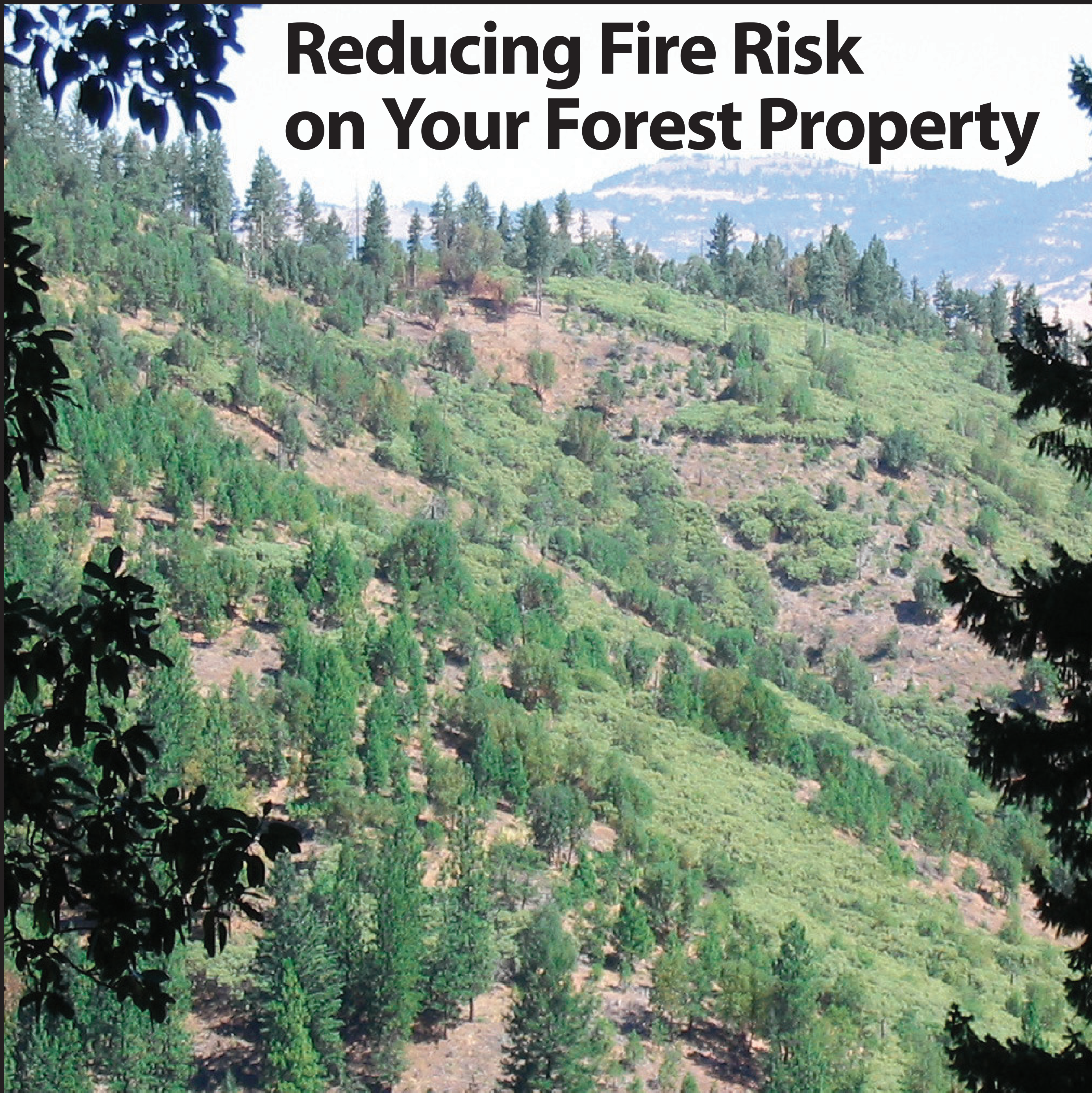
Reducing Fire Risk on Your Forest Property



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Introduction

Is your forested property in a condition that could survive a wildfire? Have you reduced the slash to the point that it's not a hazard? Could firefighters easily get to a wildfire on your property?

