WILDFIRE FUEL MAPPER

USER MANUAL

A collaborative project of the University of California Cooperative Extension (UCCE), Pepperwood and Tukman Geospatial, with support from PG&E, the Thornton Foundation, and CAL FIRE

The recent devastating wildfires in Sonoma County have highlighted the need for forest and natural resource management. To help Sonoma County landowners assess fire risk on their land and explore options for managing fuels, the University of California Cooperative Extension (UCCE), Pepperwood and Tukman Geospatial developed the Wildfire Fuel Mapper with support from PG&E, the Thornton Foundation, and CAL FIRE. The Wildfire Fuel Mapper provides a set of tools, including maps and resources, to help Sonoma County landowners with properties greater than 3 acres assess fuels and take action to reduce these fuels.

The Wildfire Fuel Mapper helps landowners to:

- Understand vegetation types
- Understand the need for fuel treatments in Sonoma County
- Obtain information on planning and implementing fuel treatments in Sonoma County
- Obtain maps for their property or watershed

What you will find in this document:

This document is a how-to-guide to use the Wildfire Fuel Mapper, including information on: how to access, interpret and use these maps to reduce fuels on your property, fuel management basics, and steps for planning a fuel management plan. *All important terms and definitions are located in the Glossary* at the end of the manual.

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1.1. Fuels and Fire in Sonoma County

For thousands of years, fire was a regular and important disturbance that shaped the flora and fauna of California's landscape and helped maintain healthy forests and ecosystems. Pre-colonization, Indigenousland management used controlled burns as a means of shaping the structure and composition of vegetation across our land. The result is that Sonoma County is within a fire adapted ecosystem; fires are an integral part of our environment. Since European colonization, however, we have significantly disturbed forest and rangeland health and resilience through decades of fire suppression and lack of vegetation management. This has led to vegetation build-up, and, along with warming temperatures and drier landscapes, fire behavior has started to change resulting in more and larger high severity wildfires.

To learn more about the history of fuel management in Sonoma County, please visit our Wildfire Fuel Mapper Story Map, located at: https://wildfirefuelmapper.org/.

1.2. What is Needed to Reduce Wildfire Risk

Understanding the relationship between *fire hazards* and *fire risk* across our region's diverse landscapes is important for protecting and preparing our community for future fires. *Fire hazards* are the physical conditions and elements that determine the likelihood an area will burn. *Fire risk* is the likelihood a fire will occur as a result of a fire hazard, the intensity of the fire behavior, and the effect or extent of damage to valued assets. In order to reduce wildfire risk, land owners and managers can evaluate individual fire hazards on their property and take action to manage those hazards. **Visit the Glossary to learn more about these terms.**

As wildfires increase in frequency and intensity, our communities are in need of a coordinated, regional approach to manage fuels and protect people, ecosystems, and infrastructure. Over 50% of the population in Sonoma County lives in the *Wildlife Urban Interface*, or WUI, meaning that the majority of our communities are dispersed amongst natural and forested areas and thus are at high risk for wildfire.

An incredible amount of research has been done to understand how to manage landscapes so they are less prone to large, severe wildfires. Vegetation management is one of the most effective tools we have in wildfire mitigation because it is carried out in ways that mimic the natural disturbance cycles of an ecosystem, helping restore natural fire regimes, recycle nutrients, promote a more diverse understory, create buffer zones around structures, and reduce fuels that can contribute to

fire hazard. Vegetation management can address a range of goals, from improving ecosystem and forest health, increasing stream flows, enhancing agricultural prospects, reducing fire risk and providing other natural and economic benefits. Fuel management is a type of vegetation management that focuses specifically on altering the structure and composition of vegetation across a landscape as a strategy to reduce fire hazards and risk.

Successful management requires collaboration between public and private stakeholders to mitigate fire risk across the landscape. While many public organizations and state entities have had the resources and staff to analyze fire hazards and risk on a broad scale across publicly managed land, there are few tools to assist private landowners and managers in evaluating and deciphering fire hazards on their land. Fuel management can appear complicated, is often expensive to implement, and planning an approach for reducing fuels requires detailed information about the landscape. With thousands of individual land parcels in Sonoma County, the Wildfire Fuel Mapper project was created to help address this gap. This toolkit provides users with detailed maps of landscape elements that help them assess fire hazards, including vegetation type and density, physical topography, and fuel, while also providing resources to support users in taking the next step in managing fuels and fire hazards.

1.3. The Wildfire Fuel Mapper

The Wildfire Fuel Mapper project is intended to support landowners and managers in understanding fuels and fire hazards on their parcel of land or a selected watershed.

Disclaimer: **This tool set is NOT intended to replace professional consultation and fuel reduction support. Fuel reduction is a complex process that requires expert knowledge of fire behavior, ecological processes and local and state regulations.**

Overview: Wildfire Fuel Mapper Components

The Wildfire Fuel Mapper project has multiple components that each supplement a different aspect of understanding and creating a fuel management plan. The following components and their intended goals are listed below.

- **Static Map Reports:** Planning an approach for reducing fuels requires good maps of your landscape. The Wildfire Fuel Mapper Reports are a set of static maps that can help users better understand their land and assess fire hazard based on a breakdown of different landscape elements. These map elements include vegetation type and density, physical topography, and fuels. It is currently the only mapping tool available at a parcel scale in Sonoma County that can be accessed directly by the public.
- **User Manual:** The user manual provides a how-to guide for accessing and interpreting map reports. It also introduces the principles of fuel management and provides users with details on how to create their own fuel management plan.

- ➔ **Story Map:** The Wildfire Fuel Mapper Story Map is an interactive web platform that gives an introduction to fuel management and provides context for the land management history in California and Sonoma County. It can be viewed here <insert link>
- ➔ **Website & Resources:** The website for the Wildfire Fuel Mapper project is the hub where users can access all the components of the toolkit. It can be accessed at this link. It includes a **Resources Listing** which has contact information of forestry and wildfire specialists or fuel management professionals, funding opportunities for land owners and managers to subsidize their fuel management plan, and other educational materials related to fuel management.

Who is this tool intended for?

The Wildfire Fuel Mapper can be used by a variety of users, such as landowners and managers, or other natural resources entities, to evaluate landscape elements and fire hazards on parcels of land greater than 3 acres or watersheds located in Sonoma County. The Wildfire Fuel Mapper can assist users of all levels of knowledge and experience. For instance, the Wildfire Fuel Mapper can be useful for individuals who have not previously had access or do not know how to start planning and implementing a fuel reduction project, providing them with critical information to get started. Additionally, the information provided can also be useful for landowners who have already conducted vegetation management or created a management plan, providing addendums to these pre-existing plans.

Section 2: The Basics of Fuel Management

Fuel management is designed to alter the types, amounts and arrangement of fuels. These actions have been shown to lead to fewer, smaller, and less damaging fires. This section will provide an introduction to the principles of wildfire behavior and fuel management.

2.1. Wildfire Fuel Basics

The Fire Behavior Triangle

The Wildfire Behavior Triangle describes three critical elements that influence fire behavior in wildland or forested environments and determine how a fire acts in response to environmental conditions. The three legs of the Wildfire behavior triangle are topography, weather, and fuel.

Topography, especially slope, has a dramatic effect on fire behavior and intensity. Fires burning upslope preheat and dry the 'vertically stacked' fuel in front of the fire which can increase the rate of spread and intensity of the fire. Fires burning downlope, on flat ground, and in drainage bottoms typically experience less extreme fire behavior. South-facing hills and aspects, where fuel is often drier and temperatures warmer, typically burn with greater intensity than north-facing aspects.

Weather has a great influence on fire behavior. The elements of weather that affect fire behavior most are humidity, wind speed, and temperature. The most extreme fire weather occurs when humidity is very low and wind is very high. In Sonoma County, these conditions are associated with late summer and fall Diablo winds, which are responsible for creating our worst firestorms. Wind is especially critical due to its role in transporting firebrands (or embers), which can ignite fires far ahead of the main fire front.

Fuel is the third leg of the fire behavior triangle. The size, type, amount, and arrangement of fuels affect how a fire moves across the landscape. Moisture level, chemical make-up, and density all determine how flammable fuels are. Fuel is one of the elements we have the most control over.

Fuel Classifications

Fuels can be characterized as *surface, ground, ladder, or crown fuels. Ground fuels* are beneath the litter layer, and include duff, roots, and other organic material in the soil. *Surface fuels* consist of leaf litter, downed branches and logs, and live plants low along the surface of the forest floor. *Ladder fuels*, like small trees and tall shrubs and branches, connect the surface layer to the canopy. Finally, crown (or aerial) fuels are the leaves and branches in the canopy of a tree.

Types of Fire

There are three primary wildland fire types: *ground, surface, and crown. Ground fires* smolder beneath the surface layer of litter, burning duff and other organic material in the soil. *Surface fires*

burn leaf litter and other downed fuels like branches and logs, as well as some surface-level plants like bushes or small trees; larger woody plants and trees are largely left alive. These types of fires are considered lower severity and seen as beneficial to the health of the forest.

Crown fires are fires that become more severe and burn up the tree canopy. Crown fires are difficult to control and often kill large trees, destroy structures, and lead to the loss of life. While crown fires are often the most destructive, structure loss can occur in all three wildland fire types. Structures, including homes, barns, and sheds, are highly vulnerable to ignition when exposed to direct contact with flame, embers, or radiant heat.

Forest Fuels in Sonoma County
In many of our oak woodlands, the exclusion of natural disturbances, poor historical land use management, changes in land use, expansion of the WUI, and lack of vegetation management across our landscape has resulted in expansion of more shade tolerant species such as Douglas fir and California bay. Encroachment of Douglas fir and bay threatens our iconic oak woodlands, which provide essential habitat for hundreds of species of wildlife as well as other ecosystem and cultural benefits.

