



# FUELS REDUCTION GUIDE

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**Mission**

The women and men of the California Department of Forestry and Fire Protection (CAL FIRE) are dedicated to the fire protection and stewardship of over 31 million acres of California’s privately-owned wildlands. CAL FIRE’s mission emphasizes the management and protection of California’s natural resources; a goal that is accomplished through ongoing assessment and research. Department personnel including foresters, environmental scientists, archaeologists, biologists, and fire personnel work closely to implement fuels management projects to reduce the threat of uncontrolled wildfires and improve forest health.

**History**

Forest and land management has been at the core of the Department since its inception in 1885. Then known as the State Board of Forestry, the Department was primarily tasked with enforcing the few laws the state had concerning wildfire and forest lands. At the turn of the 20th century, the first state forester was assigned (E.T. Allen) and the earliest stages of a state fire patrol began to form. As the century progressed, so too did the responsibilities of the Department. Today, CAL FIRE is a full-service resource protection and emergency management department responding to wildfires and all risk emergencies.

**Fire Prevention**

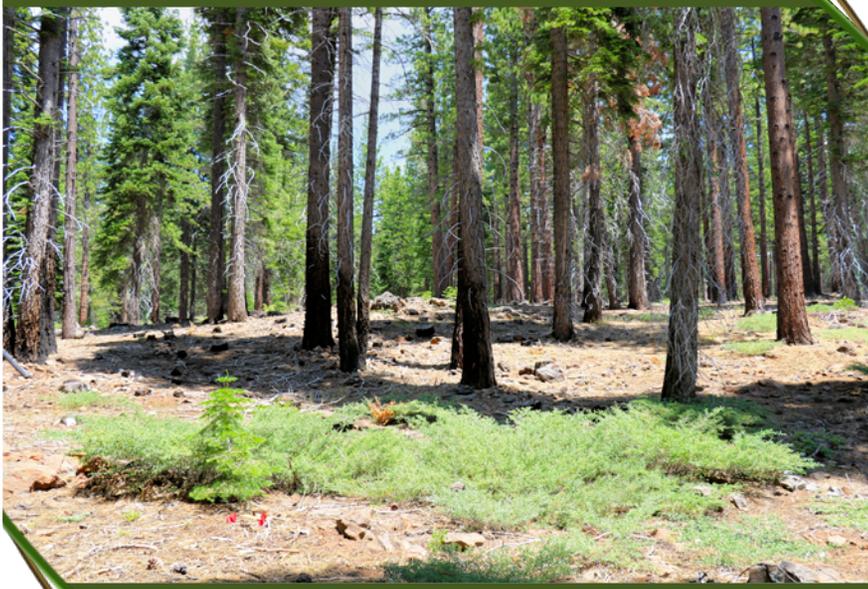
Preventing wildfires in the State Responsibility Area (SRA) is a vital part of CAL FIRE’s mission. While these efforts have occurred since the early days of the Department, CAL FIRE has adapted to the evolving threat from wildfires and has succeeded in significantly increasing its efforts in fire prevention. Common fire prevention projects include fuels reduction, prescribed fire, Defensible Space inspections, emergency evacuation planning, fire prevention education, fire hazard severity mapping, home hardening and fire-related law enforcement activities. Wildland fire prevention engineering processes reduce or eliminate fire hazards and risks by reducing fuel loads and creating a break in horizontal and vertical fuel continuity.

**Environmental Protection**

CAL FIRE uses the totality of its resource professionals to ensure that California environmental laws are obeyed for any project undertaken by the Department. Registered Professional Foresters, Environmental Scientists, Archeologists, Hydrologists, Soil Scientists, Fire Scientists, and various other experts in natural resource protection contribute to this work every day. On December 30, 2019, the Board of Forestry and Fire Protection approved a Statewide Programmatic Environmental Impact Report titled “California Statewide Vegetation Treatment Program,” known as the CalVTP. The program provides California Environmental Quality Act (CEQA) compliance for CAL FIRE and other public entities’ vegetation management projects.

For additional information, click the  
**“Learn More”** links throughout the document.