If the answer to these questions is *no* or *I don't know*, your property may be at high risk for a wildfire, which would have real financial consequences for you, your family, and your neighbors, as well as for the long-term health of your watershed and the area's ecology. The degree of wildfire risk depends on both the probability of an ignition (for example, from lightning or human activity) and the potential for damage or harm (such as loss of trees, homes, or even lives).

Recognizing that you may have a high wildfire risk is the first step in doing something about it. As a real-world illustration of what's involved, we highlight the story of the Epsteins, who purchased property in southwestern Oregon in 1987. Soon after, they learned their wildfire risk was high; in fact, parts of the property had burned in intense wildfires at least twice in the past century. You'll learn what they did to reduce their risk in their case history on page 20.

Whether you own a few acres or thousands, this publication will help you reduce the potential for wildfire damage on your property while improving overall forest health and wildlife habitat. Although these actions won't prevent a wildfire from coming onto your property, they can make it more fire resistant. In other words, by following the guidelines in this publication you can reduce a ***fire's severity*** so that most trees survive and firefighters are better able to attack and extinguish the blaze.

While this publication provides suggestions for making your property more fire-resistant, it does not specifically address the area of *defensible space* immediately around your home, cabin, or other structures. For detailed information about creating and maintaining defensible space, refer to the resources listed on page 28 of this publication.

Fire in Northwest forests

Fire has played an important role in the development and maintenance of forests in the Pacific Northwest.

Contents

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Historically, wildfires under-burned some forests, leaving mature trees intact, while in other forests, entire stands and watersheds were consumed. In still other forests, fires burned with a mix of high and low ***intensity***. Ecologically, wildfire played numerous important roles such as thinning forests, reducing accumulated fuels such as underbrush, and creating new forests of different ages and patch sizes—all of which have added to the diversity and productivity of Pacific Northwest forests.

Over the past century or so, however, many of our forests have become more vulnerable to intense wildfires, due in large part to an overabundance of hazardous fuels including dead and unhealthy trees. Moreover, as more people live in or near wooded areas—known as the wildland-urban interface—the risk is much greater for wildfire due to human negligence. Intense fires pose significant risks to private forestland, homes and other structures, and human lives. And collectively, they cost millions in lost future timber revenue and in expenses for fire suppression, reforestation, and rehabilitation of burned lands.

Laws on fire protection and other forest activity

Before you design or carry out any plan to reduce fire risk or to do work on your woodland property, learn about the fire and forest-protection laws specific to your state. They pertain to all private forestland owners, no matter how few forested acres you have.

The Oregon Department of Forestry (ODF), the Idaho Department of Lands (IDL), the Washington Department of Natural Resources, and local forest protection associations are principally responsible for overall wildfire protection on state and private lands. (See Appendix A.)

Table 1. Fire severity effects on trees, organic matter, woody debris, soil erosion potential, and vegetation.

Aspects affected	Degree of fire severity		
	Low	Medium	High
Litter/duff (decomposing needles)	Light char, slight consumption in spots	Moderate ground char; duff is deeply charred or consumed	Completely consumed
Leaves/twigs/branches	Light char	Mostly consumed	Completely consumed
Woody debris (logs)	Charred or lightly consumed	Deeply charred with some consumption	Logs consumed or deeply charred
Mineral soil	Not changed	Not visibly altered; white ash present	Significantly changed with altered soil properties; soil infiltration may be reduced.
Share of trees killed	< 20%	20–70%	> 70%
Erosion potential[1]	None/little	Some	Extensive
Photos			

[1] Erosion potential also depends on slope steepness

1. Fire Behavior Basics

When designing treatments to reduce fuel and fire risk, develop roads, and develop water sources to aid wildfire suppression, it's essential to know:

- Where potential ignitions may come from.
- How the amount and arrangement of fuel affects fire (the "fire triangle").
- How weather and topography interact with fuel to affect *fire behavior* (the "fire behavior triangle").