2.2. Principles of Fuel Management

Fuel management is designed to alter the amounts and arrangement of fuels. These actions have been shown to lead to fewer, smaller, and less damaging fires. Reducing fuel load often involves:

- ➔ Thinning some of the smaller and less healthy trees and shrubs,
- ➔ Reducing surface fuels
- ➔ Removing ladder fuels that connect the ground and tree canopy
- ➔ Increasing spacing between trees
- ➔ Maintaining larger fire-resistant species
- ➔ Creating breaks in continuous layers of fuel

Fuel Management Near Homes and Structures
Structures—homes, barns, sheds, etc.—are themselves highly vulnerable to ignition from direct flame contact, radiant heat exposure, or most commonly, exposure to embers from wildfires. Embers cause 80% of home ignitions. Research has shown that home loss in wildland fires is primarily driven by the vegetative fuels within 100 feet of structures.

Structure hardening consists of pre-fire activities residents can take to reduce the risk of ignition around homes and structures, such as creating defensible space, replacing siding, decking, or roofing with more fire-safe material, or implementing other types of retrofits or fire safety actions.

Vegetation needs to be managed immediately around homes and buildings to create *defensible space*. *Defensible space* is the buffer that landowners are required to create on their property between structures and the vegetation surrounding the structure that could burn in the event of a

fire. Defensible space is crucial to save the lives of residents and firefighters, to keep fires that start in structures from reaching wildlands, and to lower the risk of home loss in a wildfire. Reducing vegetation helps protect structures by lowering the chance that intense radiant heat doesn't ignite the structure. Defensible space also ensures that flammable brush does not transmit flames to the structure.

Landowners are required by CAL FIRE Code PRC 4291 to create defensible space within 100 feet of structures (or to the property line, whichever comes first). This zone is critical to save the lives of residents and firefighters, to reduce fire spread from house fires into surrounding wildlands, and to lower the risk of home loss. Fuel within 100 ft of structures is the primary cause of home ignition from wildland fires. Thus, fuel treatment within this zone is critical to reducing the risk of property loss, and should be prioritized in addition to forest management and habitat improvement farther from structures.

Fuel Management Across Our Landscapes

Vegetation management conducted near homes is designed to change the behavior of a fire as it moves towards homes and structures to help reduce the chances of a structure being lost . Fuel modifications conducted along roads help change the behavior of wildfire (when one occurs), making for safer evacuations. Fuel modifications conducted in wildlands with heavy fuels can 1) improve forest health, 2) reduce the chances of crown fire and 3) reduce the potential for embercast, which can start spot fires in distant areas. The exact locations and the size of fuel modifications - as well as the type of fuel modification - depend on the vegetation type and arrangement of fuels on the landscape, the location of human assets, the topography, the weather patterns in the area, and other factors.

Section 3: Navigating The Map Reports

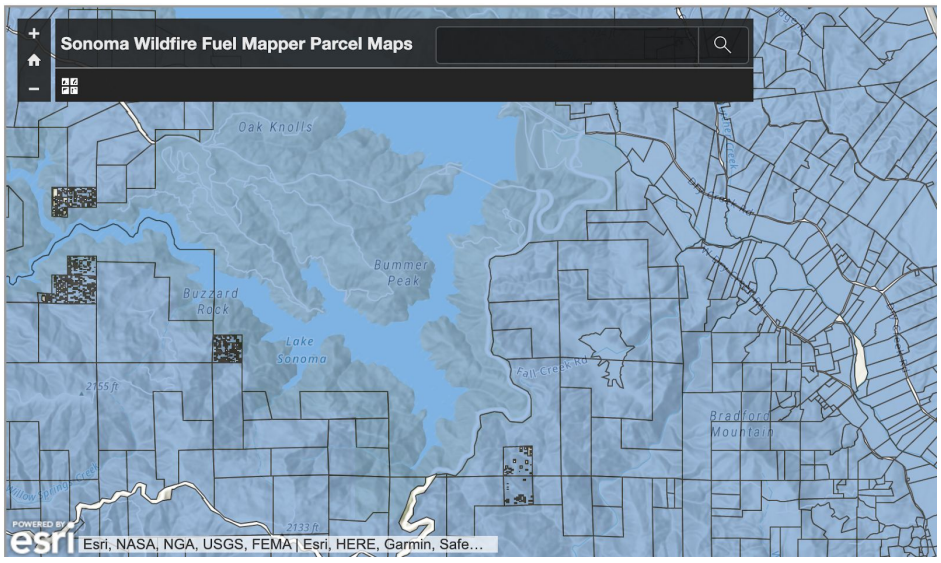
The Wildfire Fuel Mapper maps are available for download, in a compiled report, at two scales: land parcels greater than 3 acres and watersheds located in Sonoma County. This section will describe how you can access those reports and provide an overview of what each map in the report includes.

3.1 How to Access Wildfire Fuel Mapper Maps

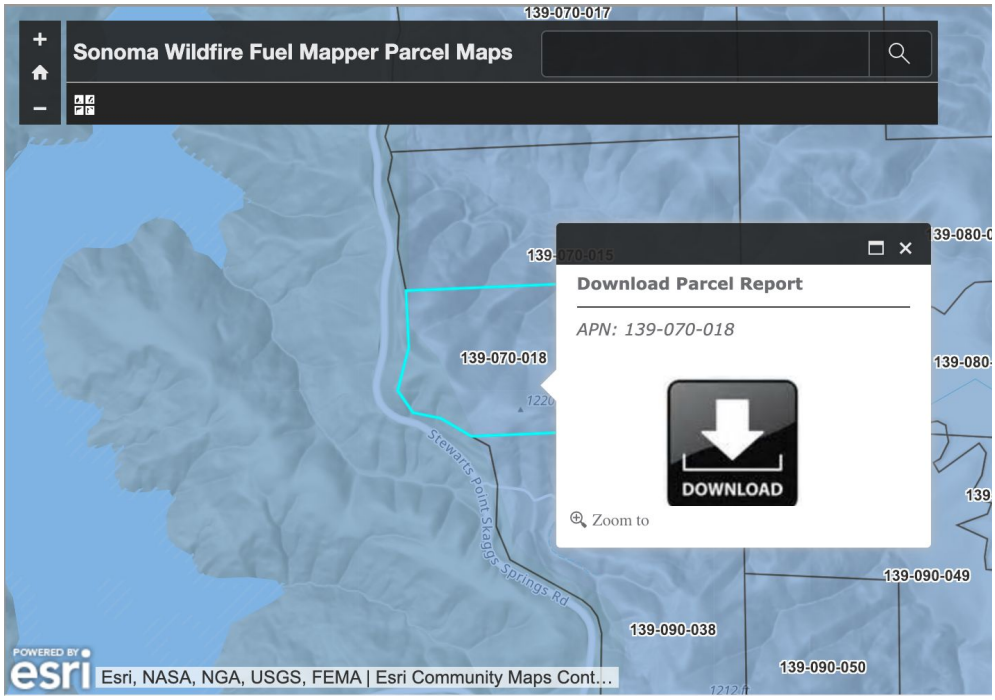
In order to access either the parcel or watershed map reports, please visit our website: www.wildfirefuelmapper.org and click on the "Custom Maps" tab, located in the upper right corner of the screen.

3.1.1 Parcel Reports

Step 1: Input your property address in the search bar at the top left corner of the map or navigate on the map to your parcel.



Step 2: Once you have clicked on the parcel of interest, click "DOWNLOAD".

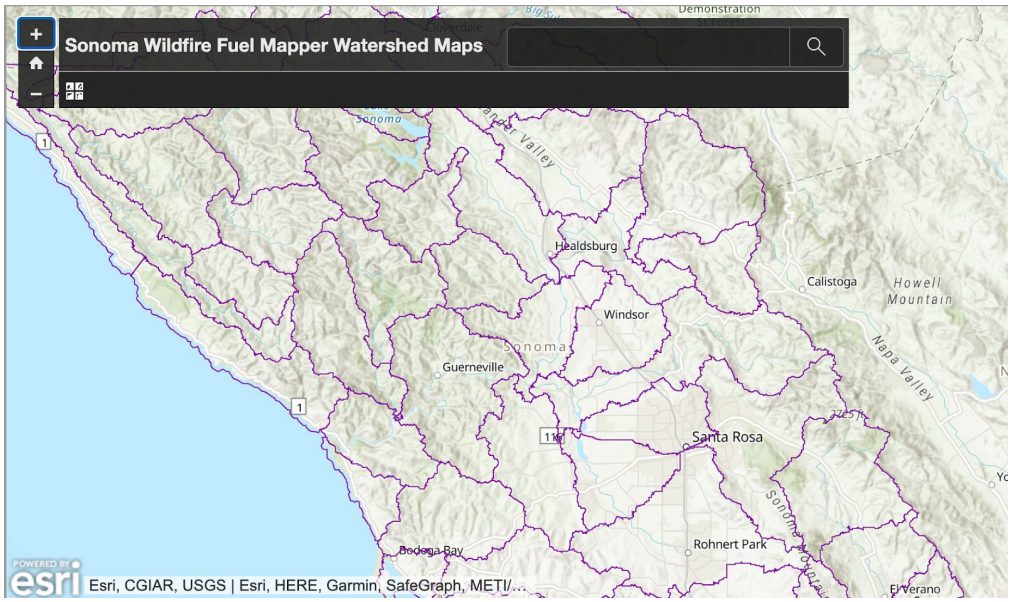


Step 3: Locate your newly downloaded report, in a PDF file, on your local machine.

