California Native Plant Society

FIRE RECOVERY GUIDE

California Native Plant Society

This Guide exists thanks to dozens of topical experts who kindly shared their time and knowledge, and the support of a thoughtful anonymous donor. We all owe them a debt of gratitude.
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.

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Cover: Redwood forest after the Nuns Fire, at Bouverie Preserve. Photo by Audubon Canyon Ranch

Inset photo: California bay resprouting after the Atlas Fire at the Foote Preserve. Photo by Mike Palladini

Above: 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

The resounding fires in Mendocino, Napa, and Sonoma Counties in 2017 had a significant impact on our community. During those terrible days, we wondered and worried about loved ones and friends. In the days immediately following, we worked to help the many who were displaced find shelter and some solace. These were our initial priorities, but before long, we started receiving requests for a different kind of help: People concerned about how the fire, or the recovery efforts, might affect the land that they love.

As more landowners reached out to CNPS for advice, we quickly realized that there was no single reference we could provide. Though the science of recovery after fire is well-developed, and there are many great resources available, there is a need for guidance for recovery after fire, presented with easy to understand solutions for people concerned about native plants and wild landscapes. So we began working with our partners to develop one.

This Fire Recovery Guide was developed to help landowners wishing to apply current science and best practices to helping their land and its inhabitants recover. It was a community effort, and numerous partners worked hard to bring it together and share it in an incredibly short time window. While this guide is designed to serve landowners in the North Bay, our hope is that others will take this material and expand and adapt it to benefit those in need elsewhere in California, today and tomorrow.

We hope that this guide will be useful – for you to identify actions that will benefit your land and the biodiversity you steward, while also helping you avoid actions that may actually be detrimental. We hope that it will further encourage conversations about how we can live with fire in an increasingly fire-prone state, while also ensuring there is a place for the beautiful plants and incredible wildlife that make living in California so special.

Even though we still face a time of difficult recovery, eventually the land will heal. Already trees are beginning to flush with new growth, blackened soils are greening up with tender sprouts, and nourishing winter rains have come. Natural recovery is an ancient miracle, and one that brings a message of recovery and resilience that is much needed today. We hope that, in coming together to care for sensitive natural places and observing their recovery, we also discover a message of hope that helps bring healing to our neighbors and ourselves.

Left: Redwood tree resprouting.

Above Left: Beargrass resprouting. Photos by Audubon Canyon Ranch

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

Common Questions and Answers

This guide offers research-based answers to common questions that homeowners face with post-fire recovery. Below are some quick replies. More in-depth information is in the sections that follow.

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

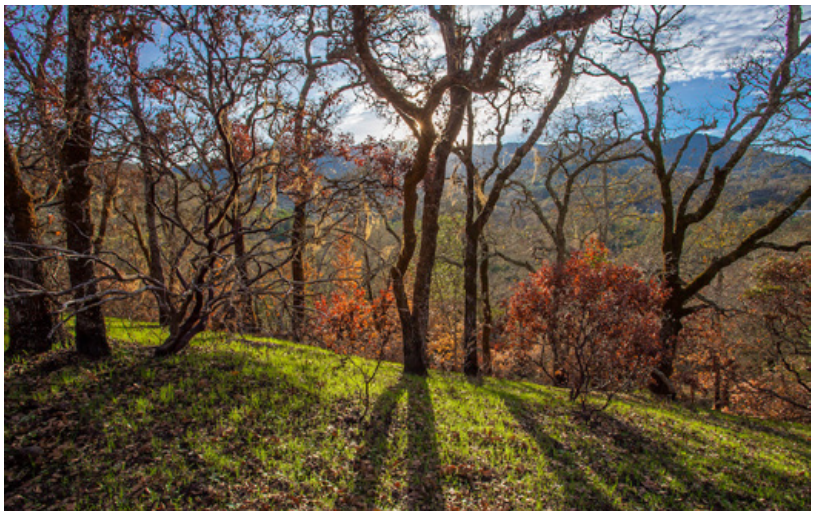
One of the most important rules is to be careful not to disturb the soil and slopes during the rainy season, as the soil can become unstable. Keeping vegetative cover (both live and dead plants) will reduce the rain's impact and any roots will help keep soil in place.

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

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

Is a burned tree dead or at risk of falling?

Looks can be deceiving. Many native trees and large shrubs are adapted to fire and can recover over time, sometimes by re-sprouting at their branches and bases in the next spring. However, if a compromised branch or tree poses a risk to people or property, you can consult a professional forester or arborist. Otherwise, leave the blackened vegetation in place and wait until spring when it will be clearer to tell if your plants are dead. Even trees and large shrubs that are completely dead provide important habitat and cover, and their roots help hold soil in place and prevent erosion.



Flush of post-fire herb growth at Pepperwood Preserve in an oak woodland, fall of 2017. Photo by Saxon Holt

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

A fire resistant landscape approach maintains a 100′ defensible space around homes by removing combustible materials and having hardscape features with high moisture/low flammability plants to limit potential fire fuels. Careful spacing with low-growing native, drought-tolerant plants is best to resist fire, although no plant is fireproof. Keep plants from creating a fire ladder up trees and select trees with low sap or resin (such as hardwoods like our lovely oaks) instead of highly flammable pines and eucalyptus.

Will fire damage affect soil fertility, and will the ash have a negative effect on the soil and future plant establishment and health?

Fire can actually have a positive benefit in 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 how much fertility increases.

However, these benefits can favor plant growth of some plant species (invasives) over others (natives). This makes it more important to protect and encourage local native plant populations and refrain from seeding in invasive grasses and plants that could take over, becoming dry fine fuels and causing other negative impacts down the road.

Ash can have various chemical compounds, depending on what the fire burned and its temperature. With the uncertainty of what is contained in all the ash, erosion control may be necessary to keep it out of the natural waterways to protect our water supplies and the wildlife in riparian habitats. The following sections will help further expand on these post-fire recovery measures.

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

Initial Post-Fire Checklist for Land Care

Every fire is different, and every landowner must face unique challenges in securing and restoring their land. However, past disasters have given us some general principles that can help each of us make the right decisions, and help educate our neighbors to do the right thing.

- ✔ Safety First! Before entering a burned site, make sure you have the "go ahead" from local fire officials. Hazards include hotspots, unstable structures, trees, and 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.
- ✔ Slow down soil movement, especially into waterways. Use fallen branches, native plants, debris, wood chips, fiber rolls/straw wattles, silt fencing, or other features to slow runoff.
- ✔ 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 wattles, mulch, rocks, and branches can act like speed bumps, slowing the running water to give it a chance to seep down into the soil and filter out sediment.

Left: Nature recovering after the 2015 Valley Fire along Butts Canyon. Photo by Reny Parker

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

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

- ✔ Using extreme caution, divert runoff away from landscapes and toward the storm drain system by using diversion ditches, staked boards, dry stacked walls, native plants, etc.
- ✔ Repair fire breaks so they blend evenly with the natural slope of the land (instead of channeling runoff).
- ✔ Reduce erosion by mulching with *only seed-free material*, such as chipper material from a known source; hydro mulch without seed, or certified weed-free loose straw. Barley, sterile wheat, or rice straws are recommended.
  - Mulching is very effective for reducing erosion in urban areas but can introduce unwanted weeds and highly flammable invasive grasslands. Be suspicious of "weed-free" material for sale. Inspect it carefully. Supplies are limited.

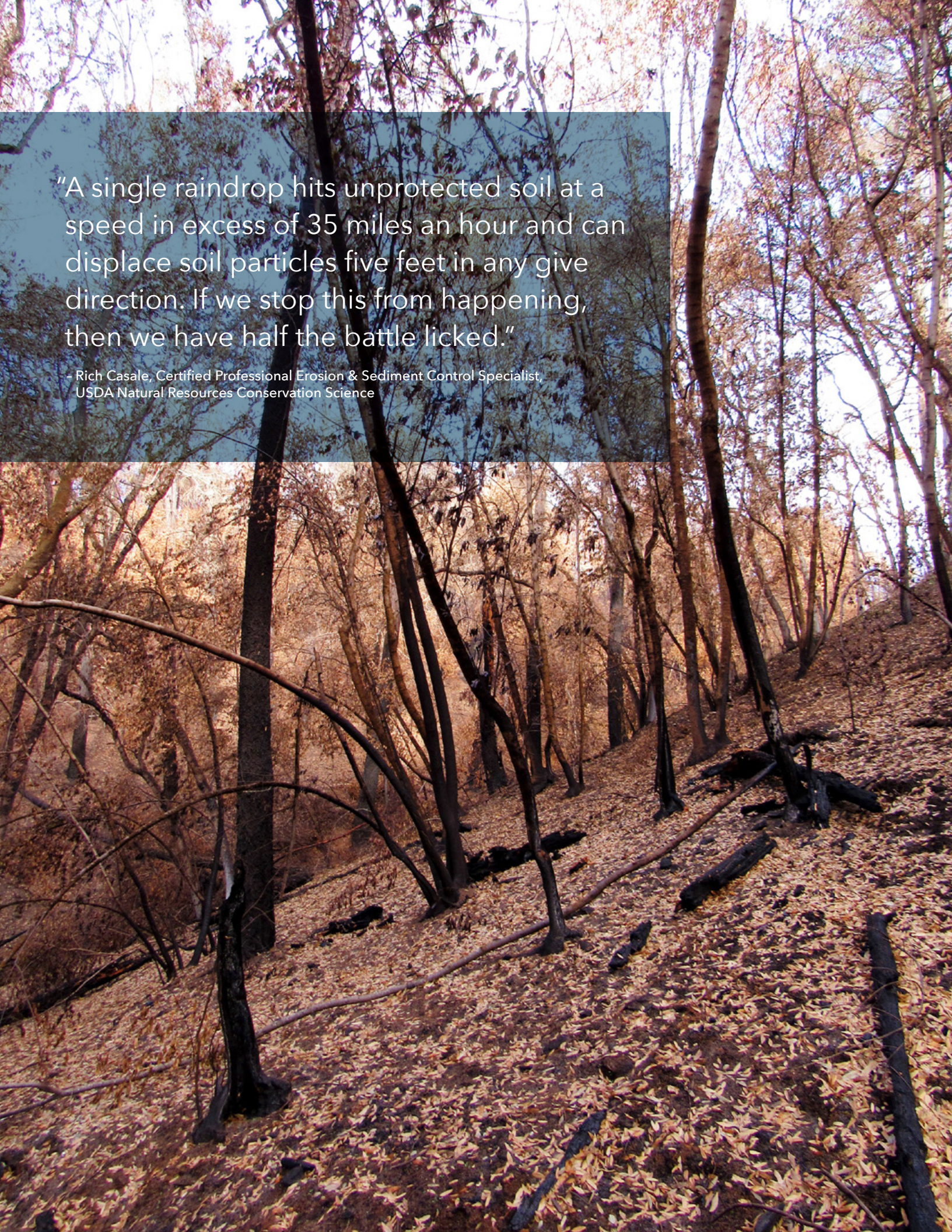
Straw wattles placed to slow and dissipate water, with rolls overlapping.
Photo by Rich Casale

- ✔ Prune back and give fire-damaged vegetation time to recover. Many damaged and scorched native plants will re-sprout 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; the existing seed bank will emerge in winter and spring. Also, consult a professional to design and install short-term or permanent methods to control runoff, prevent erosion problems, or address slope stabilization issues.
- ✔ Nix the seed mix. Most grasses found in seed mixes are short-lived with shallow roots and will be highly flammable by next summer. Also, a sudden flush of grass can attract pests. Many "native," "wildflower," and erosion control seed mixes are not genetically appropriate and can become extremely invasive. They are not for wildland or fire damaged soil/slope restoration. Non-native, invasive plants or annual grasses (such as ryegrass or zorro grass) just add fuel to a fire.
- ✔ If you do seed then 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. In most cases, once man-made debris and ash are removed, the land will heal on its own – it just needs time.

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://www.pressdemocrat.com/lifestyle/7531859-181/first-aid-for-fire-damaged, and the CA Natural Resources Conservation Service.

Decision Flow Diagram for Post-Fire Management

From Keeler-Wolf 1995



"A single raindrop hits unprotected soil at a speed in excess of 35 miles an hour and can displace soil particles five feet in any give 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 issues. 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 or 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.

- 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 intensity 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*.

- In general, fire has many positive effects on wildlands by opening up dense woody canopies, adding natural ash and smoke chemicals to the soil, enabling habitat for post-fire native plants to sprout and germinate, and reducing fuel loads for the future. Also, fire is naturally of high-intensity in chaparral, so do not employ any unnecessary management action that can compromise this ecosystem.

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

Above: Oak trees develop extensive lateral root systems that can spread 30 m 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 that will provide soil protection from rain and runoff. Again, leave the mess and let nature do the work for you!

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

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

1. 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.
- Prune or remove only high hazard fire-damaged trees capable of falling onto buildings and roads and endangering people and livestock.