## What We Are Doing



A healthy forest is more resilient to potentially devastating disturbances, such as fire, pests, disease and drought, and plays an important role in California's water supply and air quality.

Fire is an essential ecological process in fire-dependent ecosystems, such as California wildlands. However, over a century of fire suppression has led to wildlands, woodlands and rangelands that are unable to withstand normal droughts, insect outbreaks or wildfires. The purpose of any fuels reduction project is to change the size and composition

of the fuels in the forest, creating a break in fuel continuity. Doing so removes ladder fuels which can carry fire from the forest floor to the tree crowns where it can become a devastating fire that quickly spreads. The goal of fuels reduction is to create conditions that mimic the role of low intensity fire or other disturbances that once naturally thinned the forest.

In response to Governor Newsom's Executive Order N-05-19, CAL FIRE systematically identified 35 high priority fuels reduction projects and other measures to protect over 200 of California's most wildfire-vulnerable communities. For further information and detailed project reports, click [here](#).

California's Forest and Wildfire Resilience Action Plan outlines actions to reduce wildfire risk and improve the health of forests and wildlands. Learn what CAL FIRE will do by clicking [here](#).

## Personnel



People working together through public and private partnerships are CAL FIRE's biggest asset on fuels reduction projects.

CAL FIRE engages in fuels reduction work and fire prevention activities year-round. Fuels reduction work is done by dedicated CAL FIRE Fuels Reduction Crews, California National Guard, California Conservation Corps, California Department of Corrections and Rehabilitation, and CAL FIRE fire suppression resources including

firefighter hand crews and engine crews when they are not responding to other emergencies. Defensible Space inspectors ensure homeowners do their part to be ready for wildfire, and fire prevention specialists engage daily with their communities to promote fire prevention education.



CAL FIRE provides employees with a variety of career choices and diverse opportunities.

## Hand Thinning



Hand crews conduct work in areas where prescribed fire and mechanical thinning aren't practical, like neighborhoods, or where the terrain is too steep for heavy equipment.

Fuels reduction projects are either done using hand tools, known as hand thinning or by using heavy equipment, known as mechanical thinning or a combination of both. In the case of hand thinning, crews use cutting, grubbing and scraping tools like chainsaws, Pulaskis and Mcleods, to cut through vegetation, trees and understory brush. Mechanical thinning

is accomplished using equipment that can remove fuel from the project site. Once cut, crews or equipment drag the vegetation to the roadside or to a central location to be chipped or burned. The chips will either be left on site, removed to a biomass facility or burned in an Air Curtain Burner (see page 19).



**Chainsaw**— Used for felling, limbing and cutting trees and brush.



**Pulaski**— features an axe on one side for chopping saplings and brush, and a grubbing blade to remove roots and small stumps.



**Mcleod**— used for fireline construction to scrape and rake away vegetation, leaving only bare mineral soil.

## Mechanical Thinning



Using the skid steer with attachments, an operator can cut and masticate small and medium sized trees, remove and pile brush, and move piles of cut material to a central location for pile burning or removal.

Personnel are essential for hand thinning work in rough terrain, but heavy equipment allows personnel to treat large acre projects efficiently. The tracked compact skid steer loader is a common and essential piece of equipment used by CAL FIRE personnel.

Compact skid steer loaders are fitted with one of three attachments: the masticating head, a grapple head or a brush rake, depending on the project. These tools serve to decrease hand labor and increase the efficiency of fuels reduction projects.



The **brush rake** has a scoop and forks that can be used to clear brush and form piles. It can also clear the ground to bare mineral soil around brush piles, preparing them for burning.

The **grapple attachment** can pick up cut tree stems larger than what can be done by hand and move them for pile burning or chipping.



The **masticating attachment** produces a similar result to chipping, except the masticating head does all the work—it can both cut and chip trees up to about four inches in diameter.

## Chipping



Chippers are an important part of CAL FIRE's fuels reduction work. Both tracked and tow chippers are used where hand thinning projects are being completed.