Marty Main, Small Woodland Services.

The Epsteins own property with high wildfire risk in southwestern Oregon. To learn more about their story, see their case history on page 20.

Sources of ignition

Wildfires are ignited by either lightning or humans. Most ignitions on private forestland are from human activity, primarily debris burning, equipment fires, and arson (see Table 2). Although lightning set fewer fires in 2004–2008, those consumed more than three times the acreage of human-caused fires in the same period.

Identify the likely ignition sources around your property. For example:

- Do thunderstorms tend to produce lightning strikes in your area?
- Is a housing subdivision below your property?
- Is a railroad nearby, where trains could produce sparks?
- Do power lines run through or near your property?
- Does a road border your property, from which a driver might discard a cigarette and ignite roadside vegetation?
- Do you allow hunters and others to use your property?

All of these factors can increase the chance of an ignition. Some you have control over, others you don't. In either case, preventive action can reduce risk.

The fire triangle

To sustain a fire, three elements are needed: heat or an ignition source, fuel, and oxygen (Figure 1). Take any one of these elements away and the fire goes out (or doesn't start). For example, creating a fire line down to mineral soil, which is noncombustible, removes combustible material on the forest floor (***surface fuel***) and stops a fire's progress if the fire line encircles the fire.

The fire behavior triangle

Fire behavior means its rate of spread (in feet/hour) and its intensity (that is, how hot it burns and how long its flame is). Once a fire ignites in forest or rangeland, its behavior depends on the three factors that make up the fire behavior triangle: the amount and arrangement of fuel, the topography, and weather conditions (Figure 2). A change in any one factor during the fire alters its behavior and type (whether it's a ground, surface, or crown fire). See Appendix B for details on the influence of topography, weather, and fuels on fire behavior.

Other aspects of fire behavior

Other important aspects of fire behavior are as follows:

- Torching—movement of a surface fire up into tree crowns; the precursor to crowning.
- Crowning—active fire movement through the tree canopy.
- Fire whirl—result of an upward-spinning column of air that carries flames, smoke, and embers aloft; whirls often form in heavy fuels on the lee (downwind) side of ridges and, in extreme conditions, can be powerful enough to twist off entire trees.
- Spotting—when firebrands (glowing embers) are lofted up and ahead of the main fire front, igniting multiple spot fires that then feed back into the main fire front to create very extreme and dangerous fire conditions.

Types of fires

A wildfire may be composed of three different types of fire: ground, surface, and crown. The relative proportion of each type can provide clues to the overall severity of a particular wildfire.

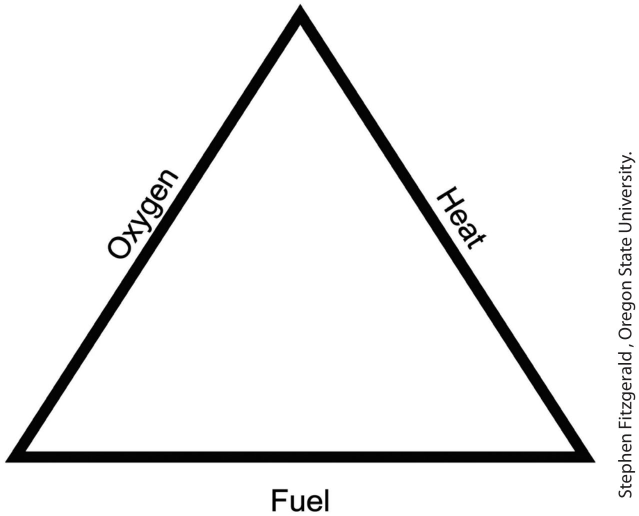


Figure 1. The fire triangle.