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 it is ideal to minimize disturbance, it is clearly not always possible, particularly around home sites. It is most important 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

- On your own property, your first goal with runoff should be to slow it, spread it, and sink it. This is always important but particularly after a fire.
- Fast moving water causes erosion and downstream flooding. Mulch, including woodchips or straw mulch, is a great way to slow down the rain. (*See more under Mulching section*.)
- Once the rain starts running down a hill slope, well-placed straw wattles, a thin cover of mulch, and branches can act like speed bumps, slowing rain down and giving it a chance to seep down into the soil as well as filtering out sediment.
- In your broader neighborhood, it is important to 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.

3. 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 to moderate fire intensity, but in disturbed areas of high fire intensity, they can be critical in preventing sediment and fire debris from washing into sensitive creek habitats.
- 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 lessen impact on saturated soil and slopes during peak storm events, and to store for later use (as irrigation for plants in drier times or for other human uses). 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.

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

After a fire, CalFire assembles a Watershed Emergency Response Team (WERT) and they generate a report that evaluates post-fire conditions and assesses potential threats including debris flow and flooding. They analyze the soils, geology, and hydrology to create maps showing which areas are at the highest risk. These reports are a valuable resource and a good place to start your land recovery plan. *(See CalFire 2017 references at the end of this document).*

If you are concerned that your property may be at risk, have an on-site assessment of fire damage conducted by a Natural Resources Conservation Service (NRCS) specialist, registered professional forester, certified professional in soil erosion and sediment control, or other qualified fire restoration specialist. Consult your local Resource Conservation District (RCD), NRCS, and/or CalFire for assistance on preventing erosion on fire/fuel breaks and access routes. Also, if there is a threat of large rocks releasing from slopes on your property or adjacent properties, seek professional assistance. Rock removal, rock fall catchments, or netting may be necessary.

On-site assessment of fire damage. Photo by Sonoma County Agricultural Preservation and Open Space District

Common Questions about Soil Erosion

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

This may happen 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.

However, there are 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?

After a late-season fire, there is usually not enough time to seed native perennial grasses and herbs for erosion control. They do not come up quickly enough from seed to hold unstable slopes before winter storms. (*See Reseeding section for more detailed information*.)

Fortunately, in most cases it is also not necessary to reseed, 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, larkspur, and other widlflowers springing up post-burn at Knoxville Recreation Area, Lake County, after the 2015 Rocky Fire. Photo by Evan Johnson

When landscaping for erosion control in or near home sites, we recommend the following:

1. Do *NOT* use annual non-native grasses for erosion control or planting. These produce flashy fire fuels and continued fire risk.
2. Do not plant non-native reseeding, erosion control seed mixes in wildland areas or in the wildland urban or agriculture interface. Work to control non-native 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
   a. Use loose straw across the ground at no more than 2 inches deep
   b. Use sterile or non-persistent plants (e.g., cereal grains like sterile wheat or barley) at low planting densities:
      i. As a nurse crop for local natives
      ii. To avoid cross-pollination with native vegetation
      iii. And to preclude migration of non-natives into adjacent natural areas.
4. Additional consultation can be necessary to determine appropriate practices, such as when sowing or planting 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) that is 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.

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

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.

Hydromulching utilizes a 1,000 to 3,000 gallon tank mounted on a truck or trailer that is equipped with a special pump and continuous agitation system. The pump forces the slurry through either a discharge nozzle mounted on top of the tank or a nozzle on the end of a hose. Hoses are typically limited to 200 feet in length. Fiber mulch and tackifier are added to the water in the tank and thoroughly mixed prior to application.

USDA is an equal opportunity provider, employer, and lender.

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% 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://sonomarcd.org/wp-content/uploads/2017/10/NRCS_hydromulching.pdf :

Loose, straw mulch with straw wattles placed along the slope contour. Photo by Julie Evens

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 mulching is done most effectively with straw. While hay (usually alfalfa, oats, and grasses) is cut when still green for its nutritional benefit for feeding livestock, straw is the leftover dead stalks after the 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.

Loose barley or wheat straw is recommended because it lasts longer. Use straw mulch in "free form."

Mulching can be done in 6-10' strips along the contour and spaced at 50-100' 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 are not recommended: wet straw bales are like brick walls that do not allow any sediment to filter through. Whole bale installation should only be done 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.

Introduction to Wattles

Straw wattles or fiber rolls are designed to slow down runoff, and filter and trap sediment before the runoff gets into waterways. Straw wattles are porous and allow water to filter through fibers and trap sediment. Because they slow runoff they reduce sheet and rill erosion.

Wattle Installation:

1. Prepare smooth slope before the wattling procedure is started. Shallow gullies should be smoothed as work progresses.
2. Dig 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.
3. It is critical that rolls are 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. Use a straight bar to drive clean holes through the roll and into the soil. Drive the stake through prepared hole into soil. Leave only 1 or 2 inches of stake exposed above roll.
6. Install stakes at 4 feet max intervals. Either staking method shown on the next page / on the right can be used.
7. Construct an 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.

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.
- Rice straw may be less expensive than barley and wheat straw, but it breaks down faster. Be careful you aren't "penny-wise and pound foolish." It is also very difficult to spread because it's light and fluffy and has a tendency to stick together. Many workers get frustrated with it and end up throwing it onto the erosion control sites in big solid flakes that won't let plants grow through!
- Straw mulch that is not certified as "weed free" will not only have weed seed in it but might have other non-native grass seed in it as well.
- Mulching will not prevent invasive plants from taking hold. In fact, studies show that mulching can actually aid in non-natives' establishment by retaining more moisture for longer periods than in areas not mulched.
- If mulch is placed deeper than 4 inches, it can delay recovery time of existing seed bank in the soil or in cases when seeding is done in conjunction with mulching.
- Widespread mulching over the watershed by hand or by plane is not cost effective and has not has not demonstrated significant benefits in the past. It may also contribute to widespread establishment of non-native plants.
- Mulch can be a fire hazard if installed when fire is still a danger especially in the interface of burned and unburned landscapes which happens to be where many firebreaks are located.
- Mulching is not needed in areas where tree leaf drop is heavy from heat damaged trees.

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

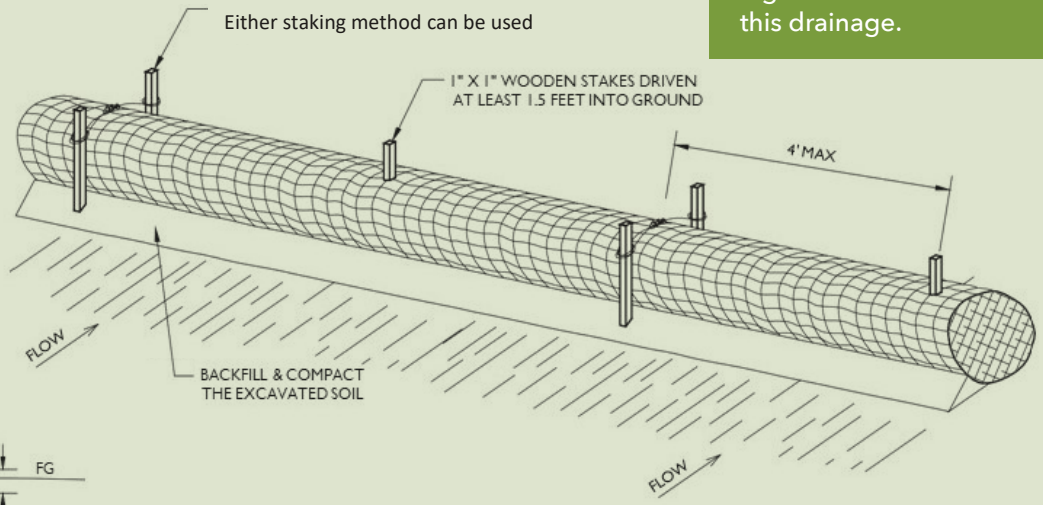
Straw wattles may be used on slopes to shorten slope length. They are designed for short slopes or slopes flatter than 3:1 and low surface flows not to exceed 1 c.f.s. for small areas.

It is important to know how much drainage area the most uphill wattle is receiving and accommodate for this drainage.

Typical Fiber Roll/Wattle Sediment Barrier

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

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



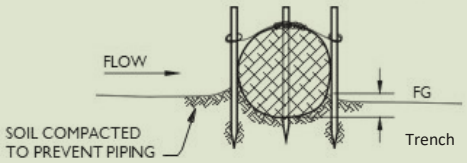


Illustration courtesy Napa County Resource Conservation District www.naparcd.org

"Native California oaks (*Quercus* spp.) have evolved mechanisms to survive periodic burning, whereby fire is a natural element of oak ecosystems."

Post-Fire Care and Recovery of Trees, Especially Oaks

Significant acreages of California broadleaf forests and woodlands – especially oak woodlands – burned in the North Bay Area fires of October, 2017. Where the fires burned intensely, some trees were totally consumed. In many places, the trees and ground were scorched and blackened, but many of the trees remain standing and are not significantly impacted.

Native California oaks (*Quercus* spp.) have evolved mechanisms to survive periodic burning, whereby fire is a natural element of oak ecosystems. With moderate- and even low-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, such as what happened in the region, 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.

As a natural process, frequent low-intensity woodland burning creates and maintains 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 a mosaic of fine-grained vegetation patches with relatively lower shrub cover. With longer periods of time between fires, build-up of woody vegetation can occur, and an increase in tree density is promoted. Some open, savannah-like woodlands have changed over time to more heavily vegetated plant communities, and these are the types of areas where fire can be most severe.

Left: Oaks resprouting post-fire at Sutro Ranch Preserve. Photo by Mike Palladini, Land Trust of Napa County

Above Left: Acorn woodpecker. Photo by Lisa Hug

Above Right: Fire can maintain groups of large oak trees. Photo by Saxon Holt

How do I know if my trees are okay?

Do *not* cut them down:

- If they have lost all of their foliage, but their stem has only minor damage
- If they have spotty scorching around their bases, and at least 10% of their cambium (layer of plant tissue beneath the inner bark) is alive
- If they are over 12 inches in diameter and are scorched all around their base, but there is no reduction in bark thickness
- If the base of the tree is intact without being hollowed out
- If buttress roots (exposed roots supporting the tree) are not burned off or killed
- Provided 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 on more details: http://naparcd.org/wp-content/uploads/2017/10/Burned-oaks-which-will-survive-UCANR.pdf

Should Any Trees Be Removed?

Oaks 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. Although some trees remain standing once the fire passes, they may be compromised to a point where they are 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. Contact: California Forestry Stewardship Program's Forestry Helpline at 800-738-Tree (8733); forestryhelp@gmail.com.

Oak trees with leaf-drop and spotty scorching.
Photo by Saxon Holt

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. However, if the fire has been hot enough to burn into the bark and reduce its thickness, the cambium is usually killed. It is sometimes 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 oak species naturally have thicker bark, helping them to protect their cambium from injury (such as blue, black, and valley oaks). 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.

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 the tree will die from a lack of moisture and nutrient transport. 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).

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, trees that are even completely dead also help hold soil in place and prevent erosion. See more on this from Audubon California's Working Lands series: http://ca.audubon.org/sites/g/files/amh421/f/landowner_guides_snags_042312.pdf.

Sprouting by Oaks

Even if an oak has been girdled and the aboveground portion of the tree has been killed, many will sprout from their bases 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, interior, and canyon live oak) are more vigorous at sprouting than deciduous oaks (like Oregon oak and blue oak), 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 re-sprouts 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. Re-sprouted trees have access to greater amounts of water and nutrients to support top growth.

Coast live oak tree resprouting from its upper branches.
Photo by Wendy Trowbridge

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, it may be desirable to plant 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.

Planting of oak seedlings with protective "tree shelters." Photos by Napa RCD

CNPS and partners are working to "Re-Oak" California. In the aftermath of the fires, thousands of volunteers helped collect acorns to Re-Oak Wine Country.

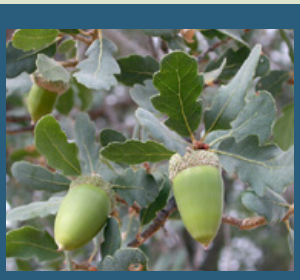
Here's how you can join the effort and Re-Oak an area near you.

- Plant either acorns or small seedlings, but make sure you plant near where acorns were collected, in locations with similar characteristics (e.g., elevation, rainfall, northern vs. southern exposure, etc.).
- Plant during the wet season, in late fall or early winter.
  - When collecting acorns to plant, determine that they are ripe (e.g., they twist easily out of the acorn cap) and visibly sound. Throw away any that have cracked or been damaged by insects with boring holes or that appear off-colored or moldy).
    - Soak collected acorns and discard any that float in a container of water (as damaged, immature, or dead seeds will float to the top)
    - Some acorns are ready for planting right after soaking and some need to go through a cold stratification
    - If acorns have been collected for cold stratification and/or later planting, then you can follow more detailed guidelines. See Turning an Acorn into an Oak, written by Betty Young: http://www.cnps.org/cnps/conservation/acorns/acorn-to-oak.pdf
- Protect young oaks from animals (e.g., double-walled plastic "tree shelters" work well for a number of oak species);
- Keep competing vegetation away from oaks (4-ft. weed-free areas are recommended) for at least two years after planting.