Chippers are used to change the size, shape and distribution of fuels in the forest, thereby reducing the risk of catastrophic wildfire. CAL FIRE uses both tracked chippers and tow chippers for fuels reduction projects. Tow chippers are typically used for roadside clearing and in neighborhoods. The cleared material is staged at the edge of the road where the chipping crew feed branches into the hopper. The chips are blown back into the area where the fuels came from. Tracked chippers are used for projects beyond the roadway and in steep difficult terrain. Working off-road, tracked chippers are moved by remote control, often across rough terrain, close to the project location, helping to limit the time crews spend dragging materials to the chipper.

As with the tow chipper, the chips are blown and dispersed back onto the forest floor.



## Masticating



An excavator with a masticator/mulcher attachment can chop or grind vegetation into 1 - 2 inch pieces creating a break in horizontal and vertical fuel continuity. Excavators are an effective tool when creating a shaded fuel break.

Excavators are versatile machines that can maneuver in steep terrain and heavier fuels where skid steer masticators are unable to accomplish the project objectives. Fitted with a masticator/mulcher attachment, large brush and trees of up to 25 feet in height and large diameters can be turned into small chunks and left on site. Just like chipping, this creates a break in horizontal and vertical fuel continuity to reduce the risk of catastrophic wildfire.



Excavators run multiple heads such as flat disk and drum.

## Crushing & Chaining



Dozers are used to crush brush by pulling a chain or a ball and chain over the brush. When fitted with a brush rake, dozers are quick and effective at removing and piling brush, preparing it for burning.

A dozer is a versatile piece of equipment that is used to clear fuels for fire breaks, move large logs and brush, improve access and repair existing roads that are often used for emergency access for the public and first responders. When used for fuels reduction, the dozer blade is lifted and a chain is pulled behind the machine to crush brush and help prepare an area for a future controlled burn.



A ball and chain pulled behind a dozer crushes brush, changing fuel composition.

## Landscape Level Fuels Reduction



CAL FIRE partners and cooperators, including land managers like United States Forest Service and community-based organizations like Resource Conservation Districts and Fire Safe Councils are essential to completing fuels reduction work at a landscape scale.

The Federal Government owns and manages 57% of the State's forested lands. In addition to grant agreements, California uses Good Neighbor Authority agreements to implement fuels reduction on federal lands. A Good Neighbor Authority agreement was signed between the California Natural Resources Agency and the United States Forest Service, allowing the Forest Service to enter project agreements using state funds and resources to perform forest, rangeland and watershed restoration services on Forest Service lands.

The Craggy Vegetation Management Project ("Craggy Project") is a Good Neighbor Authority project developed by the Klamath National Forest, CAL FIRE Siskiyou Unit and the Yreka Fire Safe Council to better protect local communities from wildfire and improve forest health, wildlife and plant habitats, and watershed conditions within the project area.



The Craggy Project played a key role in slowing fire spread and keeping fire out of the community of Hawkinsville and the greater Yreka area. It was beneficial to firefighters suppressing the Badger Fire and contributed to the successful protection of communities and infrastructure in this area of high fire risk.

**Account provided by National Fish and Wildlife Foundation.**

On July 18, 2020 two fires, the Humbug and Badger, were burning in State Responsibility Area just north of Yreka. Eventually merging into one, the Badger fire was contained at approximately 600 acres 10 days later. At the time of the fire, approximately 600 acres of mastication and 1,400 acres of hand thinning and piling had been completed on the Craggy Project.

The western part of the Badger Fire reached areas within the Craggy Project footprint that had been treated using mastication. Fire spread dramatically slowed

in those masticated areas as the fire transitioned from crown fire to surface fire. This reduction in the speed of spread allowed bulldozers time to safely build indirect fireline across the bottom of the fire during the evening and tie it in by daybreak. The lack of brush also eliminated the need for crews to be on hand conducting fireline improvements, freeing them up to work on other areas of the fire.

Continued implementation of this project will enhance these benefits during future fire events.

**Prescribed Fire**



Preparing for a prescribed fire is like other fuels reduction projects, with one key difference—prescribed burning requires a burn plan and a smoke management plan.