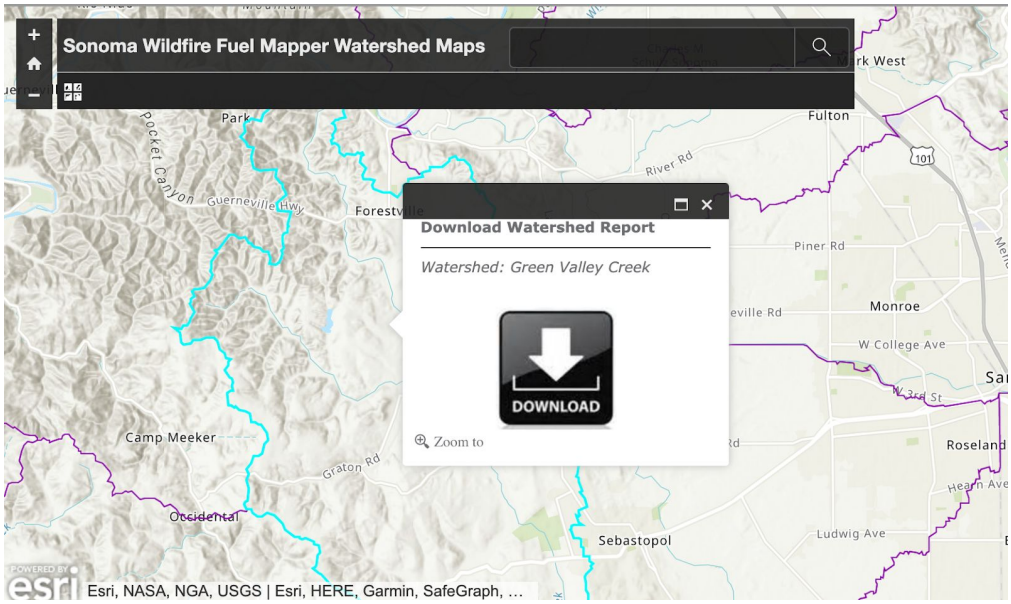
3.1.2 Watershed Reports

Sonoma County is also divided into watersheds, which indicate an area of land where all the streams and rainfall drain into a common area. Watersheds are classified into local-sub watershed levels and identified by a unique hydrologic unit code (HUC) of 12 digits, known as HUC12, which is the scale used for the maps in this report. Watersheds are helpful to organize individual parcels and communities into larger land tracks, and can provide insight into fire hazards that can lead to flood danger within an area.

Step 1: Select your watershed of interest. More information on watershed boundaries in Sonoma County can be found linked here.



Step 2: Once you have selected the watershed of interest, click "DOWNLOAD".



Step 3: Locate your newly downloaded report, in a PDF file, on your local machine.

3.2 Map Report Data and Map Elements

The Wildfire Fuel Mapper reports include 10 static maps of the parcel or watershed of interest. Each map provides unique insight into landscape elements that can help assess fire hazards across

a landscape. These elements include vegetation type and density, physical topography, and fuels, in relation to important assets such as streams, streets, and infrastructure. While both watershed and parcel reports are available for public use and have identical map categories, the following pages show examples from a parcel report.

For more detailed information on how to interpret and utilize each map to create a fuel management plan, please go to **Section 3: Using the Wildfire Fuel Mapper.**

Data Overview

Many of the static maps in this report were created using data products from the 2013 Sonoma County Vegetation Mapping and LiDAR program. The Sonoma County Vegetation Mapping and LiDAR program collected vegetation data at a 5 meter resolution, producing data products that provide a more detailed view of our landscape than other publicly available datasets, which often come at 30mx30m or greater.

Mapping fuels requires inputs from different data types, including on the ground observations, satellite imagery and other geospatial data. This tool offers a unique and important compilation of maps at both a property and landscape scale that hasn't previously been accessible. Combining these datasets, the Wildfire Fuel Mapper is able to provide the public with critical information about fuels within their own parcel and also view larger fuel patterns in their region.

Section 4: Using the Wildfire Fuel Mapper

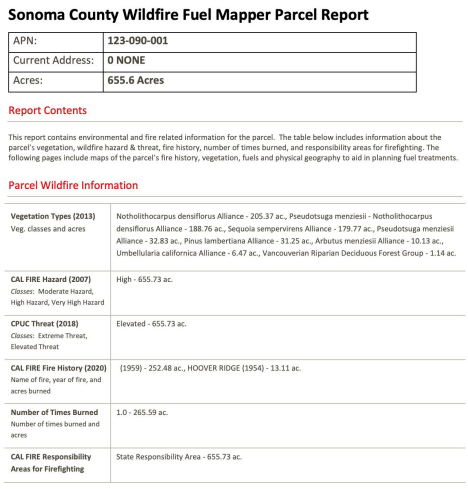
4.1. Interpreting Your Map Report

The following section helps users better understand what their parcel report indicates about fuels and fire hazards on their land. Please note, every land parcel is different and users should supplement the map reports with ground truthing, their own knowledge of their property, and input from experts or specialists. For more information about the different types of forestry and wildfire specialists and how to contact a professional, please go to **Section 5.5 Specialists and Professionals.**

4.1.1. Overview

The Wildfire Fuel Mapper reports include 10 static maps of the parcel or watershed of interest. Each map provides unique insight into landscape elements that can help assess the fuel and fire hazards across a landscape. These elements include vegetation type and density, physical topography, and fuels, in relation to important assets such as streams, streets, and infrastructure. These static maps are congregated into one map report generated for the parcel or watershed of interest. Both watershed and parcel reports are available for public use and have identical map categories. The following pages show examples from a parcel report, but can be used to interpret a watershed report as well.

4.1.2. Summary Page



Sonoma County Wildfire Fuel Mapper Parcel Report

APN:	**123-090-001**
Current Address:	**0 NONE**
Acres:	**655.6 Acres**

Report Contents

This report contains environmental and fire related information for the parcel. The table below includes information about the parcel's vegetation, wildfire hazard & threat, fire history, number of times burned, and responsibility areas for firefighting. The following pages include maps of the parcel's fire history, vegetation, fuels and physical geography to aid in planning fuel treatments.

Parcel Wildfire Information

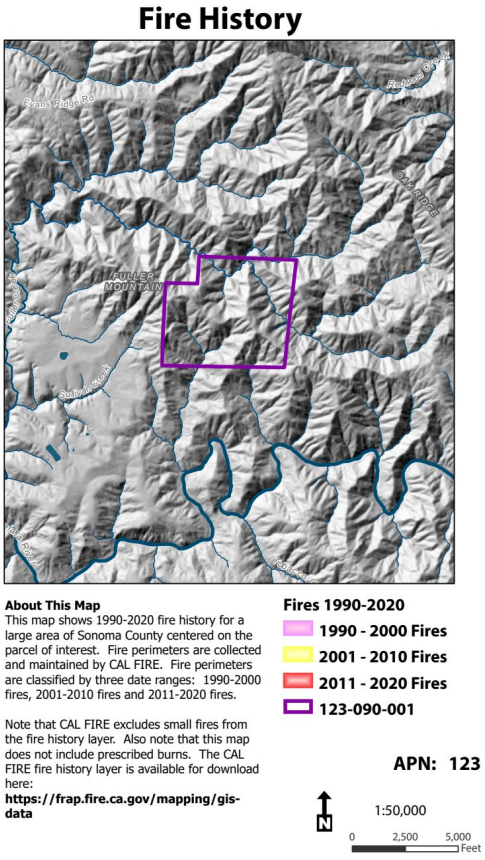
Vegetation Types (2013) Veg. classes and acres	Notholithocarpus densiflorus Alliance - 205.37 ac., Pseudotsuga menziesii - Notholithocarpus densiflorus Alliance - 188.76 ac., Sequoia sempervirens Alliance - 179.77 ac., Pseudotsuga menziesii Alliance - 32.83 ac., Pinus lambertiana Alliance - 31.25 ac., Arbutus menziesii Alliance - 10.13 ac., Umbellularia californica Alliance - 6.47 ac., Vancouverian Riparian Deciduous Forest Group - 1.14 ac.
CAL FIRE Hazard (2007) *Classes:* Moderate Hazard, High Hazard, Very High Hazard	High - 655.73 ac.
CPUC Threat (2018) *Classes:* Extreme Threat, Elevated Threat	Elevated - 655.73 ac.
CAL FIRE Fire History (2020) Name of fire, year of fire, and acres burned	(1959) - 252.48 ac., HOOVER RIDGE (1954) - 13.11 ac.
Number of Times Burned Number of times burned and acres	1.0 - 265.59 ac.
CAL FIRE Responsibility Areas for Firefighting	State Responsibility Area - 655.73 ac.

Data Content: The cover page of the report includes a general overview of landscape elements and fire hazard information about the parcel of interest. The items in the table show the classification of vegetation on the property broken down by acreage, as well as the total acreage of the property that is in CAL FIRE's hazard zones, CPUC Wildfire Threat, and burn history.

Fuel Management Application: This summary page can be used for land managers and specialists to get a quick overview of the layout of the property and understand the broad wildfire risks and hazards within the parcel.