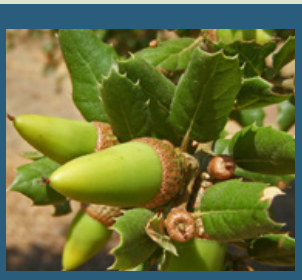
Identifying Your Oak Trees and Maintaining a Natural Forest

Various online resources are available to help you identify what oak species you have. For example: http://cemarin.ucanr.edu/Programs/Custom_Program97/Types_of_oaks/ and http://ucanr.edu/sites/oak_range/Californias_Rangeland_Oak_Species/, 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.

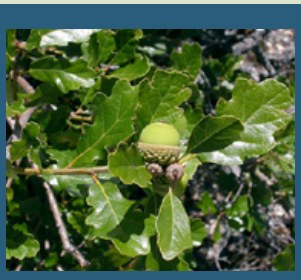
Black Oak
Quercus kelloggii
Photo by Neal Kramer



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

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

Wildlife in Oak Woodlands and Wildfire Impacts on Wildlife

Oak woodlands provide food and habitat (including cover, shelter, nesting, and reproduction) for over 300 different animals and insects. Oak acorns provide food for over 50 different animals including mule deer (*Odocoileus hemionus*), California ground squirrels (*Spermophilus beecheyi*), western gray squirrels (*Sciurus griseus*), acorn woodpeckers (*Melanerpes formicivorus*), western scrub-jays (*Aphelocoma coerulescens*), woodrats (*Neotoma* spp.), many mice (*Peromyscus*) 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). Oaks and other trees play an important role in enabling native fish to flourish, since trees along streams can stabilize the stream banks, reduce sedimentation, and provide shade and rooting masses for sheltering fish. This can be critical for the survival of Chinook salmon and steelhead trout.

"Oak and conifer trees that are killed by fire and kept in place have a positive benefit for wildlife habitat and contribute to biodiversity."

Surprisingly, low- to moderate-intensity fires can actually have a net positive effect on wildlife habitat. Scientific evidence mostly indicates that typical oak woodland understory fires do not adversely affect the majority of land-dwelling animals. For example, an experimental fire that burned approximately 50% of 500 acres of mixed blue oak - coast live oak woodland in central-coastal California had no appreciable loss of tree or shrub canopy cover. While grass cover was reduced by 70% and downed wood and woodrat houses were reduced by 30% , Vreeland and Tietje (2001) found no substantial or long-term negative impacts to over 150 vertebrate species (e.g., birds, small mammals, amphibians, and reptiles) in monitoring two years prior to and four years after the fire. Their study demonstrates that many small, resident vertebrates merely go below ground during a fire and emerge unscathed once the flames have passed. Lizards, snakes, and most rodents can readily survive fires. In most cases, sufficient suitable wildlife habitat elements exist or will recover soon after the fire, allowing the surviving smaller animals to re-occupy sites as the vegetation begins to sprout or germinate. In time, larger animals will migrate back to the fire area as the habitat recovers.

Oak and conifer trees that are killed by fire and kept in place have a positive benefit for wildlife habitat and contribute to biodiversity. For example, more than 80 species of birds rely on dead trees as important nesting sites and as 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.

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

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

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, individual goals, and preferences.

Our human tendency is to fix what we perceive as a potential problem or as something "broken" or "untidy." While reseeding and planting should be considered for erosion control or to re-landscape a home site, in many cases, natural regeneration – *allowing the landscape to recover on its own from the existing soil seed bank, or from nearby seed sources or re-sprouting of surviving perennial plants* – may be the best option.

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 and 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 many cases, where fire intensity was low to moderate, seeds or perennials can be present in the soil or able to re-sprout 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, and 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 oak acorns and herbs within two months post-fire in Pepperwood Preserve. Photo by Saxon Holt

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

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

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 areas, such as home sites and 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 resistant landscaping near home sites.

Above: A rich array of wildflowers naturally sprouting in the spring after the 2015 Valley Fire. Photo by Reny Parker

Below: Landscaping with native plants have many benefits, including providing habitat for wildlife; here, western redbud with a Bewick's wren. Photo by Bob Watkins

3. Is seeding effective at stabilizing soil post fire?

The answer depends on timing, rain, and slope. In order 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, before seeded species are established, seeding has little or no effect on erosion or flooding.

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

4. Will seeding help the recovery of native 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 non-native mustard (*Brassica*) was found in plots seeded with Italian rye grass (*Festuca perennis*) than in those allowed to revegetate naturally.

Refer to pages 34-35, "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 1-2 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).

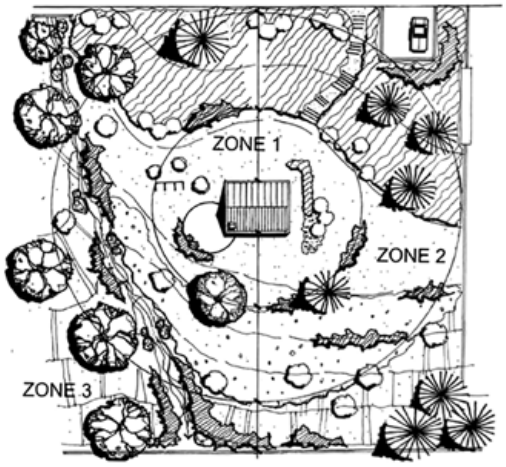
5. What is fire resistant landscaping?

Fire resistant landscape in Marin County. Photo by Mieko Watkins

Unfortunately, there are no fireproof plants. However, a fire resistant landscape approach with a "defensible space" uses high moisture/low flammability plants to limit fuels for fire and reduces the potential for vegetation to carry flames through the landscape by careful spacing and plant height selection. Fire resistant landscaping can include drought tolerant and native species, and plants with low sap or resin (such as hardwoods instead of conifer species).

Various books provide significant details on fire-resilient landscaping techniques, with topics such as spacing and groupings of plants, selections of plants, removal of weeds and grasses, fuel breaks, prescribed burns, consideration of slopes and other topographic features, ecology of sites, etc. For example, well-spaced larger plants and specific low growing plants can reduce the spread of fire by catching embers or acting to absorb heat, while groundcovers of grasses and shrubs can increase the risk of fire spreading. Some general recommendations are:

- Prevent trees and large shrubs from touching or over-hanging structures (e.g., keep limbs 15 ft. or 5 m away).
- Design with fire retardant or resistant plants such as moist broadleaf plants (e.g., vegetables, low growing perennials) and hardscape, and provide good access to water within 30 feet (10 m) of the home.
- Remove any flammable materials (e.g., fences, stacked wood, trash cans) more than 30 feet (10m) from your home.
- Keep garden zone clear of all ignitable litter and dried grasses, especially within 70 feet (23 m) of your home. Do not promote areas with wild, uncut grasses. Keep them mowed if they're around your home.
- Clear dead and diseased plants, especially within 0 to 70 feet (23 m) of your home/structure.
- Keep the majority of plants as lower growing (typically no higher than 1.5 feet or 0.5 m high) and fire retardant or non-flammable, within 30 to 70 feet (10 to 23 m) of your home.
- Create horizontal and vertical spacing between plants. Space trees and shrubs by a distance of one or two times their height – especially at distances of 30 to 100 feet (10 and 33 m) beyond your home. These should be low-maintenance plants that require little application of water or pruning, including moist broadleaf trees and shrubs.
- Perform maintenance on a regular basis: groom, dead-head, prune, rake, tidy up. Periodically re-open the vertical gaps as plants grow to remove potential fire ladders.
- Control weeds and unwanted plants between 30 and 120 feet (10 and 40 m) or more beyond your home.



Firescaping with three zones around a house or structure to increase fire-resiliency: Zone 1 extends from the structure to 30 ft., Zone 2 is 30 to 70 ft., and Zone 3 is 70 to 120 ft. Illustration from Richard Kent's book *Firescaping* (Wilderness Press 2005).

Other recommendations include the information developed by East Bay Munipal Utility District: http://www.ebmud.com/customers/emergency-preparedness/ (see the *Firescape* Link)

Above top, and above middle: Blue-eyed grass, and California wild rose.
Photos by CNPS Calscape, www.Calscape.org

Below: Resprouting of silk-tassel and scrub oak co-mingled with dense-flowered pedicularis.
Photo by Mike Palladini, Land Trust of Napa County

Tips for Native Plant Gardening and Restoration

Allowing the land to recover on its own is typically the best solution. This includes areas where a native seed bank is present and areas where native vegetation still survives – allow plants to germinate naturally from seed, or re-sprout on their own from living underground roots or stumps, or in the case of scorched trees, allow them to leaf out next spring. Many seemingly dead plants and trees will vigorously re-sprout within the following year or two.

In cases where erosion poses a threat to home sites and watersheds, various erosion control methods can be used. For burned branches, trees, or stumps, it is best to leave them alone unless they pose a hazard. In addition, dead trees and shrubs provide important habitat for a wide variety of post-fire animals.

When allowing the land to recover, here are some basic recommendations:

- Allow the soil to heal and plants to grow back.
- When possible, do not disturb or scrape the blackened ground as it may damage the biological soil crusts that are beneficial for stabilization and protect the existing seed bank.
- Observe how plants grow in the wild, and keep that in mind when you design your landscape. Determine the naturally occurring plant community in your area, and design your landscape with this suite of plants in mind.
- Refer to *Designing California Native Gardens* by Glenn Keator and Alrie Middlebrook or *The California Native Landscape* by Greg Rubin and Lucy Warren.
- Plant a suite of native plants that grow together in their natural habitats (i.e., co-planting of plants that typically grow together).
- Determine your soil conditions: is the soil relatively moist or dry, or alkaline or acidic? Nutrient-poor soils will foster a different suite of plants as compared to nutrient-rich.
- Don't dig up plants or collect seed from the wild. Buy nursery-propagated or locally sourced seeds.
- Use local native plants, preferably from the same watershed. By growing local native plants, you provide habitat necessary for native animals, including food, nectar, and cover.
- Manage areas to remove invasive plants and weeds.
- Visit www.calscape.org to see a map and query for plants that thrive in each area of the state. "Restore Nature One Garden at a Time!" Visit cnps.org to see our list of recommended sources from nurseries and groups who have collected locally sourced seeds and plants.

Ecological/Revegetation Landscaping

When landscaping for ecological purposes (habitat restoration, mitigation, revegetation, etc), first encourage the natural revegetation of local ecotypes of native plant species. Local ecotypes are best suited for the environmental conditions specific to your location. Actively manage against weeds and non-native invasive plants that may thrive in disturbed soils or have been introduced during firefighting or clean-up efforts.

Some active assistance may be required. Revegetate by planting seeds or plants grown from seeds, cuttings or divisions collected locally. What follows is a hierarchical list of recommended collection sites with the most desirable listed first:

1. From the home / project site.
2. From adjacent or nearby sites, such as from the same watershed at the same approximate elevation and slope aspect as the project site.
3. From other regional sources.

Horticultural Landscaping

When landscaping for ornamental purposes with naturally occurring native vegetation close to or downstream from the project site, the following cautions are recommended:

1. Prevent irrigation runoff and fertilizer and pesticide overspray into native vegetation.
2. Avoid planting species that are invasive and likely to spread from your garden. An inventory of invasive plant species to avoid is available from the California Invasive Plant Council website: http://www.cal-ipc.org/plants/inventory/, and see Lambert et al. (2010) and Landis (2010).
3. Avoid planting species that are likely to cross-pollinate wild natives growing nearby. Some examples of promiscuous cross-pollinators include California lilac (*Ceanothus*), manzanita (*Arctostaphylos*), oak (*Quercus*), monkeyflowers (*Diplacus*), and wallflower (*Erysimum*).
4. Avoid vegetation management practices that adversely impact local native vegetation (e.g., timing of brush clearance or pruning or dumping of yard waste).
5. If you wish to landscape with a species that grows locally, use plant material propagated from those wild populations (check your local native plant nursery or CNPS chapter for availability).
6. Avoid landscaping with cultivars of species that grow locally, since their genetic make-up may be unknown, non-local, or from multiple, wide-ranging populations. Cultivars of locally-occurring taxa should be avoided unless it is absolutely certain they originated locally.

Where can I buy seed and plants?

Various places in the greater Bay Area provide local plant/seed sources. Some offer non-native sources that may be useful in garden settings, so long as they do not reproduce naturally on their own (e.g., Mediterranean drought tolerant sages). In general, we recommend the following for locally sourced, native plants in the North Bay region:

CNPS Milo Baker Chapter seasonal plant sales
www.milobaker.cnps.org

Cal Flora Nursery, Santa Rosa
www.calfloranursery.com

Mostly Natives Nursery, Point Reyes Station
www.mostlynatives.com

Wild Garden Farms (formerly North Coast Natives), Petaluma
www.northcoastnativenursery.com

Larner Seeds, Bolinas
www.larnerseeds.com

Emersa Gardens wholesale and retail nursery, Santa Rosa:
www.emerisa.com

Annie's Annuals
www.anniesannuals.com

Visit calscape.org to find local native plants that grow in your area, select those that are easiest to grow, and connect with local nurseries that carry the plants you have chosen.