Prescribed fire is the planned and controlled application of fire to the land, under specified, low-risk weather conditions. As a land management tool, prescribed fire is an efficient and cost effective way to reduce fuels where physical and social conditions are conducive to its use. Before implementing a prescribed burn, the

site is prepared by reducing and removing the amount of vegetation to a safe burning density. Methods include using bulldozers, hand tools, herbicide treatment, pile and burn or a combination of these methods. A key element in site preparation is the construction of a well-established fireline to limit fire spread.



A **drip torch** ignites vegetation by dripping flaming fuel onto the ground.



A **helitorch** is a firing device effective for igniting prescribed fire over a large area.



A **terra torch** throws a stream of flaming liquid that rapidly ignites surrounding fuels.

Photo credit: Al Golub

## Burn Plans & Risk Mitigation



Before a prescribed fire is ever lit, a detailed burn plan and smoke management plan must be completed.

A burn plan, or prescription, includes comprehensive information about weather, terrain, fuel moisture and values at risk. Values are natural resources, humans and their developments, and public and political features, including cultural, that have inherent significance.

For a burn to be 'in prescription', conditions on the ground must meet the

### **Ecological Restoration**—

California's wildlands are adapted to fire, with the exception of some chaparral ecosystems that currently experience more frequent fire than historically. Putting fire back on the land helps protect and improve habitat for wildlife and optimizes soil and water productivity, and can also help control or eliminate noxious, invasive plants.

specifications contained in the burn plan. Burning when conditions are 'out of prescription' will not meet desired objectives and can produce undesirable conditions that may threaten the identified values and create undue risk.

Prescribed burning is done for different purposes, and will vary depending on the project location and landowner goals. Common objectives are:

### **Fuels Reduction**—

burning is an efficient solution for removing excess fuels across large landscapes.

### **Community Protection**—

fire strategically used around communities to reduce fuels.

## Broadcast & Pile Burns



Pile burning is a form of prescribed fire and is an effective way to remove excess fuels when chipping or masticating and leaving material on site isn't feasible.

A broadcast burn is when fire is put to the ground with low intensity to consume understory brush and dead, fallen vegetation. Broadcast burns require significant site preparation before burning; thinning vegetation,

piling and burning excess fuels prior to a broadcast burn being lit. These actions mitigate the risk of an unintended high intensity fire, while removing fuels and providing ecological benefit.



A broadcast burn is the controlled application of fire to wildland fuels in their natural or modified state over a predefined area, often conducted to reduce wildland fire fuel loads, restore ecological health of an area, or to clear vegetation.

## Fuel Breaks



Fuel breaks are strategically placed along ridgetops.

A fuel break is strip of land on which the vegetation and fuels have been reduced or modified to decrease the risk of a fire crossing the strip of land. Fuel breaks are not designed to stop fire spread, especially during periods of strong winds when fire can be blown across these linear features. However, fuel breaks do provide opportunities for firefighting success by creating areas of lower fire intensity, improved access for ground based firefighters, and increased fireline construction rates. The lighter fuels, often associated with fuel breaks, also provide opportunities for indirect fireline construction through backfire or burn-out operations to consume fuel ahead of the spread of the main fire.



Fuel breaks create Defensible Space around critical communication, water and power infrastructure.

## Shaded Fuel Breaks



In a shaded fuel break, trees are typically spaced so their crowns no longer touch, lower branches are pruned, and brush and dead and down material are removed or replaced with masticated material. Shaded fuel breaks are most often placed strategically on ridgetops, roads, and around structures.

Shaded fuel breaks are strips of land in which vegetation has been modified to act as strategic “defensible landscape.” The purpose is to reduce the amount of combustible material so that when a fire hits the shaded fuel break it will

decrease in intensity, cool down, and drop from the canopy to the ground. Along roadways, shaded fuel breaks create safer ingress and egress routes for fire personnel and citizens.