4.1.3. Fire History

Data Source: CAL FIRE Fire Perimeter Dataset (1950-2020) accessible at: https://frap.fire.ca.gov/media/10969/fire19_1.zip



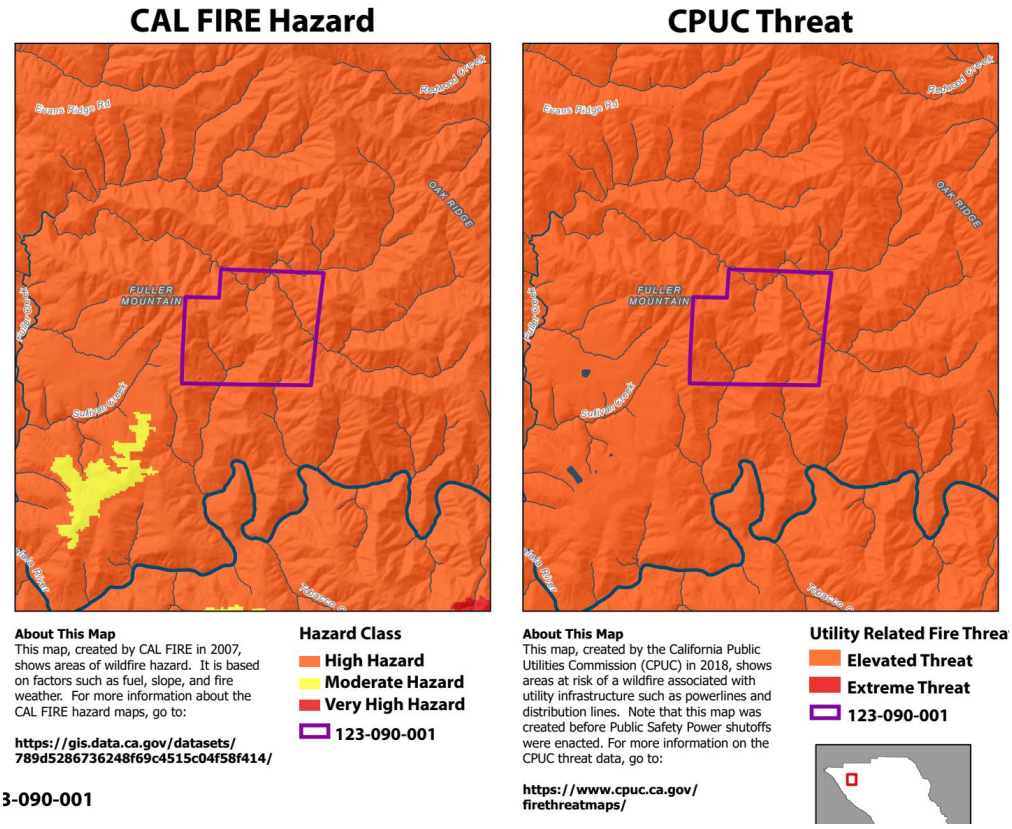
What the Map Depicts: The Fire History map shows where there have been wildfires in the past 40 years within the parcel of interest.

Fuel Management Application: Understanding where and when previous fires burned on a property can help inform future fuel management decisions.

Previous fires are important to consider when evaluating current fuels and fire hazards. The length of time since fire occurrence and the severity of the fire play a role in vegetation type, density, and accumulation. Users can utilize these maps to better understand the wildfire history of their property, or how recent or historical fires have influenced the structure and composition of vegetation. Conversely, if the area has not burned for a long time, these maps can help explain the build up of fuels, fir encroachment, limited oak regeneration, and other ecological aspects.

If there was a recent fire on a parcel, subsequent maps in the report might not reflect the change to the vegetation and landscape caused by the wildfire.

4.1.4. Cal Fire Hazard and CPUC Maps

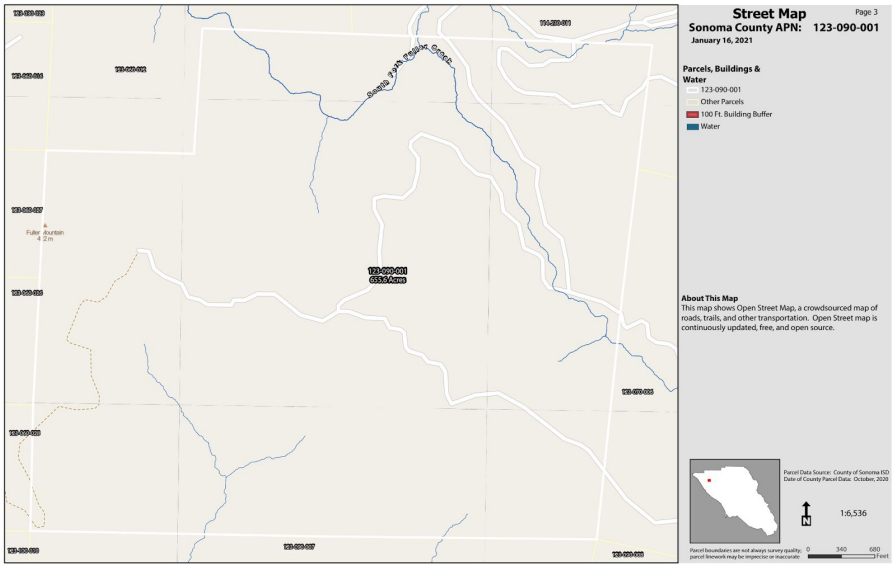


Data Source: The Cal Fire Hazard map was created by Cal fire in 2007 and the California Public Utilities Commission (CPUC) Wildfire Threat map was created in 2019. Both maps use inputs such as slope, vegetation, and terrain. The CPUC Map is a measure of risk and includes weighted risk near transmission lines and infrastructure.

What the Maps Depict: Both of these maps were created to inform the prioritization of wildfire mitigation across California and Sonoma County. The CAL FIRE Hazard maps focus on the land and terrain when weighing hazard amount, and the CPUC map aggregates variety of fire hazard inputs, weighing the different hazards, and assigning a wildfire risk output

Fuel Management Application: These maps are important for land owners because they are both well-known tools and are used broadly by policy-makers and forestry and wildfire specialists when considering high priority zones for wildfire fuel mitigation. These maps are important for understanding a high level view of wildfire risk on a property, and can be referenced in conversations with professionals and when applying for funding to indicate the urgency and high wildfire risk a property has.

4.1.5. Street Map

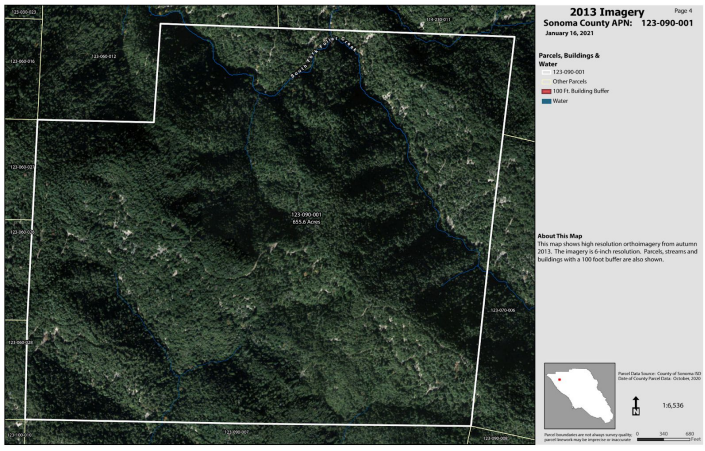


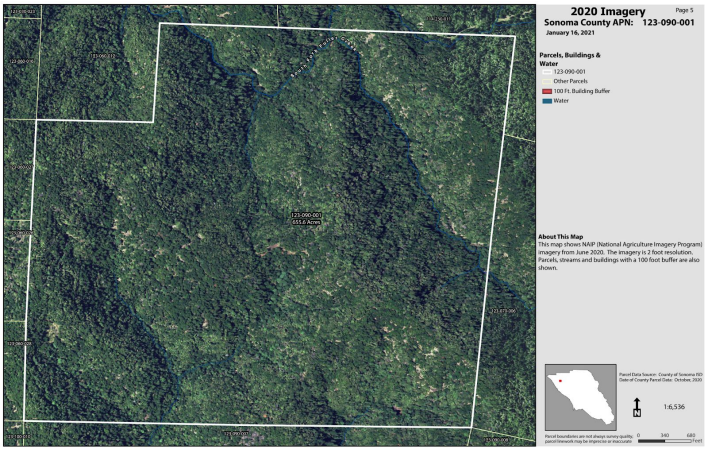
Data Source: The imagery for this map was acquired from an open-source map site, *Open Street Map*.

What the Map Depicts: The *Street* map is a simple map with an overview of streets, buildings and streams and represents the most accurate available map of roads, trails and transportation for a parcel. Keep in mind some trails or roads that have recently been paved within a parcel boundary might not have been mapped yet.

Fuel Management Application: The *Street* map is useful for orienting a user to the basic geography on their parcel and shows where they might have transportation access on their property to conduct fuel treatments that require machinery. Additionally, users should consider prioritizing fuel treatment near roads and homes/infrastructure to ensure safe evacuation routes and the protection of homes. This map will help identify where roads and buildings are in relation to other fire hazards shown on other maps in the report.

4.1.6. 2013 and 2020 Imagery



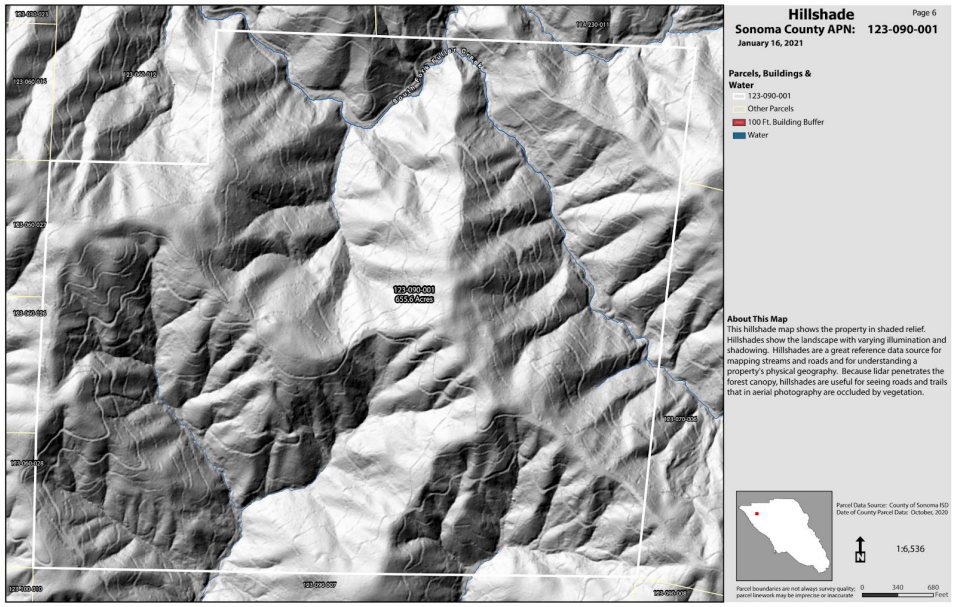


Data Source: Data is a product of the Sonoma Veg Map (http://sonomavegmap.org) and the orthoimagery using high resolution 6-inch orthoimagery from Fall, 2013 and June, 2020.