Calscape.org

Invasive Plants

Invasive plants are those species that spread so rapidly that they dramatically 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. CNPS has summaries of invasive plants from across the state that are of most concern, especially those that can have lasting effects in changing fire regimes (see Lambert and Landis).

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 non-native 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. In some of the North Bay areas that burned, French broom particularly played a role in providing extra fuel to the fire, allowing the fires to burn more intensely.

French broom has invaded this oak woodland, posing higher fire risk. Photo by Marin Municipal Water District

Grasslands or understories dominated by invasive herbaceous plants within the fire areas contained high fuel loads from annual and perennial grasses, such as Harding grass (*Phalaris aquatica*), medusahead (*Elymus caput-medusae*), wild oats and bromes (*Avena* and *Bromus* spp.), ryegrass (*Festuca perennis*), and non-native thistles (*Carduus, Silybum, Cirsium* spp.). 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.

In addition, invading plants with high flammability can ignite easier and burn more 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.

Red brome (*Bromus rubens*). Photo by Neal Kramer

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

Other annual species like thistles, stinkwort (*Dittrichia graveolens*), star thistle (*Centaurea* spp.), black mustard (*Brassica nigra*), filaree (*Erodium* spp.), and various annual grasses (especially *Bromus* spp.), 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 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* ssp. *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 pose risks of continued 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 non-native grassland vegetation.

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

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 non-natives, 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.

Prescribed fire is a powerful tool to control invasives such as French broom. Photo by Marin Municipal Water District

Grasslands and oak woodlands may benefit from fire's removal of invasive annual grass thatch. Our fire-adapted natives will sprout, if present in the seed bank, and manually removing invasive plants will give them space to grow. Within Bouverie Preserve in Glen Ellen, a prescribed burn in May of 2017 eliminated the invasive grass layer (both the thatch and the above ground plants). These areas did not re-burn or carry fire through the landscape during the Nuns Fire, thus illustrating how important it may be to manage grasses in the landscape.

However, areas may already have been heavily invaded and/or have plenty of sources for invasive plants to infest the area afterwards. Plus, areas may lack a native seed bank to rebound after fire – especially in areas where fires have occurred too frequently and weedy plants are abundant. These situations represent great opportunities to seed in and restore with native species. It's never a cut-and-dry situation, so different strategies will be useful depending on the situation.

Star thistle
(*Centaurea sostitialis*)
Photo by Neal Kramer

What Can Land Owners and Managers Do?

It is important to remain vigilant about the potential of invasive species to gain dominance or spread in areas during the seasons following the fires. This is a limited time opportunity, though, because a fine line exists between a species that can take advantage of fire and an opening for invasive species management.

If the seedlings or re-sprouts of non-natives are not controlled in the first couple of years after the fire, the problem could pose worse risks than before the fire. Ultimately, non-natives once invaded 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 wild fire, while allowing for native plants to reclaim the habitat. Taking proactive steps at your own home site to do mechanical removal (e. g., hand pull, dig out, hoe, cut down and/or rake away) invasive plants is one approach.

Other more comprehensive mechanical and cultural techniques may be needed, 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.

Thousands of French broom seedlings sprouting post-fire in the fall of 2017, under an oak woodland. Photo by Wendy Trowbridge

General approaches to reduce the potential for non-native plant infestations include:

1) Minimize or eliminate 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) Minimize the amount of resources available to any such plants that might find their way into the burned area, and 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 fire-risk, including 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

We see a growing consensus in the research community on two important points regarding seeding grasses following wildfire:

1) this management practice is usually not cost-effective, and

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

Potential Negative Effects

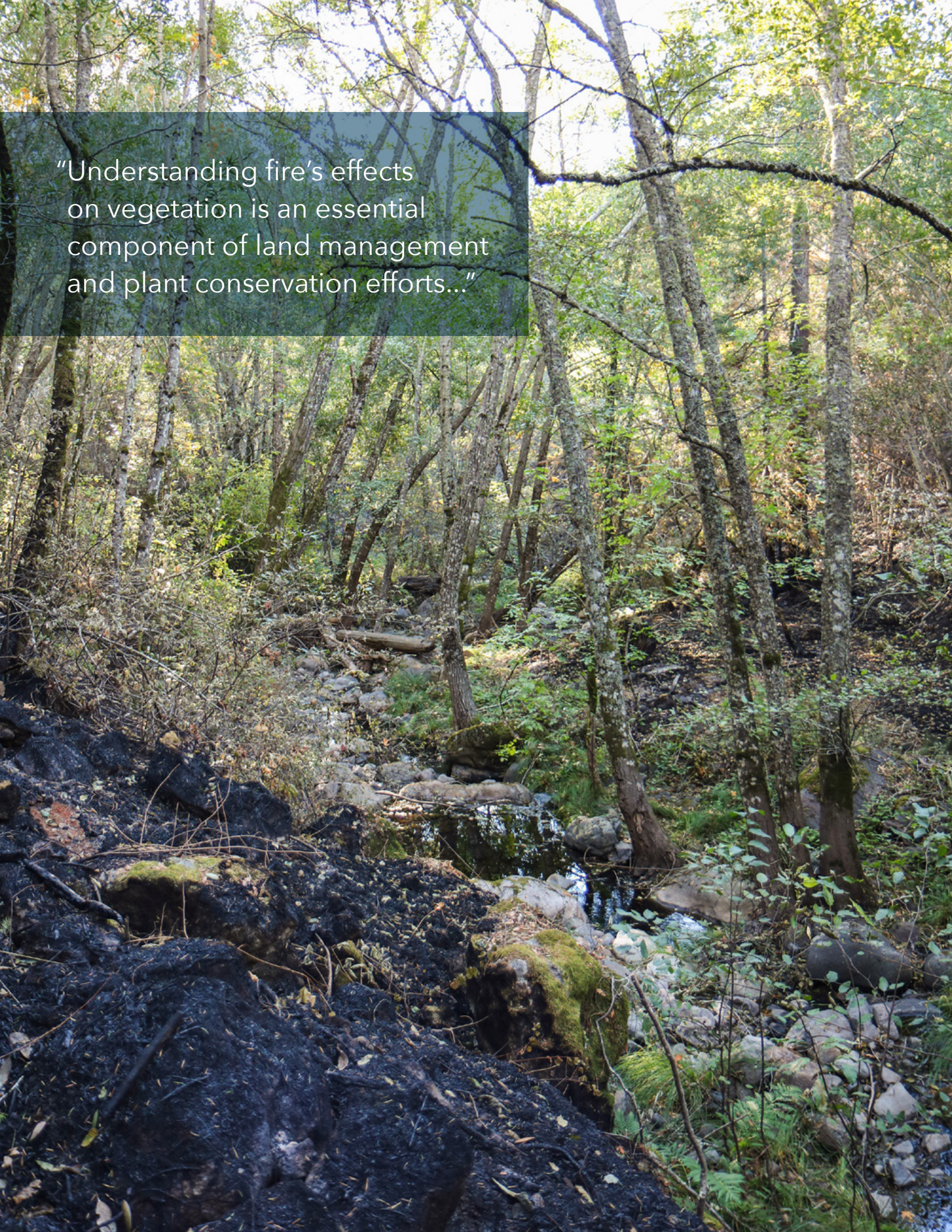
- Seeds of annual non-native grasses (like wild oats, bromes, ryegrass, etc.) develop shallow root systems that have little to no effect on slope stability.
- These grasses actually can increase infiltration, which can negatively affect steeper slopes that are prone to sliding: seeding, especially on slide prone slopes, can increase the likelihood of slope saturation and risk 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 and "dry erosion".
- 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.
- Seeding is usually not cost effective and doesn't safeguard human life or property.
- 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 and/or where ecosystems are threatened by non-native plant invasions, seeding of native grasses may be justifiable (i.e., seeding of locally sourced native perennials in heavily disturbed sites).
- Seeding certain grasses (i.e., sterile barley or wheat, or perennial native grasses) at low densities can sometimes reduce erosion and non-native, invasive encroachment.
- Seeding with proper perennial grasses and forbs (including proper seedbed preparation and location and proper care and maintenance) can help reduce the following: surface erosion, sediment, and runoff in first and/or first 2 seasons following wildfire depending on seed choice, site conditions, water holding ability of soil, timing, supplemental irrigation, seeding cover, etc.

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.

Natural recovery in spring 2013 after the 2012 North Fire along Cow Mountain in Mendocino County, of chaparral, with chamise and toyon resprouting, and wildflowers such as sky lupines, California poppies, and tuberous skullcap. Photos by Kerry Heise



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

SPECIAL NOTE: Response of oak woodlands and forests to fire is largely driven by the amount of fuels in the landscape and the local weather during the fire. If trees survive and the integrity of the landscape is maintained, fires can actually provide a benefit by removing fuels that would be otherwise be labor-intensive to remove.

Left: Riparian draw with white alder, exhibiting minimal post-fire effects. Photo by Sasha Berleman, Audubon Canyon Ranch

Above: Oak woodland and chaparral in Calabasas Creek Open Space Preserve. Photo by Sonoma County Agricultural Preservation and Open Space District

Above Left: Toyon resprouting. Photo by Mike Palladini, Land Trust of Napa County

Above Right: Fire is a natural component of Mediterranean California ecosystems. Photo by Sasha Berleman, Audubon Canyon Ranch

Special Plants and Ecosystems of the Region

An incredible mosaic of vegetation communities occurs within the North Bay Area – from Mendocino's coastal prairies to rolling oak woodlands of the Mayacamas, serpentine barrens to redwood forests, and low elevation vernal pool complexes to mountainous shrublands and forests. These plant communities vary based on climate, geology, soils, and other site conditions. Another factor shaping these ecosystems is wildfire.

Fire shapes the diversity and structure of many California plant communities. Understanding fire's effects on vegetation is an essential component of land management and plant conservation efforts within the region and across the state. However, changing climate, variable management actions, and increased human activity in combination with a general lack of data, makes it increasingly challenging to manage for and predict post-fire outcomes.

Deciduous and Evergreen Woodlands

The most common plant community of the region is oak woodlands, including evergreen oaks such as coast live oak (*Quercus agrifolia* var. *agrifolia*) and interior live oak (*Quercus wislizeni*) as well as deciduous oaks such as black oak (*Quercus kelloggii*), valley oak (*Quercus lobata*), and Oregon white oak (*Quercus garryana* var. *garryana*). Other dominant woodland trees include California bay (*Umbellularia californica*) and California buckeye (*Aesculus californica*). Small scale patches of grasslands and shrublands also often occur within these stands.

What should you do and expect for recovery of oak woodlands?

Since oak trees are well adapted to the fire environment, it is typically important to minimize removal and impacts around trees. Trees have the ability to go dormant if the canopy is burned, and their roots help stabilize the soil.

They can even go dormant for years, repairing themselves over time and sending out new leaves when they are healthy again. Evergreen and black oaks can "stump sprout", meaning, that even if the entire tree above the root crown is burned, the stump that is left behind will send out shoots or new branches, renewing its life cycle.

Moist Coastal Mixed Evergreen Forest

Coming in at a close second, mixed evergreen forest is a widespread vegetation group in the watersheds of the region. This ecosystem includes conifers like Douglas-fir (*Pseudotsuga menziesii*), ponderosa pine (*Pinus ponderosa*), knobcone pine (*Pinus attenuata*), and coast redwood (*Sequoia sempervirens*), and hardwood trees such as deciduous and live oaks, madrone (*Arbutus menziesii*), and tanoak (*Notholithocarpus densiflorus* var. *densiflorus*). Forests such as these commonly occur on north facing slopes and cooler canyons of Mendocino, Napa, and Sonoma Counties.

As with coast redwood (*Sequoia sempervirens*) forests, mature mixed evergreen forest is often a dense, multilayered forest with conifers (mainly Douglas-fir) and hardwoods in the overstory. However, this ecosystem varies in associations and density/cover depending on amount of moisture (e.g., rainfall, fog), topographic setting, time since last fire, etc.

Above: Rich mosaic of mixed evergreen forest and oak woodland showing mixed fire severity after the Nuns Fire.

Below: Higher fire severity in dense conifer forests of McCullough preserve after the Tubbs Fire. Photos by Sonoma County Agricultural Preservation and Open Space District

Will the fire affect this forest ecosystem differently than oak woodlands?

Many variables affect how severely a fire will burn in this ecosystem. Lower severity fires with less impact to the forest will be more common in areas where vegetation density is lower, whether that density is natural or has been enhanced by active management like prescribed fire and stewardship-driven forest thinning.

Some trees will naturally respond by stump sprouting, including tanoak and madrone trees. Other trees actually require fire for their germination. For example, knobcone pine has closed cones that only open when burned by fire, releasing seeds that grow fast in soils fertilized by the ash of plants that would have otherwise been their competitors.

What if your forest had a high density of trees or high cover of understory plants?

Higher fire severity and greater impacts will be found in areas where trees were at a high density and/or where duff was built-up on the ground and where understory plants were high in cover. This is because fire can more easily climb into the crowns of the trees. Embers from fires in tree crowns also can carry in the wind and create spot fires. Sites where non-native woody shrubs (like French broom) have invaded stands can also pose more risk since these shrubs provide extra fuels. In these situations, higher tree mortality is likely.