During the 2020 Creek Fire, thousands of residents and visitors were safely evacuated along the Highway 168 corridor, where Highway 168 Fire Safe Council had received grant funding to construct a roadside fuel break and clear dead trees from the massive beetle kill caused by drought. The role these fuel breaks and tree removal played in keeping this fire

from being much more destructive cannot be understated. They played a key role in buying time, allowing for preparation around communities and managing fire activity. Dozers were able to quickly open up and expand fuel breaks, turning them into constructed line that aided fire fighters in saving homes and resources.

## Sawmill



Portable sawmills can be moved and used in the field or at a central location where suitable logs have been staged.

On some fuels reduction projects, there will be a few trees of good quality timber, but not enough to be economically feasible to transport to a sawmill. Portable sawmills can be used to process saw logs on-site where they can be set up next to the trees being cut. The sawn logs are used to make

picnic benches, desks, siding, window frames, shelves and more. Produced at a sufficiently small scale not to compete with private industry, these products are donated to State agencies, local governments, charities or used at CAL FIRE facilities.



Specialty timber products not readily available through lumber yards can be milled on a portable sawmill. They are useful in urban settings too, where moving logs would be unpractical.

## Air Curtain Burner



An Air Curtain Burner works by pushing high velocity air over the top of the burn chamber, creating a curtain of air which the rising smoke cannot penetrate. The unburned particulates are pushed back down into the chamber where they reburn until they are light enough to rise through the air curtain.

Air Curtain Burners or Air Curtain Incinerators are used to dispose of forest waste generated from fuels reduction projects in areas where the debris cannot be left on-site, and broadcast or pile burning is not an option. Air Curtain Burners produce a much cleaner, nearly smokeless burn with emissions consisting mostly of water vapor and biogenic carbon dioxide.

The air curtain reduces particulate matter (PM), or smoke, which results from burning clean wood waste, to an acceptable limit per United States Environmental Protection Agency

guidelines. Because Air Curtain Burners consume fuel so efficiently, they can be operated on days when weather conditions aren't suitable for broadcast or pile burning. Air Curtain Burners are capable of burning five to seven tons of material per hour.



## Landowner Assistance



Individuals and communities play a role in fuels reduction and community fire safety. There are several programs and organizations to support these efforts.

Unit fire plans and Community Wildfire Protection Plans outline fire and fuel hazard situations at the local level for each of CAL FIRE's 21 Units statewide. Each identifies prevention measures to reduce risks, to educate and engage the local communities, and provide a framework to diminish the potential loss due to wildfire. Planning includes other state, federal and local government agencies, as well as Fire Safe Councils and community

based organizations. Building strong partnerships and community trust are core values for CAL FIRE; these are essential for planning and implementing fuels reduction projects in and around communities and the wildland.

CAL FIRE Unit Fire Plans.

### CAL FIRE Cost Share Incentive Programs

The Vegetation Management Program (VMP) is a cost-sharing program that focuses on the use of prescribed fire, and mechanical means for addressing wildland fuel hazards and other resource management issues on State Responsibility Area (SRA) lands.

The California Forest Improvement Program (CFIP) provides technical assistance and funding to improve the management of private forest lands.

## Resource Conservation Districts



Resource Conservation Districts combine the accountability and transparency of a public agency with the flexibility and non-regulatory approach of a non-profit organization. This nimbleness allows them to adapt to the ever-changing needs of communities, build trusted relationships, and act as the crucial bridge that connects individuals with state and federal partners and programs. (Excerpted from <https://carcd.org/>)

Resource Conservation Districts (RCD's) were first founded after the Dust Bowl in the 1930s to bring federal and state funding and technical assistance to farmers and ranchers so that they could voluntarily conserve water, soil, and wildlife habitat on their land with

the help of a local and neutral partner. RCD's are an important partner for forest health and fire prevention project planning and implementation with landowners in communities across the state.

### Grant Programs

**Fire Prevention**  
The Fire Prevention Grant Program, aims to reduce the risk of wildland fires to habitable structures and communities, while maximizing carbon sequestration in healthy wildland habitat and minimizing the uncontrolled release of emissions emitted by wildfires.

