.M. Evens, T. Keeler-Wolf, and J.O. Sawyer. 2016. California's Botanical Landscapes: A Pictorial View of the State's Vegetation. California Native Plant Society Press, Sacramento, CA.

Griggs, F.T. 2009. California Riparian Habitat Restoration Handbook, 2nd edition. River Partners, www.RiverPartners.org. [Accessed Feb. - May 2019]

Keeley, J.E. and C.J. Fotheringham. 1998. Mechanism of Smoke-Induced Seed Germination in a Post-Fire Chaparral Annual. *Journal of Ecology*. 86(1):27–36.

Keeler-Wolf, T. 1995. Post-fire emergency seeding and conservation in southern California shrublands. Pages 127–139 in J.E. Keeley and T. Scott. 1995. Brushfires in California Wildlands: Ecology and Resource Management. International Association of Wildland Fire, Fairfield, WA.

Kliejunas, J. and D. Adams. 2003. Tree Notes: White Pine Blister Rust in California. California Department of Forestry and Fire Protection, http://calfire.ca.gov/foresteward/pdf/treenote27.pdf. [Accessed Feb. - May 2019]

Lanner, R.M. 1999. Conifers of California. Cachuma Press, Los Olivos, CA.

Risser, R.J. and M.E. Fry. California Wildlife Habitat Relationships System. California Department of Fish and Game, California Interagency Wildlife Task Group, https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=67368. [Accessed Feb. - May 2019]

Sawyer, J.O., T. Keeler-Wolf, J.M. Evens. 2009. A Manual of California Vegetation, 2nd edition. California Native Plant Society Press, Sacramento, CA.

Van Wagtendonk, J.W., N.G. Sugihara, S.L. Stephens, A.E. Thode, K.E. Shaffer, J.A. Fites-Kaufman, and J.K Agee. 2018. Fire in California's Ecosystems, 2nd edition. University of California Press, Berkeley, CA.

Warner, R.E. and K. Hendrix. 1984. California Riparian Systems: Ecology, Conservation, and Productive Management. University of California Press, Berkeley, CA.

West Coast Watershed. 2012. Russian River Integrated Coastal Watershed Management Plan. Report to Department of Water Resources. Mendocino County Resource Conservation District, http://www.northcoastresourcepartnership.org/documents/view/7603. [Accessed Feb. - May 2019]

USFS: Pacific Southwest Research Station. 2018. Fire in Chaparral Ecosystems. https://www.fs.fed.us/psw/topics/fire_science/ecosystems/chaparral.shtml. [Accessed Feb. - May 2019]

USGS: Western Ecological Resource Center. Publication Brief for Resource Managers: Fire in California's Ecosystems. http://www.californiachaparral.com/images/Fire_in_California_s_Ecosystems_Brief.pdf. [Accessed Feb. - May 2019]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Butte County
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ALLIANCE
FOR NATURE


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PRESERVE
Inspiring conservation through science


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EDUCATION
DEFENSIBLE SPACE


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Helpful Resources

Local and Regional Conservation Services

California Natural Resource Conservation Districts
www.ca.nrcs.usda.gov

Local Fire Safe Councils
https://cafiresafecouncil.org/local-fire-safe-councils-2/

Note: Your local park districts, fire prevention bureaus, and other municipal services are valuable sources of information. Be sure to look up your city and county resources online.

Fire Preparedness and Defensive Space

Cal Fire
http://www.readyforwildfire.org/

California Chaparral Institute
http://www.californiachaparral.com/images/From_the_House_Outward.pdf

National Fire Protection Association
"Preparing Homes for Wildfire"
https://www.nfpa.org/Public-Education/By-topic/Wildfire/Preparing-homes-for-wildfire

University of California Cooperative Extension
"Fire in California"
https://ucanr.edu/sites/fire/

Licensed Foresters and Certified Arborists

California Licensed Foresters Association
https://www.clfa.org/about-us/rpf-locate/

International Society of Arboriculture
http://www.treesaregood.org/findanarborist

Additional CNPS Resources

Fremontia special issue
https://cnps.org/wp-content/uploads/2018/03/Fremontia_Vol38-No2-3.pdf

CNPS Fire Policies
Fire Management: cnps.org/fire-management-policy

Seeding After Fire: cnps.org/seeding-after-fire-policy

Fire Safety: cnps.org/fire-safety-policy

CNPS Sanhedrin Chapter Fire-Wise Planting
https://sanhedrin.cnps.org/index.php/fire/fire-wise-planting

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Dear neighbor,

CNPS is providing this guide to landowners with the hope that it can help you maintain the natural beauty of landscapes affected by recent fires. We hope you will find it useful. If not, then we ask that you please share it with a neighbor or friend who will appreciate the information. If you'd like to order more copies of this guide or have questions, please contact us at cnps@cnps.org.

Interested in learning more about native plants and local ecology?
Get connected with your local chapter and become a CNPS member at cnps.org/join. Your membership supports important, ongoing work. As a member, you'll meet experts sharing hidden insights, discover beautiful books and magazines, enjoy discounts with CNPS partners, and know that you are making a genuine difference in saving California's incredible plants and special places.