What the Maps Depict: 2013 Imagery and *2020 Imagery* show an aerial view of the parcel with an overlay of streams and buildings as seen in the Street Map. These images are displayed in true color, which means it is similar to what a person might see from above, and users can delineate vegetation from bare ground.

Fuel Management Application: Many of the maps in this report use data from the 2013 Sonoma Veg Map project where high-resolution remote-sensing data was gathered for all of Sonoma County. Users can compare the 2013 map to the 2020 map for a rough indicator of how much their property vegetation might have changed during that time period and how that might influence the use of the maps in executing fuel management. For example, if an area experienced a burn in 2017, the 2020 map might show more bare ground patches compared to forested areas captured in 2013.

4.1.7. Hillshade

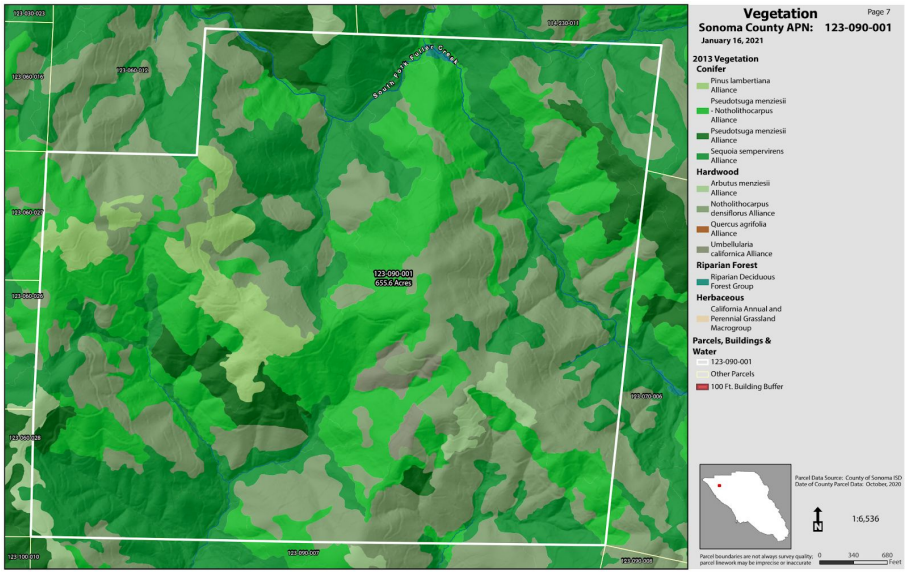


Data Source: This map was created using high resolution LiDAR data that was collected for Sonoma County in 2013 for the Sonoma Veg Map project. This map was updated in 2019.

What the Map Depicts: The hillshade map is a 3D representation of an area. It shows the physical geography, such as hills and valleys within the parcel.

Fuel Management Application: Similar to the *Street* map, the *Hillshade* map can be utilized to orient the user to the geography of their property. It can also inform users on where there might be difficult terrain in implementing a fuel management project.

4.1.8. Vegetation

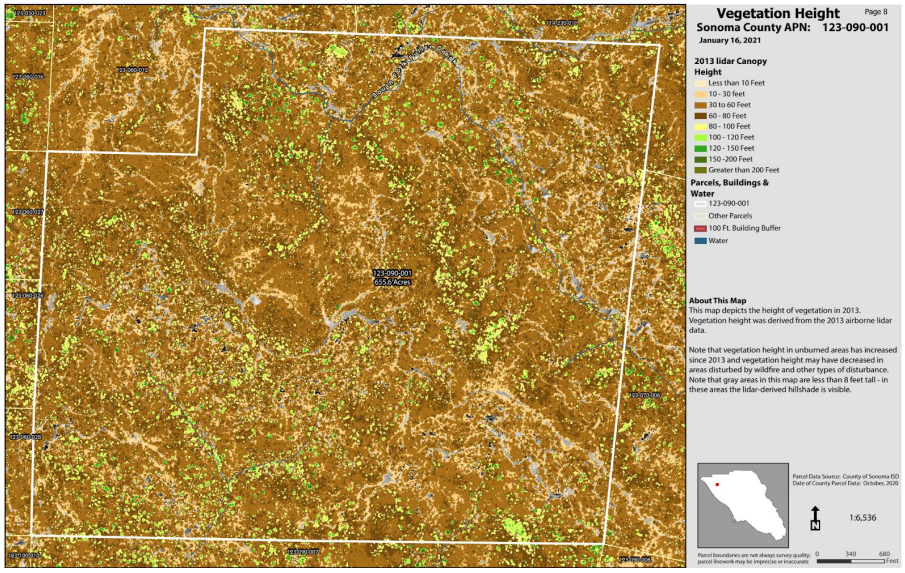


Data Source: This map was created using high resolution LiDAR data that was collected for Sonoma County in 2013 for the Sonoma Veg Map project.

What the Map Depicts: Classification of fine-scale vegetation. Various vegetation categories are delineated in the legend, such as conifers and hardwood, and the individual vegetation types are colored on the map.

Fuel Management Application: Different vegetation types require different fuel treatment methods. Some vegetation types are at a greater risk for wildfire ignition. The vegetation map can help users visualize the breakdown of vegetation types on their property, which will aid in creating a fuel management plan that is specific to the plant types on their property.

4.1.9. Vegetation Height

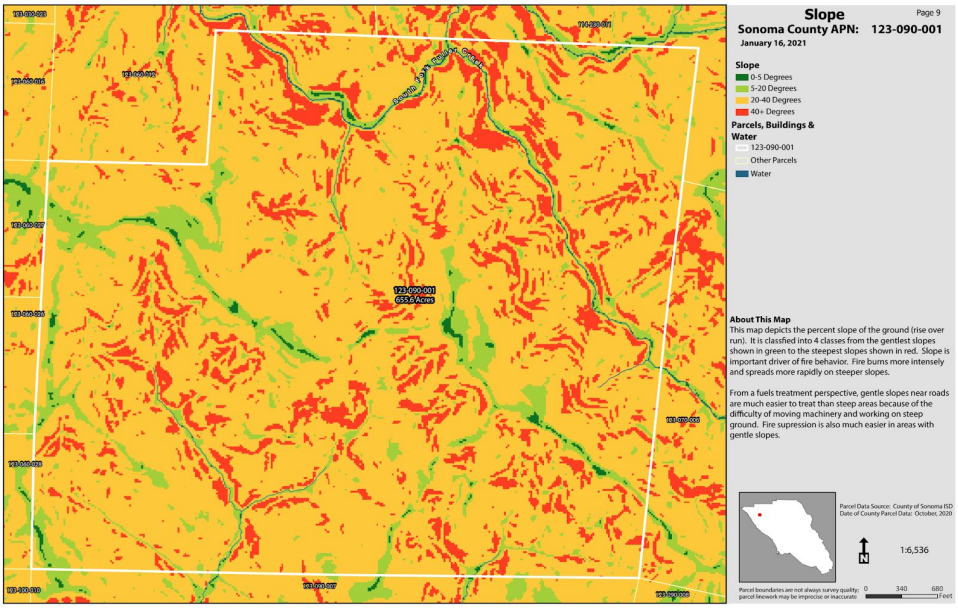


Data Source: This map was created using high resolution LiDAR data that was collected for Sonoma County in 2013 for the Sonoma Veg Map project.

What the Map Depicts: This map shows the height of the tree-tops, or canopy, across a parcel from a scale on the ground to greater than 200 feet.

Fuel Management Application: The canopy height, or the vegetation height, across a landscape can impact both wildfire's ability to spread embers and influence the wildfire behavior. This map can be used in conjunction with the vegetation and ladder fuels map to understand where the greatest risk is for a crown fire, a fire that spreads from the ground to the treetops, might occur based on the density of ladder fuels and vegetation height.

4.1.10. Slope



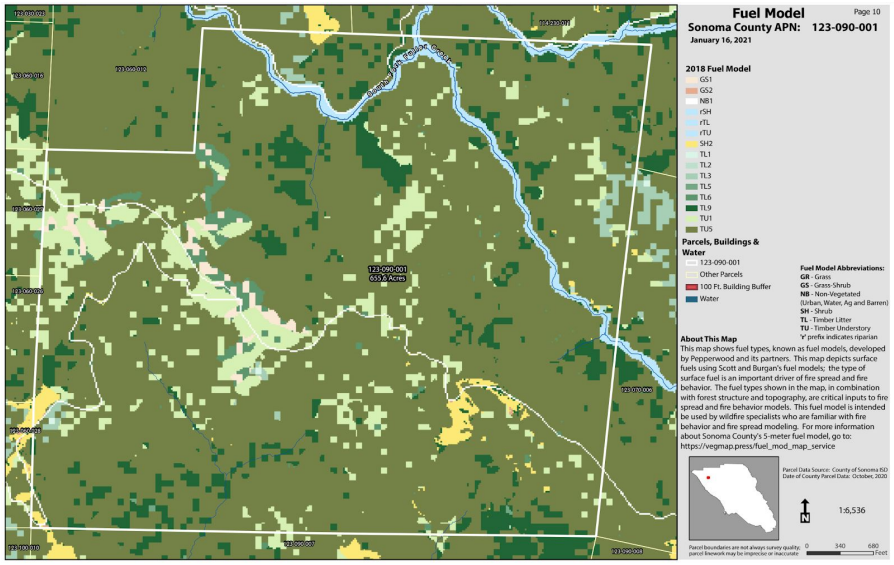
Data Source: This map was created using high resolution LiDAR data that was collected for Sonoma County in 2013 for the Sonoma Veg Map project. This map was updated in 2019.