**Forest Health**  
The Forest Health Program funds active restoration and reforestation activities aimed at providing for more resilient and sustained wildlands while also mitigating climate change, protecting communities from fire risk, strengthening rural economies and improving California's water & air.

## What Can I Do?



### FIND OR CREATE A LOCAL FIRE SAFE COUNCIL OR FIREWISE COMMUNITY

Fire Safe Councils are grassroots, community-led organizations that mobilize residents to protect their homes, communities, and environments from catastrophic wildfire. Fire Safe Councils throughout California educate homeowners about community wildfire preparedness activities while working with local fire officials to design and implement projects that increase the wildfire survivability of their communities. Many Fire Safe Councils have successfully implemented such projects as hazardous-fuel-reduction, Community Wildfire Protection Planning, and homeowner training.

Many communities have a Fire Safe Council. [Click here](#) to see the one closest to you, or learn how to start one.

The national Firewise USA® recognition program provides a collaborative framework to help neighbors in a geographic area get organized, find direction, and take action to increase the ignition resistance of their homes and community and to reduce wildfire risks at the local level. Any community that meets a set of voluntary criteria on an annual basis and retains an "In Good Standing Status" may identify itself as being a Firewise® Site.

Find out how to be recognized as a Firewise community by [clicking here](#).

## Get to Know CAL FIRE



Get to know CAL FIRE by following us on Social Media. Information about fuels reduction work, emergency incidents, fire prevention and fire safety education is posted regularly to keep the public up to date on CAL FIRE's work.



Do you want to learn more about CAL FIRE? Visit our website where you will find resources and information about our programs, the equipment we use, how to protect your home and family, careers and more.



## Terminology

**Broadcast burn:** A broadcast burn is the controlled application of fire to wildland fuels in their natural or modified state over a predefined area, often conducted to reduce wildland fire fuel loads, restore ecological health of an area, or to clear vegetation. Broadcast burns accomplish planned resource management objectives under specified conditions of fuels, weather, and other variables.

**Burn Plan:** The burn plan will provide a description of the burn area, target weather conditions, hazards that may be encountered, personnel needs, safety, and contacts to make prior to burning. Prescribed fire projects must have an approved, written burn plan before a prescribed fire can be implemented.

**Chipping:** Chippers are used to change the size, shape and distribution of fuels, thereby reducing the risk of catastrophic wildfire. Brush chipping is an excellent option for fuels reduction, as it can be more economical than hauling and safer than burning. The chips are blown and dispersed back onto the land returning nutrients and providing erosion control.

**Community Wildfire Protection Plan (CWPP):** A collaborative effort involving government entities and affected non-governmental interests, especially local community residents. A CWPP identifies and prioritizes areas for hazardous fuel reduction and recommends measures to reduce the ignitability of structures.

**Crown fuels:** The tops of trees and shrubs usually ignited by a surface fire.

**Defensible Space:** Defensible Space is an area around a house or other structure that has been modified to reduce wildfire threat. This is usually done by clearing and separating highly flammable material so there are no paths for fire to travel to the home. California law requires 100' of Defensible Space around homes and structures. When residents have done their Defensible Space, firefighters can defend property with confidence and safety, knowing fire behavior will be disrupted when it meets the area with broken up fuels.

**Fuel Break:** A natural or manmade change in fuel characteristics that changes fuel arrangement and continuity to reduce fire spread to structures and/or natural resources, and to provide a safer location to fight fire. Fuel breaks are strategically placed along a ridge, valley bottom, access road, or around a subdivision.

**Fuel continuity:** A qualitative description of the distribution of horizontal and vertical fuels. Discontinuous fuels disrupt fire behavior and slow fire spread. Continuous fuels readily support fire spread. The larger the fuel discontinuity, the greater the fire intensity required for fire spread.

**Fuel Type:** An identifiable association of fuel elements of distinctive species, form, size, arrangement, or other characteristics that will cause a predictable rate of spread or resistance to control under specified weather conditions.