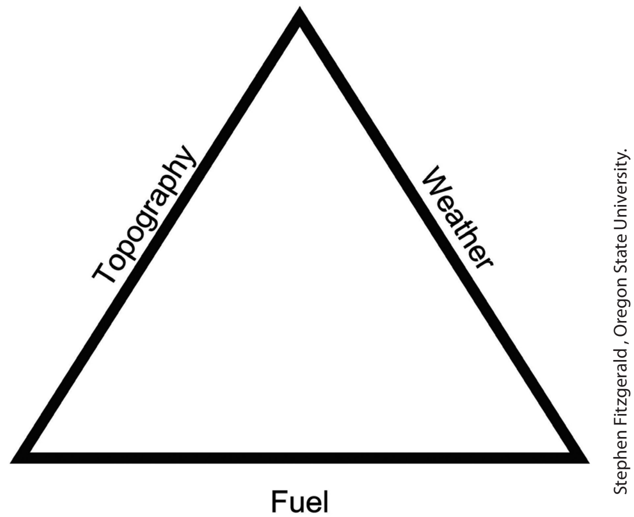


Figure 2. The fire behavior triangle.

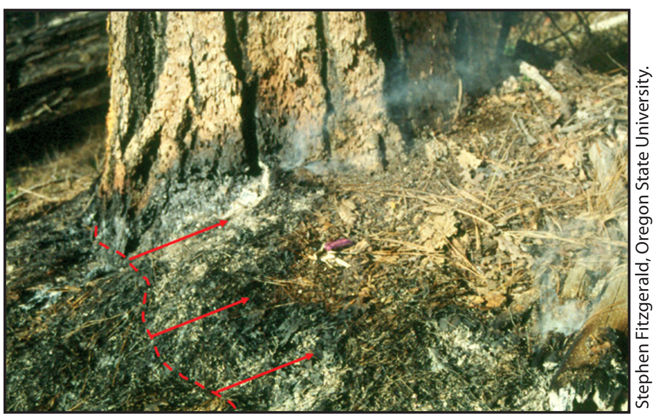


Figure 3. Ground fire. Dashed line represents base of smoldering duff layer.

Figure 4. Surface fire.

Ground fires

Ground fires consume mostly the duff layer and don't produce visible flames (Figure 3). Ground fires can also burn out stumps and follow and burn decaying roots and decayed logs in the soil. A fire burning in tree roots often goes undetected except when it follows a root near the soil surface. In such cases, it can emerge, ignite surface fuels, and become a surface fire. Ground fires can often smolder for days or weeks, producing little smoke.

Slash piles containing too much soil can allow a ground fire to smolder for weeks or months (called a hold-over fire), only to re-emerge later to ignite surface fuels. To prevent this, a skilled tractor operator should use a ***brush blade*** to create clean slash piles or use hydraulic excavators to stack and pile slash without adding soil to the pile.

Surface fires

Surface fires produce flaming fronts that consume needles, moss, lichen, herbaceous vegetation, shrubs, small trees, and saplings (Figure 4). Surface fires can ignite large woody debris and decomposing duff, which can burn (glowing combustion) long after surface flames have moved past. Surface fire severity can be low to high. High-severity surface fires kill most trees (more than 70 percent). Surface fires with flame lengths less than four feet can be controlled by ground crews. Surface fires can develop into crown fires if ***ladder fuels*** connect surface fuels to crown fuels, fuel moisture is low, or weather conditions favor torching and crowning.

Figure 5. Torching.

Figure 6. Active crown fire.

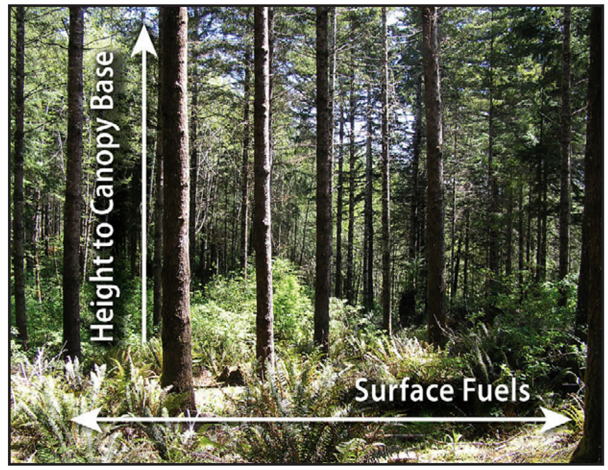


Figure 7. Factors affecting the transition from surface to crown fire.