What the Map Depicts: The *Slope* map shows the change in elevation, or the change in steepness across the landscape. Slope is measured in degrees, with higher degrees indicating a steeper terrain.

Fuel Management Application: Slope, has a dramatic effect on fire behavior and intensity. Fires burning upslope, or uphill, preheat and dry the 'vertically stacked' fuel in front of the fire which can increase the rate of spread and intensity of the fire. Fires burning downlope, on flat ground, and in drainage bottoms typically experience less extreme fire behavior.

This map, in conjunction with the vegetation and ladder fuel maps, can be used to identify areas where there is steep terrain coupled with dense, high-wildfire risk vegetation. Some forms of fuel treatment are much more difficult and costly on a steep terrain and this map will help users and specialists identify the fuel treatment needs based on the geography of the parcel.

4.1.11. Fuel Model



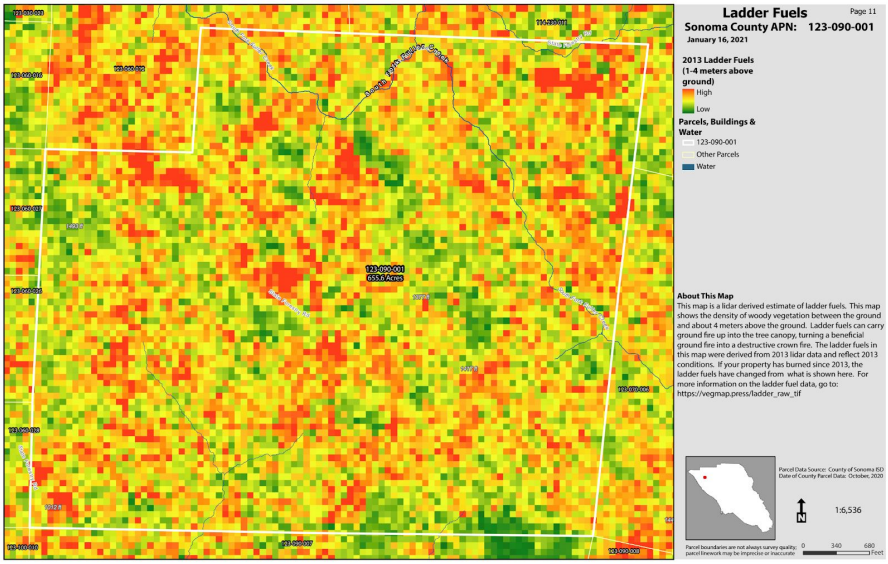
Data Source: The Sonoma County 5-meter Fuel Model was developed by Pepperwood and Tukman Geospatial, with funding from the Thornton Foundation. The fuel model was developed from a combination of LiDAR data representing forest structure and topography, combined with information from Sonoma County's fine-scale vegetation map. The 5-meter fuel model is more resolute and derived from higher quality datasets than other de-facto standard statewide fuel models. This offers a higher spatial resolution than the existing publicly available fuel models.

What the Map Depicts: The fuel model provides a fine scale map of fuel conditions on the landscape, classifying different types of surface fuels based on the Scott and Burgan Surface Fuel Classification. These surface fuels are a primary driver of fire behavior. Each of the fuel classes on the map have different characteristics when they burn. These characteristics include how much fuel the class contains per unit area (fuel load), how quickly the fire spreads in the class, and how intensely the class burns. The fuel model is a required input for fire behavior and fire spread models.

Fuel Management Application: Fuel models are used by professionals as inputs for larger models that demonstrate and predict fire behavior and spread across a landscape. These fire behavior models, which use a fuel model as an important input, are useful for simulating the effects of fuel management projects on fire behavior and provide a tool for comparing the benefits of different fuel management alternatives. This is the most technical map in the report, and is useful when working with a mapping professional or fire expert on predicting fire behavior across your property and identifying areas for hazard containment.

Please visit this website for more information: https://sonomaopenspace.maps.arcgis.com/home/item.html?id=2d194202dfee4ab5b157e978cd0e4901

4.1.12. Ladder Fuels



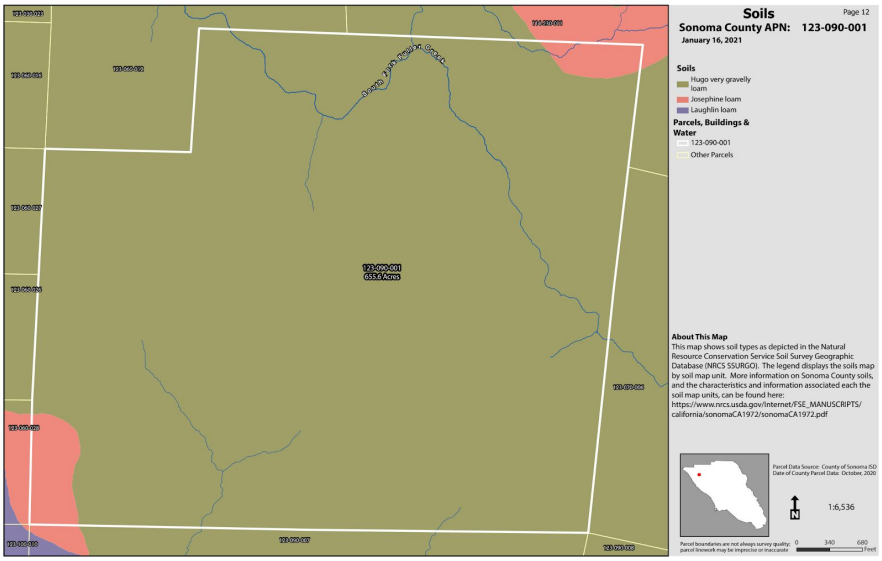
Data Source: This map was created using high resolution LiDAR data that was collected for Sonoma County in 2013 for the Sonoma Veg Map project. This map was updated in 2019.

What the Map Depicts: This *Ladder Fuel* map shows the density of ladder fuels across a parcel, where there is a greater concentration of low-lying vegetation that can cause fires to travel from the ground up into the tree canopy.

Fuel Management Application: Ladder fuels, like small trees and tall shrubs and branches, connect the ground to the tree canopy. Reducing ladder fuels is a key element of a fire resilient landscape because fewer ladder fuels improves chances that fire will stay on ground rather than turn into an uncontrollable and destructive fire across the tops of trees.

This map shows where dense ladder fuels exist across a parcel. While the landscape may have changed since the data was collected in 2013, it is critical to identify areas with dense vegetation that could lead to ground fires climbing up into treetops and prioritize treating these areas. Reducing ladder fuels and the density of vegetation near a house increases the chance that a home will survive wildfire. Reducing ladder fuel and density of low-lying vegetation fuels can significantly change local fire behavior and reduce the chances of extensive tree mortality.

4.1.13. Soils



Data Source: Natural Resource Conservation Service Soil Survey Geographic Database (NRCS SSURGO), which contains information about soil collected by the National Cooperative Soil Survey through a series of on-the-ground observations and soil sample analysis.

What the Map Depicts: Soil is an important asset to a landscape and plays an important part in the vegetation that is growing. The *Soils* map shows soil type as delineated by the Natural Resource Conservation Service Soil Survey.

Fuel Management Application: When creating a fuel management plan, especially across larger parcels and properties, it will be important to use the soil map to draw boundaries of management. Understanding the underlying soil type across a landscape can help explain the success and encroachment of different vegetation types.

Section 5: Your Fuel Management Plan

5.1. Overview

With a basic understanding of the principles of fuel management and a mapping report showing landscape elements and fire hazards across a property, land managers and owners can take the next step in pursuing a fuel management plan for their property.

While the The Wildfire Fuel Mapper can provide users with a lot of information to understand landscape elements and assess fire hazards on their land, there are critical steps and planning requirements necessary to take before implementing a fuel management plan. This section will review common goals of fuel management, define and provide contact information for important forestry and wildfire specialists and fuels-management professionals, and offer a step-by-step overview of creating a fuels management plan.

5.2 Vegetation Management Goals

Managing vegetation across a property can achieve more than just wildfire fuel reduction. Natural resource goals can vary, depending on the interests of the landowner, fire severity risk areas and the natural resource itself. Management can provide valuable ecological services that benefit the forest and rangeland resources, while also reducing fuels and fire hazards, a landowner should determine the area's goals, and if these goals are achievable, affordable and sustainable. Other goals beyond reducing fuels might include:

- ➔ Manage unwanted and/or excessive vegetation to reduce fuel loads
- ➔ Reduce the risk of large catastrophic fires; increase landscape resiliency
- ➔ Improve forage quality and quantity available for livestock or wildlife
- ➔ Increase economic viability from the property
- ➔ Increase carbon sequestration, water recharge, or other ecosystem service benefits
- ➔ Promote desired native species, increase biodiversity
- ➔ Increase water storage; reduce rapid runoff and accelerated erosion
- ➔ Others

5.3 Types of Fuel Treatments for Your Property

There are a number of different types of fuel treatments. The exact locations, size, and type of fuel treatments will depend on the vegetation type and arrangement of fuels on the landscape, location of human assets, topography, weather patterns, and other factors. The maps provided in the Wildfire Fuel Mapper (for each parcel in the county and for watersheds) provide information useful for planning an appropriate fuel treatment.