However, mature conifers such as Douglas-fir and pines are adapted to survive fire because their thick bark insulates their trunks' cambium and prevents mortality by fire, yet smaller trees and understory plants will naturally be thinned out of stands. If dead trees present a hazardous post-burn situation, then consult with a trained arborist to evaluate tree structure and identify trees that pose a hazard.

Annual and Perennial Grassland

Grasslands are an economically and ecologically important part of our region's native plant diversity. The North Bay supports both annual and perennial grasslands, usually in fine-scale combinations with other vegetation. Coastal prairies and grasslands occur along upper slope terraces and hills, while vernal pools and swales occur in areas that collect water. Prairies with perennial grasses occur where soils are deep and well-drained. Annual grasslands can vary floristically depending on soil depth from shallow to deep, and on soil texture from clayey to loamy.

Grasslands are remnants of historic populations. The grasslands comprise various associations of perennial, annual, native, and non-native grasses, as well as various other herbs with high micro-habitat diversity. Patches of native perennial grassland are quite rare, though they are found intermixed with annual grassland habitats and within oak woodlands and shrublands.

How will grasslands respond to fire?

After fall and winter rains, native annual and perennial grasses, as well as various native herbs will respond favorably to the nutrients added to the soil by fire affects and appear in brilliant wildflower displays. Native grasses, such as California's state grass purple needlegrass (*Stipa pulchra*), are some of the earliest species to start growing again after fire, even before the arrival of the rainy season. An amazing array of plant diversity can speckle the slopes, from poppies (*Eschscholzia* spp.), larkspurs (*Delphinium* spp.), lupines (*Lupinus* spp.), paintbrush (*Castilleja* spp.), Chinese houses (*Collinsia heterophylla*), and goldfields (*Lasthenia* spp.), to name just a few. Also, geophytes (plants with bulbs, corms or other belowground storage structures) are quite prolific after fire including wild hyacinths (*Triteleia* spp.), death camas (*Toxicoscordion fremontii*), and mariposa lilies (*Calochortus* spp.), among many others.

Unfortunately, the same nutrients that enhance native grasses and wildflowers also provide an advantage to the non-native annual grasses and forbs. Many of these weeds were accidentally introduced by European settlers, and their seeds live in abundance in the grassland soil seed bank. When amplified by post-fire nutrients, and with few natural enemies, invasive annual plants can grow larger and more abundant than in normal conditions. In some cases, they have the effect of outcompeting our native plants and reducing the brilliance of California's legendary native wildflower displays.

Perennial bunchgrass reprouting after the Atlas Fire. Photo by Mike Palladini, Land Trust of Napa County

Grassland immediately after the Nuns Fire in the fall of 2017, in which fire helped maintain this as open habitat. Photo by Sonoma County Agricultural Preservation and Open Space District

A grassland rebounding in the spring after the 2015 Valley fire with purple needgrass and mariposa lilies. Photo by Reny Parker

Chamise resprouting from its base in the spring after the 2013 Morgan Fire along Mount Diablo. Photo by Brad Heckman

Chaparral

Chaparral is often used as a general term that includes several vegetation types in the region, often dominated by chamise (*Adenostoma fasciculatum* var. *fasciculatum*), toyon (*Heteromeles arbutifolia*), McNab Cypress (*Hesperocyparis macnabiana*), Sargent cypress (*H. sargentii*), California-lilac (*Ceanothus* spp.), or manzanita (*Arctostaphylos* spp.). These woody shrubs often make chaparral impenetrable to humans, and even other animals, due to their low and dense structure. After a fire, chaparral is opened up and becomes home to a diverse community of post-fire responders.

Chaparral plants are typically drought-adapted with small, hard, thickened leaves, often redolent with rich-scented herbal resins. To survive drought, some plants "self- prune" and so intertwined dead stems can build during the long intervals between fires. Thus, chaparral stands naturally burn as canopy or crown fires, where a once dense shrub stand is reduced to ash, bare mineral soil, and standing dead stems. The "moonscape" landscape after a chaparral fire can be alarming to a casual observer. Despite the dramatic change however, hot canopy fires are a natural and healthy way for chaparral to burn.

What is expected in post-fire chaparral?

High severity fire is common in dense chaparral, here at Calabazas Creek Open Space Preserve. Photo by Sonoma County Agricultural Preservation and Open Space District

Chaparral naturally burns less frequently than grasslands and oak woodlands: any chaparral areas burn just once every 30 to 50 years, and fire intervals of a century are not uncommon. Soon after a fire, shrub species quickly begin to reclaim the landscape. "Sprouter" shrubs like chamise quickly spring back to life even when the above-ground biomass is burned away, powered by the energy stored in their lignotuber, also known as a burl. This lignotuber acts like a woody potato, storing energy over the life of the plant and between fire events, ready to sprout when the aerial portion of the plant is burned away. Other chaparral plants are "obligate seeders," plants that invest all of their energy into seed production, building up a soil seed bank that germinates en masse when triggered by wildfire.

Even as the shrubs begin to resprout, a burned site becomes rich with a community of short-lived plant species that benefit from this short window or opportunity. Many of these species are seen only every few decades, after a fire, an ephemeral explosion of fleeting color that lasts a couple years and then disappears back into the soil seed bank until the next fire. Often this unique and extraordinarily beautiful flora includes many statewide and locally rare plant species. Plant diversity and ecological dynamics in these short-lived systems are not well understood, despite high interest from many land managers, ecologists, and botanists. We still have much to learn.

Jim brush has reclaimed slopes ten years after the 2004 Geysers fire, at Modini Mayacamas Preserves. Photo by Julie Evens

How is it that these plants can remain dormant in the soil seed bank for decades, and then germinate all at once when fire has created the conditions in which they can thrive? Plant scientists are beginning to discover the incredible adaptations that trigger this burst of growth. In some cases, heat of fire melts waxy seed coats and enables water to finally permeate and trigger germination and growth. For other species, seeds are sensitive to specific chemicals in charcoal and smoke, and break their dormancy when these chemicals wash over them. Regardless, the developing wildflowers thrive in the ash, are well adapted to stand-replacing fire, and can quickly return to pre-fire conditions – as long as they don't burn too often and are not invaded by aggressive invasive species.

Should you seed grasses or other plants in chaparral post-fire?

NO! Introduced grasses compete with the tiny shrub and wildflower seedlings and so can retard healthy natural recovery. For the post-fire flora to thrive, native plants need to grow as large as possible and produce as much seed as possible to replenish the dormant soil seed bank they rely on to make it to the next fire. Any unnecessary competition by exotics put them at risk.

Additionally, introduced annual grasses are "flashy fuels" that increase the likelihood of a premature re-burn. Chaparral plants have adaptations that let them recover after fire, but these are analogous to insurance policies. If they burn too frequently then they do not have time to rebuild their stores. Seeding with grass increases frequency of fire, starves the native chaparral, and results in tragic type conversion of diverse chaparral to species-poor stands of weedy grasses and forbs (Keeley, 1995).

Moreover, seeding does little to stabilize chaparral burns. Some evidence indicates that when steep brushland slopes are type-converted to grassland, the incidence of erosion and slope failure can increase markedly due to the shallower interface between roots and underlying soil (Barro and Conard 1987). Invasive plants such as ripgut (*Bromus diandrus*), rat's tail fescue (*Vulpia myuros*), and mustards aggressively displace the native herbs that otherwise would bind and stabilize the soils. In the end, introduced species planted in burned areas may disperse and establish more widely in surrounding ecosystems, eliminating native plants and further increasing fire risk. Thus, non-natives aren't recommended for replanting.

Jepson's Ceanothus germinating from a seed bank along Snell Peak. Photo by Mike Palladini, Land Trust of Napa County

Native flowering bulbs springing forth post-fire. Photo by Mike Palladini, Land Trust of Napa County

Post-fire herbs in chaparral along Mount Diablo.
Photo by Nomad Ecology

"A burned site becomes rich with short-lived plants.... Many of these species are seen only every few decades, after a fire, an ephemeral explosion of fleeting color ... Soon after a fire, shrubs quickly begin to reclaim the landscape."

Right, Top to Bottom: Photo sequence while revisiting chaparral surveys along Mount Diablo in one, two and three years after the 2013 Morgan Fire. Photos by Nomad Ecology

Riparian Forest and Shrubland

Streams and floodplains have various riparian plant communities depending on the amount and frequency of water flows, proximity to the coast, and elevation range. At lower elevations, you will find valley oak (*Quercus lobata*), coast live oak (*Q. agrifolia*), cottonwood (*Populus balsamifera* ssp. *trichocarpa, P. fremontii*), tree willows (*Salix laevigata, S. lucida*,), box elder (*Acer negundo*), redwood, shrub willows (*S. lasiolepis, S. exigua, S. melanopsis*), California blackberry (*Rubus ursinus*), sedges (*Carex*), rushes (*Juncus*), and ferns. Along canyon bottoms and higher elevations, you will find white alder (*Alnus rhombifolia*), Oregon ash (*Fraxinus latifolia*), bigleaf maple (*Acer macrophyllum*), blue elderberry (*Sambucus nigra*), California bay, monkeyflower, sedges, ferns, among others.

Close to the mouths of coastal streams, and in marshes where the 2017 fires did not reach, are willow (*Salix hookeriana, S. sitchensis*) and alder (*Alnus rubra*) stands, pacific silverweed (*Agentina egedii*), and water-parsley (*Oenanthe sarmentosa*) along with various sedges, rushes, and other herbs.

> "Thankfully, riparian areas act as moist buffers where fires don't typically burn severely... all the slopes are upstream of sensitive habitat for wildlife."

What concerns for erosion are present for riparian ecosystems?

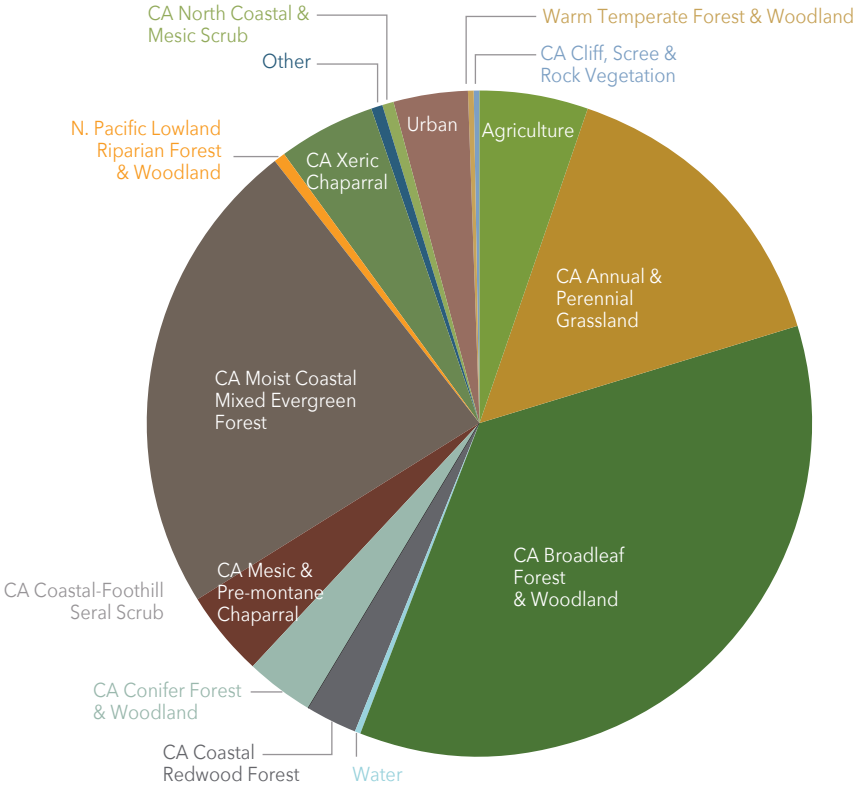
Thankfully, riparian areas act as moist buffers where fires don't typically burn severely except in sites infested with weeds. However, erosion of sediments, toxic ash from home sites, and other debris from upslope or upstream features can threaten riparian habitats. In the North Bay Area fires, all the slopes are upstream of sensitive habitat for wildlife, including for coho, chinook, and steelhead salmon. Fine sediment and pollution running in the creeks are a serious problems for spawning habitat.
Also, hazardous waste products associated with burn structures need to be addressed regardless of what is downstream.

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

Baseline Vegetation Maps

Baseline, pre-fire maps of vegetation were completed in Sonoma and Napa Counties in the past 1-15 years (SCAPOSD 2017, Thorne et al. 2004). Plus, other data sources exist in these counties (e.g., Pepperwood Preserve data, Audubon Canyon Ranch data, Sonoma County carbon storage data, etc.). These resources are now useful for various purposes (targeting restoration actions of invasive plants, evaluating carbon storage in different habitats). They also are useful for understanding the effects of fire on vegetation towards developing long-term conservation and monitoring strategies for myriad plants and plant communities, which had varying degrees of fire severity.

Right: Percent of habitats burned by vegetation group for the fire areas in Sonoma County



Acreage of habitats burned by vegetation group and by alliance or other name.