Crown fires

Crown fires are either passive or active. Passive crown fires involve the torching of individual trees or groups of trees (Figure 5). Torching is the precursor to an active crown fire. Crown fires become active when enough heat is released to preheat and combust fuel above the surface, followed by active spreading of fires from one tree crown to the next though the canopy (Figure 6). Crown fires are usually intense and are strongly influenced by wind, topography, and tree (crown) density.

Four factors influence the transition from a surface fire to a crown fire (Figure 7):

- Foliage moisture content.
- Surface flame length.
- Height to the base of tree crowns (i.e., lower height of the canopy).
- Density of tree crowns (degree of overlapping of tree crowns).

The common denominator is fuel

We have little or no control over most factors governing the type of fire and fire behavior triangle. For example, we can't control the wind, topography, or oxygen, nor can we prevent every fire ignition. One element we can control is fuel. Reducing the amount of fuel and changing its arrangement before a wildfire erupts can affect fire behavior. Recent examinations of wildfires in the West show that where fuels have been reduced beforehand, fire intensity and severity are usually reduced. Thus, removing or reducing fuels in strategic locations on your property can lower fire risk and help make your property more resistant to wildfire.

Table 2. Number, cause, and extent of wildfires on private lands in Oregon, Washington, and Idaho, 2004–2008.

State	Human[1]		Lightning	
	No. of fires	Acreage	No. of Fires	Acreage
Oregon	3,905	24,071	1,519	67,124
Washington	2,692	4,009	595	15,770
Idaho	783	16,067	778	76,629
Total	7,380	44,147	2,892	159,523

[1] Includes wildfires caused by railroad, equipment, recreational use, smoking, debris burning, arson, juvenile, miscellaneous, and undetermined.
Source: Oregon Department of Forestry, Washington Department of Natural Resources, and the Idaho Department of Lands.

2. Principles of Fire-resistant Forests

The five principles of creating and maintaining ***fire-resistant forests*** are:

- Reduce surface fuels.
- Increase the height to the base of tree crowns.
- Increase spacing between tree crowns.
- Keep larger trees of more fire-resistant species.
- Promote more fire-resistant forests at the landscape level (i.e., your surrounding private and public neighbors) by reducing fuels both vertically and horizontally.

Following these principles accomplishes three goals:

1. Reduces the intensity of a fire, making it easier for firefighters to suppress.
2. Increases the odds that the forest will survive a fire (Figure 8). Small trees, shrubs, and other understory vegetation may be injured or killed, but larger trees in the stand will only be scorched, and soil damage also will be reduced.
3. Reduces the extent of restoration activities needed, such as replanting or erosion control measures.


Bureau of Land Management.

Figure 8. Example of a fire-resistant forest, Squire Fire, 2002, near Jacksonville, Oregon. Note low flame lengths. About two years prior to the fire, the stand had been thinned and the slash piled and burned, giving it structural characteristics that helped it survive the wildfire: low levels of surface fuels, a large gap between the ground and the base of the live crown, and large, thick-barked, widely spaced trees.

Reduce surface fuels

The reason for reducing surface fuels such as slash and small shrubs is to reduce potential flame lengths, making fire easier to control and less likely to reach into tree crowns. "Reducing" does not mean removing all organic material down to mineral soil; instead, reduce significant accumulations of surface fuel. Specific treatment methods for various fuels are discussed in more detail in the following section.