The types of treatments (also known as fuel treatments), are described below. *Do not attempt any of these treatments without consulting a specialist on your fuel treatment needs.* Different professional forestry and wildfire specialists are listed and contact information is provided in **Section 5: Your Fuel Management Plan.** You can also visit: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/cp/ncps/ to learn more about NRCS Conservation practices.

Hand Labor: Hand labor treatments involve pruning, cutting or removal of grasses, shrubs and/or trees by hand or using hand-held equipment. Fuels that are managed with hand labor are usually in areas that are small in size or have difficult access, where heavy equipment costs may be too high, or in areas with sensitive environmental concerns. Landowners with capacity can achieve a great deal of their vegetation management goals with hand labor.

Chemical Treatment: Chemical treatments involve the application of herbicides to kill plants or prevent their regrowth or in combination with other treatment methods. Application following another treatment method, where the targeted plants were pruned, can increase the effectiveness of the chemical treatment. Herbicides are frequently used to kill herbaceous plants along roadsides.

Prescribed Grazing: The harvesting of vegetation with grazing and/or browsing animals with the intent to achieve specific ecological, economic, and management objectives. Grazing is particularly effective where the plants are palatable to the animals selected, including cattle, sheep and/or goats. Grazing can be implemented to reduce grasses, shrubs or the understory of tree stands or as a maintenance method to control fuel regrowth.

Prescribed Burning: The use of fire under predetermined conditions to achieve specific objectives including wildfire hazard reduction, ecosystem restoration, vegetation management, and habitat enhancement. Prescribed fire is increasingly recognized and utilized as an effective strategy by landowners, and federal and state agencies, to reduce wildfire severity and restore and maintain ecosystem health. There are recommended processes involved with conducting a prescribed burn on a property, including working with specialists, adhering to liabilities, and putting together appropriate planning documents. You can learn more about the process and additional resources at the California Prescribed Burn Association (PBA) website. Typical burn process steps, identified by the California PBA, are listed below:

1. Connect with your local PBA
2. Take a site visit of the potential burn unit
3. Start a burn plan
4. Create a burn plan checklist
5. Determine required permits
6. Create a smoke management plan
7. Determine liability
8. Prepare the burn unit, conduct your burn, and monitor how the burn went

Mechanical: Mechanical treatment involves cutting grasses, shrubs and/or trees up to 4 inches in diameter through the use of a tractor or other machinery. This is referred to as grading, mowing, disking and/or crushing. Mechanical vegetation management practices that can be cost shared through the Natural Resource Conservation Service include:

Brush Management: Brush management is the management or removal of woody (non herbaceous or succulent) plants including those that are invasive and noxious, using mechanical, chemical or biological methods either alone or in combination.

Woody Residue Treatment: Woody residue treatment involves the material that is created due to management activities or natural disturbances. Treatment methods may include piling, burning, chipping/masticating, lop and scatter, offsite removal, or crushing.

Tree/Shrub Pruning: Tree/shrub pruning is a treatment applied to trees and shrubs that involves the removal of selected branches, shoots, or roots. It may also be applied to the removal of all above-ground material where a coppicing technique is being used to renew the growth of trees or shrubs.

Forest Stand Improvement: Forest stand improvement involves the manipulation of species composition, stand structure, or stand density by removing selected trees or understory vegetation to achieve desired forest conditions or obtain ecosystem services

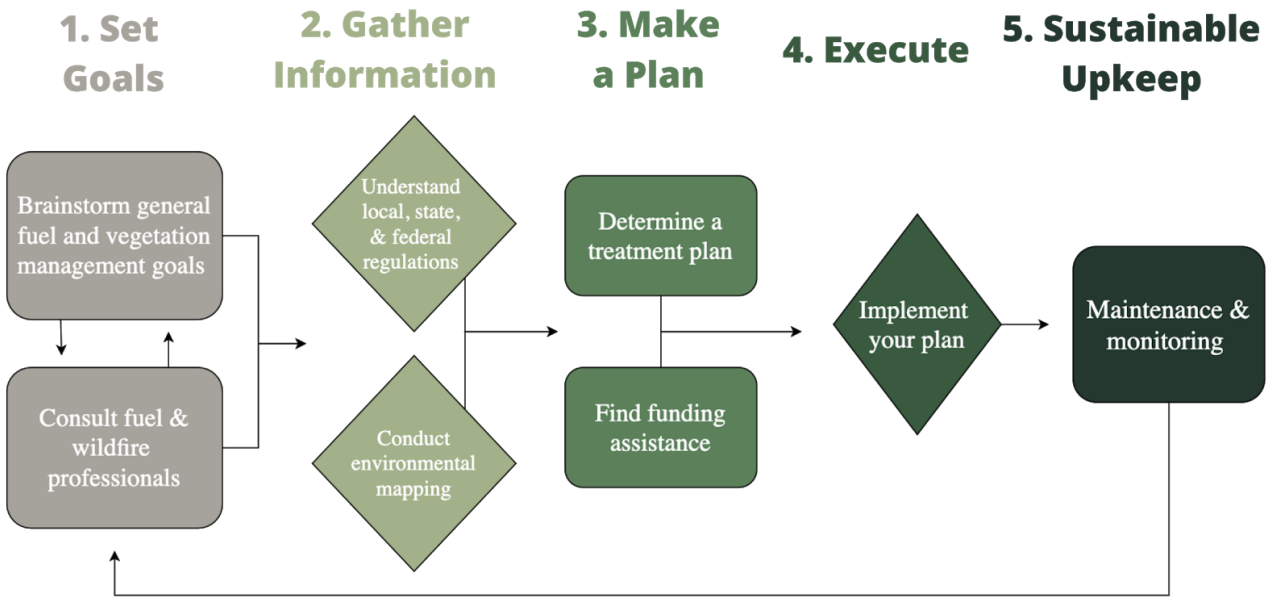
Fuel Break: A fire fuel break is a strip or block of land on which the vegetation, debris, and detritus have been reduced and/or modified to control or diminish the risk of the spread of fire crossing the strip or block of land. There are two types of Fuel Breaks:

Firebreak: A firebreak is a strip of land from 2 to 15 feet wide that is cleared of all vegetation and organic matter. They are used to prevent advancing fires from reaching any more combustible material.

Shaded Fuel Break: A shaded fuel break is a strip of land where vegetation has been modified or reduced to leave only the overhang of treetops. Shaded fuel breaks retain moisture under the understory better than fire breaks, but a fire might more easily cross the break because there is more vegetation.

5.4 Step-by-Step Guide

This section walks through 5 simplified steps to implement a fuel reduction project.



1. Set Goals

Consult vegetation management specialists and experts: Before implementing your project, make sure to consult with local specialists , who can help identify your property's hazardous fuels, based on your ***Wildfire Fuel Mapper*** maps and parcel report, and advise on next steps in your project. It is critical to work with an expert in designing your project to ensure you are following regulatory requirements and applying appropriate pre-treatments. Visit **Section 5.5 Fire Specialists and Fuel Management Professionals** for a list of professionals that can aid in your fuel management plan.

Set general vegetation management goals: Setting clear and defined vegetation management goals serve as the foundation for a successful project. Examples of goals can include reduced fuels, increased biodiversity, increased forage, improved habitat and carbon sequestration. Land owners and managers should brainstorm goals with a specialist or expert to determine appropriate vegetation management goals to meet the needs of the property and regulatory constraints.

2. Gather Information

Understand requirements and regulations: Prior to any significant vegetation management projects, it is important to review federal, state, and local regulations or requirements. The location and status of your property will determine which agencies have the primary duty to help you prevent and suppress fires, and which regulations you must adhere to. Find your property's designation in the Wildfire Fuel Mapper Parcel Report and contact your local CAL Fire office to learn more about what regulations apply to your property.

Conduct Environmental Mapping: Planning an approach for reducing fuels requires maps and information about your landscape. Maps can help you better understand fuels, forest type,

fuels, slope, roads, buildings, and streams and lakes. These maps can be shared with experts as you create your treatment plan. ***The Wildfire Fuel Mapper*** Report includes many helpful maps, but users may wish to acquire additional maps that clarify their property's assets.

3. Make a Plan

Determine a treatment plan: Once the report results from the ***Wildfire Fuel Mapper*** are generated, landowners must work with experts to further assess and specify which areas to treat and the treatment activities to do so effectively. Different activities will require different planning documents, such as a Forest Stewardship Plan, a Smoke Management and Burn Plan, or a Timber Harvesting Plan. The ***Wildfire Fuel Mapper*** report will help to expedite this process of identifying and selecting your treatment plan.

Find Funding Assistance: There are various funding opportunities and cost share programs available through local, state and federal agencies to help you implement your fuel treatment plan. Additionally, agencies such as the Natural Resource Conservation Service (NRCS) assist landowners with free technical assistance and cost share programs to help offset the costs of implementation. Additional information on these funding opportunities can be found on our website under "Data and Resources".

4. Implement your treatment plan

Once you are ready to move forward with your project, use the information you have gathered to begin implementing your chosen fuel treatment strategies. Effective and sustainable management of vegetation often requires integrating several treatment options.

5. Sustainable Upkeep

To maintain a fire resilient landscape, fuel management is a continuous effort. Over time, vegetation grows back and fuel treatments need to be repeated. After a fuel reduction project is conducted, it is important to monitor the conditions of the treatment area. As early as 5-10 years post-treatment, new growth of vegetation may require a second treatment. Following treatments will require much less work in areas that have already been treated.

5.5 Specialists and Professionals

There are several different forestry and wildfire specialists and fuel management professionals that can help with setting goals and creating the best fuel management plan for your property. There are different kinds of specialists and experts that can help with different components of the fuel management process, including implementation, technical assistance, and planning. For a

quick link to the Wildfire Fuel Mapper's compiled list of specialists and professionals to contact, please visit: https://wildfirefuelmapper.org/resources.html .