Group	National Vegetation Classification Standard Name	Acres	Total Acres
Agriculture	Agricultural & developed vegetation	3125	6,049
	Vineyard	2705	
	Deciduous orchard, vineyard	164	
	Irrigated row and field crops	56	
CA Annual & Perennial Grassland	California annual and perennial grassland	14709	17,202
	California annual forb/grass vegetation	2492	
CA Broadleaf Forest & Woodland	*Quercus agrifolia*	11651	49,946
	Californian broadleaf forest and woodland	7193	
	Quercus spp. (*agrifolia, douglasii, garryana, kelloggii, lobata, wislizeni*)	6902	
	Umbellularia californica	6720	
	Quercus douglasii	2751	
	Quercus wislizeni	2155	
	Quercus chrysolepis	1344	
	Quercus lobata	1301	
	Quercus kelloggii	893	
	Aesculus californica	37	
CA Cliff, Scree & Rock Vegetation	Barren	218	266
	Central California coast ranges cliff and canyon	46	
	Allium spp. – *Streptanthus* spp. – *Hesperolinon* spp. Serpentinite Sparse	2	
CA Coastal Redwood Forest	*Sequoia sempervirens*	2,815	2,815

Group	National Vegetation Classification Standard Name	Acres	Total Acres
CA Coastal-Foothill Seral Scrub	*Eriodictyon californicum - Lupinus albifrons*	7	7
CA Conifer Forest & Woodland	*Pinus attenuata*	3,202	3,871
	Pinus sabiniana	355	
	Hesperocyparis sargentii	292	
	Hesperocyparis macnabiana	22	
CA Mesic & Pre-montane Chaparral	*Arctostaphylos (canescens, manzanita, stanfordiana)*	3,381	4,843
	Quercus durata	703	
	Californian mesic chaparral	427	
	Quercus wislizeni (shrub)	258	
	Californian serpentine chaparral	74	
CA Moist Coastal Mixed Evergreen Forest	*Pseudotsuga menziesii*	12,173	26,615
	Quercus garryana (tree)	6,818	
	Vancouverian evergreen broadleaf and mixed forest	4,227	
	Arbutus menziesii	3,196	
	Notholithocarpus densiflorus	111	
	Pseudotsuga menziesii – Notholithocarpus densiflorus	90	
CA North Coastal & Mesic Scrub	*Baccharis pilularis*	448	450
	Ceanothus thyrsiflorus	2	
CA Xeric Chaparral	*Adenostoma fasciculatum*	4,474	5,499
	Californian xeric chaparral	867	
	Ceanothus cuneatus	95	
	Arctostaphylos viscida	63	
N. Pacific Lowland Riparian Forest & Woodland	Vancouverian riparian deciduous forest	613	788
	Acer macrophyllum	97	
	Alnus rhombifolia	78	
Other	Western North American freshwater marsh	154	523
	Arid west freshwater emergent marsh	1	
	Eucalyptus spp. – *Ailanthus altissima – Robinia pseudoacacia*	71	
	Pinus radiata	3	
	Western North America vernal pool	12	
	Juncus arcticus (var. *balticus, mexicanus*)	7	
	Carex serratodens	1	
	Rubus armeniacus – Sesbania punicea – Ficus carica	13	
	Southwestern North American riparian/wash scrub	89	
	Pinus ponderosa – Pseudotsuga menziesii	67	
	Pinus lambertiana	53	
	Unknown	4	
	Southwestern North American riparian evergreen and deciduous	40	
	Populus fremontii	1	
	Western North American freshwater aquatic vegetation	6	
Urban	Urban	4,104	4,104
Warm Temperate Forest & Woodland	Temperate forest	311	311
Water	Riverine, lacustrine, estuarine, marine	207	207

"Recent fires offer many special opportunities to better document the post-fire flora along the North Coast and Northern California Coast Ranges."

Rare Plant Species

Mendocino, Napa, and Sonoma Counties are home to an incredibly rich flora, including more than 300 rare plant species. Many of these rare plant species are endemic to the area, meaning they occur nowhere else in the world. Even though we have been very successful at saving California plants from extinction, we have lost 22 plants in California and the North Bay is notable for having five plants believed to be extinct, though CNPS and others are working to rediscover or de-extinct these species.

Many North Bay communities have their own unique set of rare plants. The great diversity of rare fire-dependent shrubs includes Ceanothus endemic to Rincon Ridge (*C. confusus*), Calistoga (*C. divergens*), and Sonoma (*C. sonomensis*); gardeners also treasure the elegant manzanitas of Vine Hill (*Arctostaphylos densiflora*), Konocti (*A. manzanita* subsp. *elegans*), and Rincon Ridge (*A. stanfordiana* subsp. *decumbens*). The biological diversity of the North Bay, combined with a proud culture of private land stewardship, offers interesting challenges and special opportunities for helping these special plants.

"Amazingly, plants with tiny seeds can live dormant in the seed bank for 80 years or more, a testament to the evolutionary relationship between some plant species and fire."

Rare Plants and Fire

The recent fires burned tens of thousands of acres of native plant habitats, and the consequences for sensitive rare plants are not well understood. On one hand, some species are known to respond well to fire. Those plants well adapted to fire are known by scientists as pyrophytes, and some will only germinate when activated by smoke, heat, and/or chemical triggers associated with fire. Many fire-following rare plants are short-lived such as false lupine (*Thermopsis macrophylla*) or Mount St. Helena morning-glory (*Calystegia collina* subsp. *oxyphylla*). Abundance of rare plants such as these is amplified in post-fire years, and they fade into nearly unnoticeable populations between fires.

Brewer's calandrinia (*Calandrinia breweri*) is a notable fire follower, a small annual plant that spends most of its life cycle as a tiny seed in the soil seed bank, waiting for fire to coax it above ground to flower, fruit, and set seed – before the seeds return again to their secret life underground. Amazingly, plants with tiny seeds like Brewer's calandrinia can live dormant in the seed bank for 80 years or more, a testament to the evolutionary relationship between some plant species and fire.

Left: St. Helena fawn lily (*Erythronium helenae*) prolifically blooming post-fire.

Above Left: Hall's harmonia (*Harmonia hallii*) along Snell Peak. Photos by Mike Palladini, Land Trust of Napa County

Above Right: Brewer's calandrinia is a widespread but rare post-fire herb. Photo by Nomad Ecology

Redwood Lily (*Lilium rubescens*). Photo by Vernon Smith

Raichei Manzanita (*Arctostaphylos stanfordiana* ssp. *raichei*). Photo by Steve Matson

Bristly Leptosiphon (*Leptosiphon acicularis*). Photo by Vernon Smith

Konocti Manzanita (*Arcostaphylos manzanita* ssp. *elegans*). Photo by Dana York

While we know much about the life history strategies of these fire followers, we lack information on the following: how variabilities in fire severity affect these species, how fire influences the life spans of seeds in the soil seed bank, and how variability in rainfall during the years following fire effect secondary germination events of these fire followers. Overall, we know little to nothing 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 that are not directly related to fire-adapted ecosystems.

How does fire affect rare plant species that grow in vernal pools, like Sonoma sunshine (*Blennosperma bakeri*) or Baker's navarretia (*Navarretia leucocephala* subsp. *bakeri*)? Or Clara Hunt's milkvetch (*Astragalus claranus*) or serpentine collomia (*Collomia diversifolia*), plants with unusual soil requirements? How does fire impact coast iris (*Iris longipetala*), which is found in moist coastal prairie and forest? Fires in these ecosystems are less frequent, yet with a climate change future, how will burning and shorter fire return intervals affect these rare species?

As climate change alters the environment, and as invasive species and altered fire regimes further stress rare plant populations, it becomes increasingly important to explore questions like these so we can better understand, appreciate, and protect these rare and special creatures.

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

The recent fires offer many special opportunities to better document the post-fire flora in the Northern California Coast Ranges. We are particularly lacking 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 pre- and post-fire.

There are two major reasons that this is a special opportunity to advance our understanding. First, fires have opened access to lands that previously were too densely vegetated for field expeditions. Second, fires stimulate growth of plants that may not appear any other time. 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 engendered widespread interest in contributing to the effort, another important reason to work now to help landowners in their ongoing effort to more fully understand the lands they steward.

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 Scientist" effort is a fun and engaging way to learn about local, rare plants, while collecting data and specimens that make a tremendous scientific contribution.

This season, Treasure Hunts are focusing on burned areas. Numerous special rare plants can be found in wildlands of the North Bay. 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 be able to offer this service to as many as possible. Scientists and volunteers will make a special commitment to serving areas affected by the recent fires, in order 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 Center 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.

> "Rare Plant Treasure Hunts are focusing on burned 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* ssp. *oxyphylla*)
Photo by Robert Sikora

Rare Plants of Mendocino, Napa, and Sonoma Fall 2017 Fire Areas	Conservation Status			Broadleaved Upland Forest	Chaparral	Chenopod Scrub	Cismontane Woodland	Closed-Cone Coniferous Forest	Coastal Prairie	Coastal Scrub	Coyote Brush Scurb	Lower Montane Coniferous Forest	Marsh (Freshwater)	Marsh (Salt)	Marshes and Swamps	Meadows and Seeps	North Coast Coniferous Froest	Riparian Scrub	Upper Montane Coniferous Forest	Valley and Foothill Grassland	Vernal Pools
	CRPR	STATE	FED																		
Alopecurus aequalis var. *sonomensis*	1B.1	None	FE												•			•			
Amorpha californica var. *napensis*	1B.2	None	None	•	•		•														
Anomobryum julaceum	4.2	None	None	•								•					•				
Antirrhinum virga	4.3	None	None		•							•									
Arctostaphylos densiflora	1B.1	CE	None		•																
Arctostaphylos manzanita ssp. *elegans*	1B.3	None	None		•		•					•									
Arctostaphylos manzanita ssp. *laevigata*	1B.2	None	None		•																
Arctostaphylos stanfordiana ssp. *decumbens*	1B.1	None	None		•		•														
Astragalus claranus	1B.1	CT	FE		•		•													•	
Astragalus rattanii var. *jepsonianus*	1B.2	None	None		•		•													•	
Blennosperma bakeri	1B.1	CE	FE																	•	•
Brodiaea leptandra	1B.2	None	None	•	•		•					•								•	
Calandrinia breweri	4.2	None	None		•					•											
Calochortus uniflorus	4.2	None	None						•	•						•	•				
Calystegia collina ssp. *oxyphylla*	4.2	None	None		•							•								•	
Castilleja ambigua var. *ambigua*	4.2	None	None						•	•	•				•					•	•
Ceanothus confusus	1B.1	None	None		•		•	•													
Ceanothus divergens	1B.2	None	None		•																
Ceanothus purpureus	1B.2	None	None		•		•														
Ceanothus sonomensis	1B.2	None	None		•																
Centromadia parryi ssp. *parryi*	1B.2	None	None		•				•						•	•				•	
Collomia diversifolia	4.3	None	None		•		•														
Cordylanthus tenuis ssp. *brunneus*	4.3	None	None		•		•	•													
Cryptantha excavata	1B.1	None	None				•														
Downingia pusilla	2B.2	None	None																	•	
Erigeron biolettii	3	None	None	•			•										•				
Erigeron greenei	1B.2	None	None		•																
Eryngium constancei	1B.1	CE	FE																		•
Erythronium helenae	4.2	None	None		•		•					•								•	
Fritillaria liliacea	1B.2	None	None				•		•	•										•	
Gratiola heterosepala	1B.2	CE	None												•						•
Harmonia hallii	1.B2	None	None		•																
Harmonia nutans	4.3	None	None		•		•														
Hemizonia congesta ssp. *calyculata*	4.3	None	None				•													•	
Hemizonia congesta ssp. *congesta*	1B.2	None	None																	•	

Rare Plants of Mendocino, Napa, and Sonoma Fall 2017 Fire Areas	Conservation Status			Broadleaved Upland Forest	Chaparral	Chenopod Scrub	Cismontane Woodland	Closed-Cone Coniferous Forest	Coastal Prairie	Coastal Scrub	Coyote Brush Scurb	Lower Montane Coniferous Forest	Marsh (Freshwater)	Marsh (Salt)	Marshes and Swamps	Meadows and Seeps	North Coast Coniferous Froest	Riparian Scrub	Upper Montane Coniferous Forest	Valley and Foothill Grassland	Vernal Pools
	CRPR	STATE	FED																		
Hesperolinon adenophyllum	1B.2	None	None		•		•													•	
Hesperolinon bicarpellatum	1B.2	None	None		•																
Horkelia tenuiloba	1B.2	None	None	•	•															•	
Hosackia gracilis	4.2	None	None	•			•	•	•	•	•				•	•	•			•	
Iris longipetala	4.2	None	None						•			•				•					
Juglans californica	4.2	None	None		•		•			•								•			
Lasthenia burkei	1B.1	CE	FE													•					•
Layia septentrionalis	1B.2	None	None		•		•													•	
Leptosiphon acicularis	4.2	None	None		•		•		•											•	
Leptosiphon jepsonii	1B.2	None	None		•		•													•	
Leptosiphon latisectus	4.3	None	None	•			•														
Lilium rubescens	4.2	None	None	•	•							•					•		•		
Lomatium repostum	4.3	None	None		•		•														
Lupinus sericatus	1B.2	None	None	•	•		•					•									
Melica spectabilis	4.3	None	None									•				•			•		
Micropus amphibolus	3.2	None	None	•	•		•													•	
Microseris paludosa	1B.2	None	None				•	•		•										•	
Navarretia leucocephala ssp. *bakeri*	1B.1	None	None				•					•				•				•	•
Orobanche valida ssp. *howellii*	4.3	None	None		•																
Oxalis suksdorfii	4.3	None	None	•													•				
Penstemon newberryi var. *sonomensis*	1B.3	None	None		•																
Perideridia gairdneri ssp. *gairdneri*	4.2	None	None	•	•				•											•	•
Plagiobothrys lithocaryus	1A	None	None		•		•													•	
Puccinellia simplex	1B.2	None	None			•										•				•	•
Ranunculus lobbii	4.2	None	None				•										•			•	•
Ribes roezlii var. *amictum*	4.3	None	None	•			•					•							•		
Ribes victoris	4.3	None	None	•	•																
Sidalcea oregana ssp. *valida*	1B.1	CE	FE													•					
Streptanthus barbiger	4.2	None	None		•																
Streptanthus brachiatus ssp. *brachiatus*	1B.2	None	None		•			•													
Streptanthus glandulosus ssp. *hoffmanii*	1B.3	None	None		•		•													•	
Thermopsis macrophylla	1B.3	CR	None		•																
Toxicoscordion fontanum	4.2	None	None		•		•					•			•	•					
Trifolium amoenum	1B.1	None	FE								•									•	
Trifolium buckwestiorum	1B.1	None	FE	•			•		•												
Triteleia lugens	4.3	None	None	•	•					•		•									
Viburnum ellipticum	2B.3	None	None		•		•					•									

Fire Awareness and Preparedness in the Future

How Can We Protect Ourselves From the Next Fire?