**Ground fuels:** Fuels that lie beneath surface fuels, such as organic soils, duff, ground fuels, decomposing litter, buried logs, roots, and the below-surface portion of stumps.

**Hand tools:** Grubbing, scraping and cutting tools used for removing fuels without heavy equipment.

**Ladder fuels:** Fuels which provide vertical continuity, thereby allowing a fire to spread from the ground to the canopy. Branches, shrubs or an understory layer of trees are considered ladder fuels.

**Mastication:** A mechanical process that changes the shape, size and distribution of fuels. Whole trees and large brush are broken down into small chunks and left on the forest floor or removed for burning or biomass. Mastication is effective for clearing trees along roadsides, ravines and places that could be difficult to reach with other equipment or on foot.

**Pile burn:** Piling materials resulting from management activities and subsequently burning the individual piles.

**Shaded Fuel Break:** Fuel breaks built in areas where the trees on the break are thinned and pruned to reduce the fire potential yet retain enough crown canopy to make a less favorable microclimate for surface fires.

**Smoke Management Plan:** A smoke management plan identifies smoke sensitive receptors, including population centers, recreation areas, hospitals, airports, transportation corridors, schools, and other values that may be impacted. Smoke mitigation strategies and techniques to reduce the impacts of smoke production must be included, and must comply with local air district requirements.

**Surface fuels:** Fuels lying on or near the surface of the ground, consisting of leaf and needle litter, dead branch material, downed logs, bark, tree cones, and low stature living plants.

**Thinning:** Cutting of trees to reduce the density of the remaining trees.

**BEFORE**

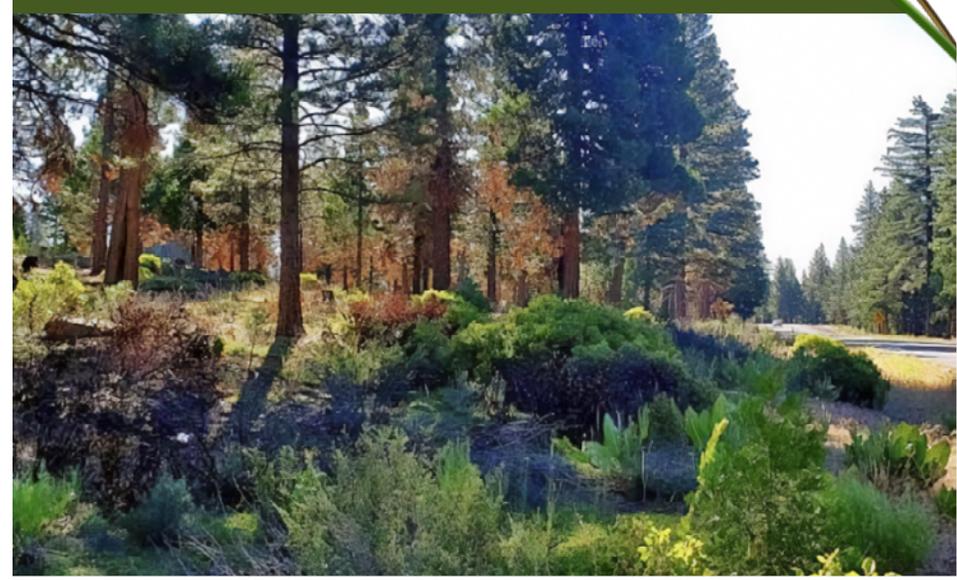


Removing brush strategically across the landscape interrupts fuel continuity which helps slow an advancing wildfire, allowing firefighters a safe place to defend nearby communities and protect natural resources.



**AFTER**

**BEFORE**



Shaded fuel breaks along roadways remove heavy fuels and are designed to prevent roadside sparks from becoming a devastating wildfire. They also create safer ingress and egress routes for emergency personnel and residents.



**AFTER**



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*When a high-intensity wildfire burns into an area that has been treated with thinning, mastication, or prescribed fire, fire behavior moderates, often shifting from a crown fire to a surface fire with low intensity fire behavior. Low intensity fires have ecological benefits, remove brush and ladder fuels and help protect nearby communities.*