Specialist Type	Job Description	Role in fuel management	How can they support a fuel management plan?
Registered Professional Forester (RPF)	A RPF is a person licensed by the State of California to perform professional services that requires the application of forestry principles and techniques to assist in the management of forested landscapes. To become a RPF, an individual must have seven years of experience in forestry work. Under the Professional Foresters Law [PRC§752], most forest management activities require working with an RPF, especially if you want to develop a management plan or sell, barter, or trade timber resources from your property. Even if a management activity does not require an RPF, you may still want to consult one for their expertise.	*Technical assistance* *Planning*	➔ Prepare forest management plans ➔ Prepare and maintain forest inventories ➔ Assist in forestland appraisals ➔ Prepare timber harvest plans and contract administration ➔ Advise and ensure compliance with state laws ➔ And any other assistance a landowner may need
Arborist	Arborists specialize in tree care. They are knowledgeable about the needs of trees, and are trained and equipped to provide proper care to trees across a property. To become an arborist, an individual must have three years of experience and pass a rigorous exam to demonstrate an understanding of tree growth, plant care, pruning and ecology. It is recommended that you work with an Arborist certified by the American Society of Consulting Arborists (ASCA) or International Society of Arboriculture (ISA).	*Implementation* *Maintenance*	➔ Specialize in care for individual trees ➔ Help plan and prepare trees within the defensible space zone

Licensed Timber Operator	LTOs have been licensed under the Forest Practice Act law and are authorized to conduct forest tree cutting and removal operations. California State Law requires that any person who cuts and removes forest trees in order to sell the logs, or to develop a building site on forest covered lands, must be a Licensed Timber Operator	*Implementation* *Maintenance*	➔ Conduct on the ground logging ➔ Plan timber harvest ➔ Process trees post-harvest ➔ Maintain and clear-roadways post-harvest
Fuel Treatment Contractor	Fuel Treatment Contractors are public or private contracted employees or crews that can come out to a property and conduct mechanical and hand treatment of fuels on a property. They are specially trained to manage forests and properties for hazardous fuels reduction.	*Implementation* *Maintenance*	➔ Conduct vegetation clearing ➔ Create defensible space around homes and structures
Natural Resource Conservation Service (NRCS) Advisors	The NRCS is a federal agency within the U.S. Department of Agriculture. Local and regional advisors provide technical assistance to farmers and private land managers.	*Technical assistance* *Planning* *Funding*	➔ Assist with site specific questions ➔ Help with developing a conservation plan ➔ Provide technical assistance and help with management decisions and forest conservation activities ➔ Provide financial cost-share opportunities
University of California Cooperative Extension (UCCE) Forestry Rangeland	UCCE Forestry Advisors provide critical research-based information, education, and advising across a variety of disciplines related to forestry, including	*Technical assistance* *Planning*	➔ Offer technical advice in fuel

and/or Natural Resource Advisors	environmental stewardship, forest management, and fire and fuels management. Forestry Advisors work with landowners and other natural resource professionals, to practice forest stewardship and management for forest resiliency.		management planning - Help address forestry challenges
Certified Rangeland Managers	A CRM is a person licensed through the California State Board of Forestry and Fire Protection to provide landowners and managers with expertise in managing rangeland and rangeland resources. It is highly recommended that landowners and managers utilize CRMs when conducting rangeland operations on forested landscapes. CRM's may be an especially helpful resource for making management recommendations such as prescribed grazing for reducing fuels.	*Technical assistance* *Planning*	- Consult and draft Range Management Plans and Conservation Plans to meet natural resource goals - Make management recommendations, such as prescribed grazing -Conduct monitoring
Prescribed Burn Associations	Prescribed Burn Associations (PBA) are local community-based, mutual aid networks that help private landowners conduct prescribed burns on their properties. PBA's offer a "neighbors help neighbors" model to help community members implement burns by providing labor, equipment, and skills. PBA's can also help with the burn planning process and offer specialized expertise. PBA's exist in many different local communities throughout California, including Sonoma	*Implementation* *Planning*	- Help with burn planning - Provide planning documents and templates - raining - Provide the labor and implementation for

	and Marin Counties' "Good Fire Alliance".		prescribed burns → Can provide equipment for implementing burning

5.6 Regulations, Zoning, and Permits

Prior to any tree removal or significant vegetation management projects, it is important to review federal, state, and local regulations or requirements and consult with experts. There are many different regulations and zoning laws within Sonoma County and regulations may depend on the type of vegetation treatment plan. If you are interested in creating a forest treatment plan, contact an RPF. If you are interested in just learning more about general laws and regulations that might apply to your property, contact your local CAL Fire office.

Additionally, depending on your location and property status either the state or local agencies (e.g. county or municipality) have primary duty to prevent and suppress fires. You can find your parcel's designation in the Wildlife Fuel Mapper Parcel report on the summary page under "CAL Fire Responsibility Area" which will help you determine your defensible space requirements.

Section 6: Feedback and Support

6.1 Frequently Asked Questions

What is the difference between a fire hazard and a fire risk?

Fire hazard is the physical conditions and elements that determine the likelihood an area will burn. Fire risk is the likelihood a fire will occur as a result of fire hazards, the intensity of the fire behavior, and the effect or extent of damage to valued assets.

Where does the data for the maps come from? How accurate is the data?

The Wildfire Fuel Mapper maps use the best available data for our region, using various sources such as ground observations, satellite imagery and other geospatial data. Many of the static maps in the report were created using data products from the 2013 Sonoma County Vegetation Mapping and LiDAR program. The Sonoma County Vegetation Mapping and LiDAR program collected vegetation data at a 5 meter resolution, producing data products that provide a more detailed view of our landscape than other publicly available datasets, which often come at 30mx30m or greater. The maps in the report offer a unique and important compilation of maps at both a property and landscape scale that hasn't previously been accessible. It is important to note that because much of the data used in the map reports are from 2013, elements on your property (e.g. vegetation height, ladder fuels) could have changed since then.

Why is my parcel not available for download?

All parcels of 3 acres of greater within Sonoma County are available for download. If you do not see your parcel, it is likely because it is too small of a parcel or it does not fall within Sonoma County boundaries.

Can I start treating fuels after I get my mapping report?

While the The Wildfire Fuel Mapper can provide users with a lot of information to understand landscape elements and assess fire hazards on their land, there are critical steps and planning requirements necessary to take before implementing a fuel management plan. Before treating fuels on your landscape, it is important that you consult with a specialist to plan your fuel reduction project. To find specialists to help you, visit the "Resources & Data" page on our website: https://wildfirefuelmapper.org/resources.html.

Will my parcel report line up with my neighbors?

Your parcel report should line up with your neighbor's property, however, only if their property is 3 acres or greater. Parcels smaller than 3 acres will not appear on the Wildfire Fuel Mapper maps.

Why is my road not on the map?

Some roads may not be detectable by the datasets used in the Wildfire Fuel Mapper maps. Users can use the Street Map or 2020 Imagery map to identify landmarks/structures on their property in order to locate and draw where their undetected roads occur.

What should I do if my property has recently burned down? / Does a recent fire affect my map report?

Previous fires are important to consider when evaluating current fuels and fire hazards. The length of time since fire occurrence and the severity of the fire play a role in vegetation type, density, and accumulation. Because the vegetation maps used in the Wildfire Fuel Mapper report are from the Sonoma County LiDAR program in 2013, vegetation on your property may have changed since then, especially if your property has burned. We advise working with a specialist or expert to assess post-fire fuels and changes in vegetation.

Who do I contact to start planning fuel management on my property?

There are different kinds of specialists and experts that can help with different components of the fuel management process, including implementation, technical assistance, or planning. For a quick link to the Wildfire Fuel Mapper's compiled list of specialists and professionals to contact, please visit: https://wildfirefuelmapper.org/resources.html .

6.2 Have Feedback?

User feedback and input is greatly appreciated and will help us ensure that the Wildfire Fuel Mapper is as effective and useful as possible for users.

Contact Dr. Stephanie Larson (slarson@ucanr.edu) or Dr. Tosha Comendant (tcomendant@pepperwoodpreserve.org) and visit: https://wildfirefuelmapper.org/

GLOSSARY

Aspect
The orientation of slope, or which direction a hill faces

Crown Fire
A fire that becomes more severe and burns up from the ground into the tree canopy

Defensible Space
An area around a structure, generally 0 - 100 feet, that is maintained to remove fuels, reduce the risk of ignition, and "defend" the home from wildfire threat.

Fuel Model
A stylized set of surface fuel characteristics used as input for a variety of wildfire modeling applications.

Ground Fire
A fire that smolders beneath the surface layer of litter, burning duff and other organic material in the soil

Structure Hardening
Pre-fire activities residents can take to reduce the risk of ignition around homes and structures.

Ladder Fuels
Small trees, tall shrubs and branches that connect the surface fuel to the canopy fuels, and can promote the spread of surface fire upward into the canopy.

LiDAR
Light Detection and Ranging, is a remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances) to the Earth.

Prescribed Burn
A small, controlled fires that are intentionally ignited to reduce the fuel load and/or improve forest health in a given area

Red Flag Warning
A warning issued for weather events which may result in extreme fire behavior that will occur within 24 hours

Surface Fire
A fire that burns leaf litter and other downed fuels like branches and logs, as well as some surface-level plants like bushes or small trees; larger woody plants and trees are largely left alive.

Watershed
A drainage basin is any area of land where precipitation collects and drains off into a common outlet, such as into a river, bay, or other body of water.

Wildfire Hazard
Physical conditions and elements that determine the likelihood an area will burn, an element that can cause harm

Wildfire Risk
The likelihood a fire will occur as a result of a fire hazard, the intensity of the fire behavior, and the effect or extent of damage to valued assets, the chance that the hazards will cause harm

Wildland Urban Interface
A zone of transition between human communities and wildland areas