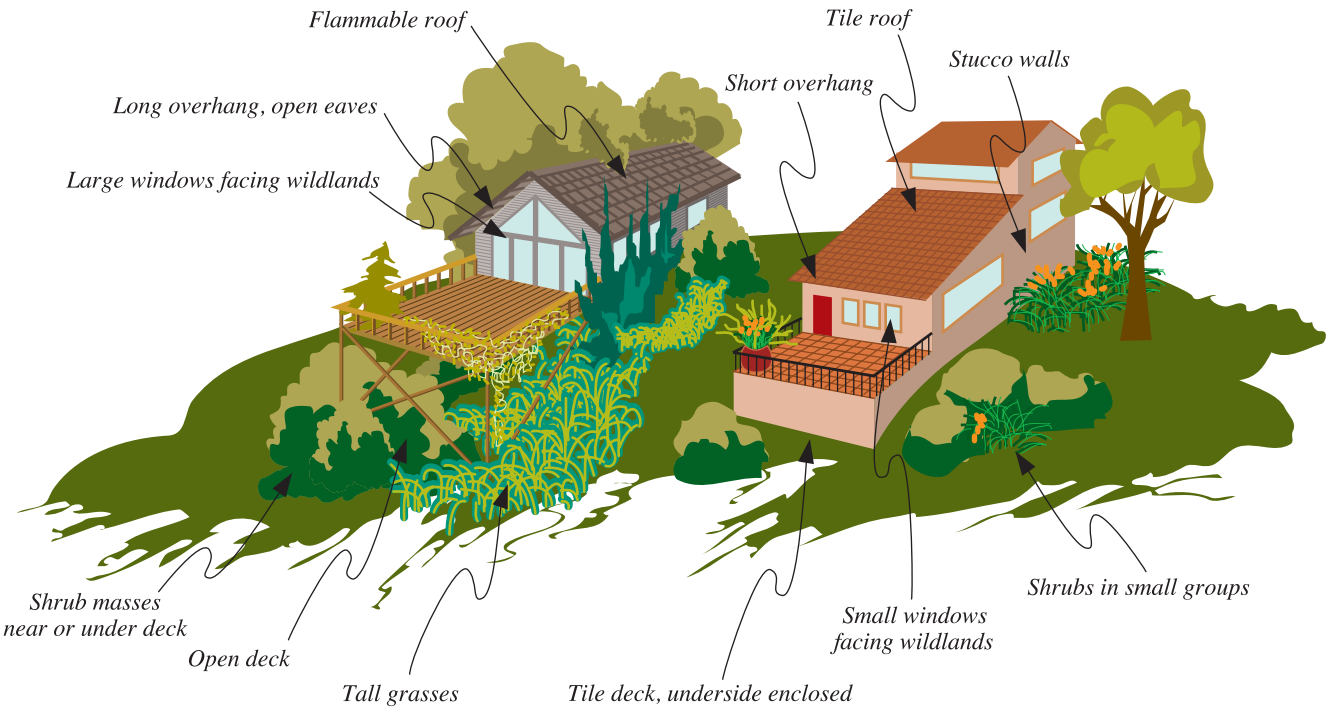
After observing many destructive fires in California over the past 20 years, science has demonstrated that the most effective and efficient way to protect lives and property is from "*the house out*" rather than from the wildlands in. This means addressing the potential flammability of homes, around homes and communities first.

Fire resistant landscaping, photos by Pete Veilleux, East Bay Wilds, and Veronica Bowers, CNPS Milo Baker Chapter

A set of guidelines to increase fire preparedness are presented here:

1. Through the planning process, fire corridors and high fire hazard areas should be properly considered before additional developments can be permitted.
2. New developments within two miles of wildlands should have fire safe construction (e.g., ember resistant vents, non-flammable roofing, minimal wood exposure, metal framed double pane windows, external sprinklers.).
3. Assistance should be considered for older communities within two miles of wildlands to help residents retrofit structures with critical fire-safe features.
4. One hundred foot defensible space regulations should be enforced that include removal of any flammable materials within 30 feet of the home (e.g., fences and stacks of wood), removal of flammable cultivars throughout (e.g., *Eucalyptus*, Monterey, and other non-local pines), and proper thinning (not clearing) of native vegetation in the 30 to 100 foot (10 to 33 meter) zone.
5. The creation and maintenance of properly thinned, 100 foot (33m) buffers around communities in high fire hazard zones should be considered.
6. Consider creating limited, strategic fuel breaks near communities for firefighter safety and fire suppression opportunities.

Landscaping around home sites with fire-wise design



Above: Landscaping around home sites with fire-wise design (on right) and with poor design (on left), where arrangement and spacing of vegetation are critical. Image by EBMUD 2013

Left: View of native plant garden that essentially served as a fire break protecting the Dwight Center. Photo by Lisa Micheli

When developed with fire in mind, native plant gardens can be a powerful tool for landscaping around residences and structures. CNPS and others encourage homeowners to select and design gardens with native, fire-adapted plants – they also provide added benefits for pollinators and added beauty to our built environment.

To learn more about native plant gardening and garden designs, please join CNPS. You can also visit the Calscape (www.Calscape.org) to explore plant selections for your local area and gardening ideas.

Questions About the North Bay Area Fires of 2017

1. Why Were the Fires so Fierce and Fast on the night of October 8th?

The fires were powered by strong, sustained Diablo winds with gusts of 70+ miles per hour. Combined with low humidity and drought, the winds created a firestorm that propelled burning embers a great distance onto any available surface. This created conditions that easily ignited structures and made it impossible for the flames and flying embers to be contained. Similar winds propelled the 1964 Hanly Fire, a blaze which burned nearly the same territory as the Tubbs Fire but was even larger. While both the 1964 Hanly fire and the 2017 Tubbs fire spread similarly, one main difference between the two fires is that in 2017 many more homes lay in the path of the fires.

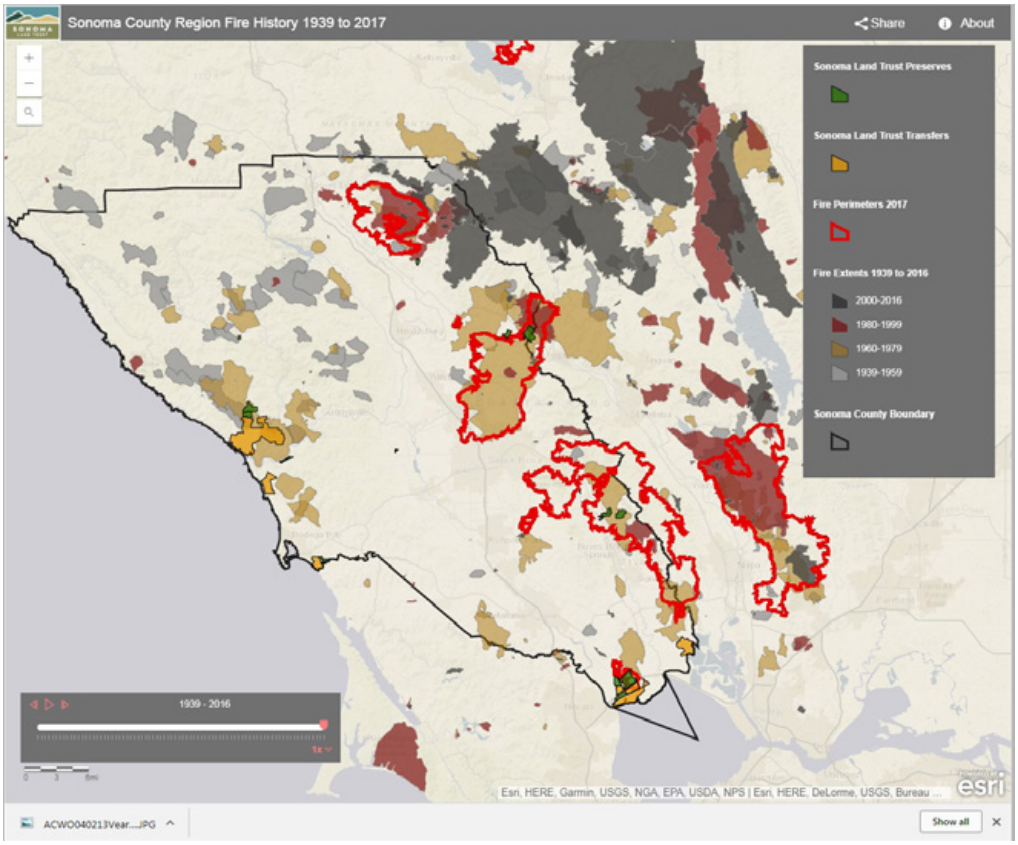
2. What is the Natural Fire Pattern in Napa and Sonoma Counties?

Napa and Sonoma Counties have some of the lowest lightning frequencies, and hence lightning-caused fire, in California. From 1919 to 2016, Sonoma County had 489 fires per million hectares per year, of which only 6 were from lightning. Therefore, before humans arrived in the region, fires were likely spaced on the order of 50 – 100 years or more.

Native Americans in this region have a long and nuanced relationship with fire. For thousands of years, Native Americans have used fire as a key management tool to clear vegetation and improve hunting and gathering. Pre-European fire return intervals in some parts of the Mayacamas likely had a fire return interval of around seven years (Steve Barnhart, pers. comm.), and there was more chaparral and less forested area than presently (Arthur Dawson pers. comm.).

Today, in grasslands, oak woodlands, and savannahs with an understory of grasses, repeat fire at shorter intervals (i.e., 10 to 50 years) and regular grazing can help maintain them. However, increasing fire frequency can lead to the elimination of native forests and shrublands, as invasive European grasses burn, then become more abundant, and then fuel more fires in a cycle of landscape conversion.

Below: Sonoma County region fire history. Interactive map by Joseph Kinyon, Sonoma Land Trust. Data from CalFire FRAP.



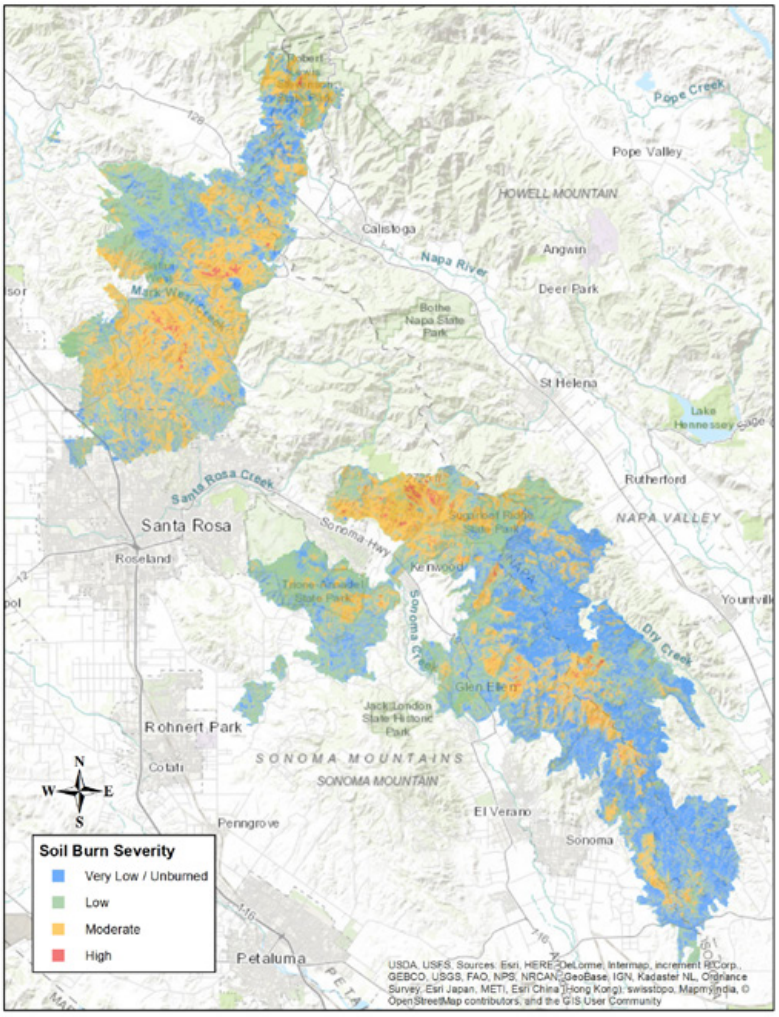
3. How Did Native Vegetation Interact with the Fires?