Increase distance to base of tree crowns

Increasing the distance from the lower surface fuels up to the base of tree crowns means a longer flame is needed to ignite the crowns. When tree crowns ignite (torching), the stage is set for a crown fire. Removing ladder fuels, including surface fuels, and pruning the larger trees raises the base of the forest canopy. Pruning is particularly effective in young stands, where crowns may still be low to the ground.

Increase spacing between tree crowns

When tree crowns are farther apart, it is harder for fire to spread from one crown to another, even when the wind is blowing. Thinning reduces crown density. It's important, however, to reduce the slash generated from thinning, to reduce the potential for a high-intensity surface fire.

Keep large trees of more fire-resistant species

Fire kills trees by killing the cambium layer (a layer of cells just inside the tree bark that produces new wood and bark), scorching the foliage, and killing buds and roots.

When thinning to improve fire resistance, strive to leave the larger trees. Large trees have thicker bark, which insulates the cambium. Although a fire may scorch the foliage, the cambium is protected. Also, large trees tend to have higher crowns, so their foliage and buds are less likely to be damaged.

Species selection is important. Ponderosa pine, western larch, and Douglas-fir all tend to develop thick bark that insulates the cambium from heat, and their root systems are deeper and thus more protected. Ponderosa pine has other features that help it survive fire, including an open crown, high moisture content in the foliage, and thick bud scales. Western larch also is very fire-resistant. Species such as lodgepole pine, the true firs, and hemlock have thin bark and shallow roots, and so are more likely to be killed in a fire, even a surface fire.

Hardwood trees are a significant component of many Pacific Northwest forests, particularly west of the Cascades. Some hardwoods, especially deciduous species such as bigleaf maple, red alder, and Oregon white oak, have higher moisture contents than conifers; as a result, they burn at lower intensities. Evergreen hardwoods such as Pacific madrone, common in southwest Oregon, have intermediate flammability. Most hardwoods are readily killed by fire due to their thin bark, but with a few exceptions they will sprout back rapidly from stumps or root crowns.

Promote fire resistance at the landscape level

The four principles described in the preceding section aim to increase fire resistance in your forestland in part by creating vertical gaps in the ***fuel profile*** (that is, between the ground and the tree canopy).

Resistance to crown fire can also be promoted across a forest landscape by creating or enhancing horizontal gaps in fuels across your property and neighboring properties.

Examples include the following:

- Installing a shaded fuel-break in a strategic location such as a ridgetop or next to a road.
- Maintaining an area of relatively light fuels, such as an oak woodland, by removing encroaching brush and conifers.
- Thinning more heavily next to a natural feature such as a meadow or rock outcroppings.

Each tactic breaks up a continuous layer of fuels, which helps firefighters get a toehold when fighting a fire. To some extent, these actions emulate the historic role of fire in creating and maintaining a "mosaic" of vegetation, with reduced fuels in both horizontal and vertical directions, which results in a less wildfire-prone landscape.

3. Fuel Reduction Methods

There are a variety of ways to reduce or treat surface, ladder, and crown fuels to create fire-resistant forests. Table 3 lists fuels reduction methods, their costs, and the effects of each on surface, ladder, and crown fuels. Since few methods are effective on all types of fuels, they are typically used in combination. For example, a stand may be thinned, pruned, and the resulting surface fuels piled and burned. For more information about fuels reduction methods, refer to the "For More Information" section on page 28.

Thinning

Common questions about thinning include: Which trees should be selected? How far apart should trees be spaced? And when should I thin (or not thin) during the year? In this section, we address these questions only with respect to creating fire-resistant stands. Making decisions about thinning will involve a variety of other considerations. See the "For More Information" section for references on thinning in general.

Tree selection

Remove smaller trees and retain larger, more vigorous trees (Figure 9). This approach, called ***thinning from below***, removes ladder fuels, raises the base of tree crowns, and increases the spacing between tree crowns. Large trees are more fire-resistant due to thicker bark. This approach tends to shift species composition away from shade-tolerant species that have thin bark and are often abundant in the understory.