The 2017 fires burned through a rich mosaic of woodlands, shrublands, and grasslands. As with most wildfires, the impacts were patchy. Some areas burned more intensely (hotter) than others, consuming different amounts of a community's organic material (severity). Communities like chaparral naturally burn with high-severity, and very little is left after a chaparral fire; in contrast, oak woodlands and Douglas fir forests usually burn with mixed severity. Consequently, there are 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 some areas has been changed dramatically. In some forested areas there has been 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 non-native 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 had during the 2017 fires, there is abundant fuel for spreading the flames, and the wind provides the mechanism for propelling burning embers (NOTE: CalFire's David Shew estimated that 80-90% 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.

Below: Map of soil burn severity in the Tubbs and Nuns fire areas. Map by SCAPOSD, data from USFS WERT report.



4. Why Did Some Areas Burn More Severely Than Others?

Every plant community has its own unique relationship to fire, and this relationship is often revealed by examining characteristics of the dominant plants. For example, madrone and bay laurel are vigorous re-sprouters and come back after fire by sending up new shoots from near surface burls. In manzanita and *Ceanothus* species that are "obligate seeders," seeds are stimulated to germinate by the chemicals in the charred wood or smoke produced by immolation of the parent plants. In contrast, Douglas fir, redwood, and most oak trees

"Mixed-severity fires create extremely complex, post-fire environments... that provide important habitats for a large diversity of species."

have thick bark that provides protection to the tree's growing tissues, reflecting the fact that these trees live in communities that generally experience cooler, mixed-severity fires. However, from time to time high-severity fires still occur in such forests, periodically consuming large patches of otherwise fire-resistant trees.

5. Did Sudden Oak Death Play a Role in the Fires?

Contrary to popular rumor, the fires were not caused by Sudden Oak Death (SOD). The relationship between fire behavior and tree pests or diseases is *far* from straightforward. While there is evidence of 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.

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

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

For example, during the Big Basin fires of Big Sur, oaks suffering from early-stage 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 bay laurels. As a result, SOD-invaded forests can see an increase of gaps and in the number of smaller, fire-intolerant bay laurels, 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 bay laurels). It remains to be determined whether local hotspots may have also occurred due to drought-related tree mortality and gaps.

Because homes mimic gaps in a forest canopy, the presence of dead trees should be minimized near dwellings. It has been repeatedly documented that such dead trees will significantly increase flame length and the intensity of the fire front. 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.

6. 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

our 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. Non-native weeds may quickly spread in disturbed areas. Restoring such disturbed 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.

Immediately post-fire landscape at Snell Peak Preserve, after the 2014 Butts Fire. Photo by Mike Palladini, Land Trust of Napa County

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. Emergency protection strategies are being employed, such as in the Sonoma Valley through the Sonoma Ecology Center and through the local Resource Conservation District and NRCS contacts.

7. Will Our Natural Environment Recover from the Fires?

The fires we experienced in 2017, while infrequent, were natural events driven by strong winds and dry conditions. Most of the plants in the region possess adaptations that help them survive the flames or regenerate post-fire, and they should continue to flourish.

Many shrubs and trees burned that burned in the fire will re-sprout from underground roots and burls, and in others new stems and leaves will quickly emerge from aboveground buds. While re-sprouters like our oaks and madrones begin their regeneration, seedlings of other species will appear after the first rains, growing from seeds that have been in the soil since the last fire. Some of these seeds, from wildflowers to larger species like manzanita, are stimulated to germinate by the chemicals in smoke or charred wood. Other plant seeds, like those from wild lilac (*Ceanothus*), are stimulated to germinate by the fire's heat.

For older Douglas-fir trees that were only scorched, like those in Annadel State Park, thick bark protected their sensitive growing tissues from the fire. For others that were killed, new seeds blown in from nearby live trees will give birth to a new generation. Within ten years or so, depending on rainfall, many of the oaks will return to their former glory, conifer saplings will mature, and the shrub-dominated chaparral will begin to reform the critical dense habitat needed by so many animal species.

"Within ten years or so, depending on rainfall, many of the oaks will return to their former glory, conifer saplings will mature, and the shrub-dominated chaparral will begin to reform the critical dense habitat needed by so many animal species."

Rather than being a destructive force that harms nature, natural fire establishes new opportunities for a wide diversity of fire-following species. Seeds of woody species that have been dormant in the soil for decades will germinate and start the next stage of succession, ultimately forming a closed canopy of intertwining twigs and branches. Fire-following wildflowers will seemingly explode across the landscape after the first rains. Some of the birds and other wildlife that were rare prior to the fire will increase and thrive, as they take advantage of new insect populations and nesting sites. Nature will renew.

Common Questions and Answers

Ernst, A.W. 2017. Tubbs fire reminds locals of Hanley fire of '64. Napa Valley Register. Available: http://napavalleyregister.com/calistogan/news/local/tubbs-fire-reminds-locals-of-hanley-fire-of/article_dce8464f-1557-5956-a508-04fffe8d7043.html (Accessed 12/04/2017).

LeBaron, G. 2014. Historic wildfires' catastrophic lessons. Press Democrat. Available: http://www.pressdemocrat.com/news/2377919-181/lebaron-historic-wildfires-catastrophic-lessons?artslide=0 (Accessed 12/04/2017).

Keeley, J.E. 2002. Native American impacts on fire regimes of the California coastal ranges. *Journal of Biogeograpy*. 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.

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.

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.

Calfire 2017. Watershed Emergency Response Team (WERT) reports:

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

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

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

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

CNPS. 2001. CNPS guidelines for landscaping to protect native vegetation from genetic degradation. Sacramento, CA. Available: http://www.cnps.org/cnps/archive/landscaping.pdf

Keeler-Wolf, T. 1995. Post-fire emergency seeing 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.

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

Post-Fire Care and Recovery of Trees, Especially Oaks

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.

McCreary, 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. Available: http://anrcatalog.ucanr.edu/pdf/21538.pdf.

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

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.

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.

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

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, Sacramento, CA. Available (Accessed 12/07/2017): http://vegetation.cnps.org.

Smiley, E.T., N. Matheny, and S. Lilly. 2011. Best Management Practices. Tree Risk Assessment. Second 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, editors. 2005. A Planner's Guide for Oak Woodlands, Second Edition. Publication 3491. University of California, Agriculture and Natural Resources, Oakland, CA.

Vreeland, J.K and W.D. Tietje. 2001. Numerical responses of small vertebrates to prescribed fire in a California oak woodland. Pages 269–279 in Proceedings of the Fifth Oak Symposium: Oaks in California's Changing Landscape. PSW-GTR 184. USDA Forest Service Pacific Southwest Research Station.

Other Web Resources:

Recovering from Wildfire: A Guide for California's Forest Landownders: http://anrcatalog.ucanr.edu/pdf/8386.pdf

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

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

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

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

SCAPOSD. 2017. Sonoma County Fine-Scale Vegetation and Habitat Map. [Online]

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. Rept. PSW-102.

CNPS 1995. Statement of Policy – Seeding after wildfire. California Native Plant Society, Sacramento, CA.

CNPS. 2001. Guidelines for landscaping to protect native vegetation from genetic degradation. California Native Plant Society, Sacramento, CA.

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 Vol. 42, pp. 175-179.

Keeley, J.E. 1994. To Seed or not to Seed? Wildfire. March Issue.

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. Volume 104(1): 1–2.

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

Landis, B. 2010. How CNPS developed a policy on native plants and fire safety. Fremontia 38(2): 7–15. Available: (Accessed 12/07/2017): http://www.cnps.org/cnps/publications/fremontia/Fremontia_Vol38-No2-3.pdf.

Schettler, S. 2010. Fire resistant landscaping: A general approach and Central Coast perspective. Fremontia 38(2): 46–50.

USDA/NRCS. 2017. Hydromulching Fact Sheet. Available: hydromulching http://sonomarcd.org/wp-content/uploads/2017/10/NRCS_hydromulching.pdf

Invasives

Brooks, M. and M. Lusk. 2009. Fire Management and Invasive Plants: A Handbook. United States Fish and Wildlife Service, Arlington Virginia Available (Accessed 12/07/2017): https://www.fws.gov/invasives/pdfs/USFWS_FireMgtAndInvasivesPlants_A_Handbook.pdf.

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, editors. Proceedings 10th MEDECOS Conference, April 25–May 1, 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, editors. The Landscape Ecology of Fire. Springer, Netherlands.

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. Available: (Accessed 12/07/2017): http://www.cnps.org/cnps/publications/fremontia/Fremontia_Vol38-No2-3.pdf.

Special Plants and Ecosystems of the Region

Armstrong, W.P. 2014. Ashes To wildflowers: A promise of renewal springs from destruction. Online, Wayne's Word. Available: https://www2.palomar.edu/users/warmstrong/ww0604.htm.

Keeley, J.E. and Fotheringham, C.J. 1998. Mechanism of smoke-induced seed germination in a post-fire chaparral annual. Journal of Ecology 86, 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.

West Coast Watershed. 2012. Russian River integrated coastal watershed management plan. Report to Department of Water Resources. Mendocino County Resource Conservation District. Available: http://www.northcoastresourcepartnership.org/documents/view/7603.

Baseline Maps

SCAPOSD. 2017. Sonoma County Fine-Scale Vegetation and Habitat Map. [Online]
Available: http://sonomavegmap.org/blog/2017/06/01/fine-scale-vegetation-and-habitat-map-now-available/, accessed 28 Feb. 2018.

Thorne, J.H., J.A. Kennedy, J.F. Quinn, M. McCoy, and T. Keeler-Wolf. 2004. Vegetation - Napa County and Blue Ridge Berryessa [ds201].
Available: https://map.dfg.ca.gov/metadata/ds0201.html, accessed 28 Feb. 2018.

Fire Awareness and Preparedness in the Future

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

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Helpful Resources

Local and Regional Conservation Services

Napa County
Emma Chow, District Conservationist
707-252-4189, emma.chow@ca.usda.gov

Sonoma and Marin Counties
Jennifer Walser, District Conservationist
Jennifer.walser@ca.usda.gov

Mendocino County
Carol Mandel, District Conservationist
707-485-3233, Carol.Mandel@ca.usda.gov or see
https://www.nrcs.usda.gov/wps/portal/nrcs/main/ca/newsroom/features/
for other state contacts.

Napa Resource Conservation District
Leigh Sharp, Executive Director
707-690-3119, leigh@naparcd.org
http://naparcd.org/fire/ for other resources

Sonoma Resource Conservation District
Jeff Schreiber, Program Development Manager
707-569-1448 x110, jschreiber@sonomarcd.org
http://sonomarcd.org/resources/fire-recovery/

City of Santa Rosa
707-543-3800

You can also consult with a registered professional forester or certified arborist for specific advice on which trees to preserve or cut.
Contact: California Forestry Stewardship Program's Forestry Helpline at 800-738-Tree (8733); forestryhelp@gmail.com.

Additional CNPS Resources

Fremontia Special Issue | Native Plants and Fire Safety | Vol 38, No 2-3
http://www.cnps.org/cnps/publications/fremontia/Fremontia_Vol38-No2-3.pdf

CNPS Policies of Fire and Native Vegetation
http://www.cnps.org/cnps/conservation/policies.php

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

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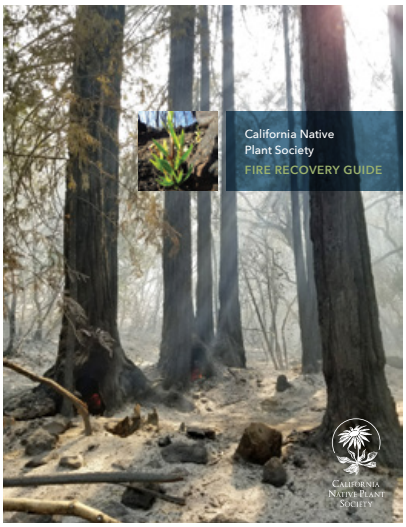

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Dear neighbor,

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.