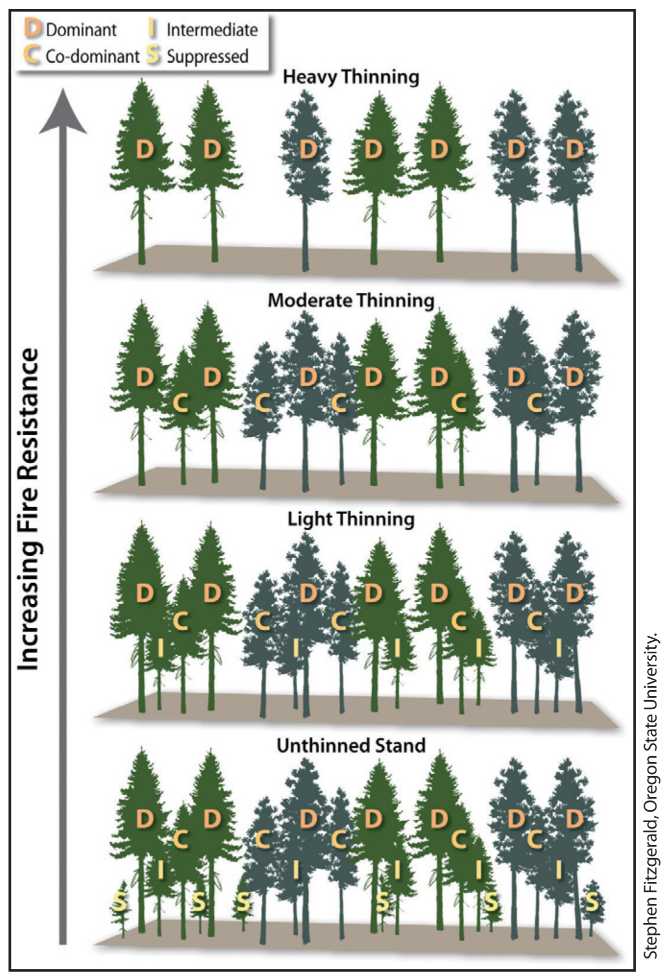


Figure 9. Thinning intensity diagram.

Thinning from below is a common approach in even-age stands. In cases where you want to maintain or promote an uneven-age forest (a forest containing three or more age classes), a modified approach can be used. Trees can be thinned across the range of diameter or age classes so that stand density and ladder fuels are reduced while maintaining an uneven-age character. Compared to an even-age stand, such a stand will have a higher risk of crown fire because some younger understory trees (ladder fuels) would remain.

Tree spacing

How far apart do crowns need to be to reduce crown fire? In general, if the branches of adjacent trees are overlapping within the stand, crown density is high enough to sustain crown fire under the right weather conditions and terrain. Conversely, if trees are widely spaced, say with crowns spaced more than one dominant tree crown width apart, crown fires are much less likely to occur. Factors that tend to increase the required crown spacing include steep slopes, locations with high winds, and the presence of species like grand fir with dense, compact foliage. Tree spacing does not have to be even. Small patches of trees can be left at tighter spacing, benefiting some wildlife.

Opening up the stand significantly will dry surface fuels due to increased surface winds and temperatures. This may increase surface fire intensity and rate of spread, unless surface fuels are further reduced. In addition, thinning that allows significant light to reach the

Table 3. Effects, cost, and considerations of fuel-reduction methods when used as stand-alone treatments

Method	Effects on...			Cost per acre	Considerations
	Surface fuels	Ladder fuels	Crown fuels		
Thinning	Increase	Decrease	Decrease	\$100–\$800[1]	Requires slash abatement to be effective.
Pruning	Temp. increase	Decrease	No effect	\$50–\$250[2]	Best combined with thinning in young stands with low branches.
Prescribed underburning	Decrease	Decrease	No effect	\$50–\$450	Initial mechanical treatment will facilitate safer burning; liabilities increase risk for private owners.
Cut and scatter	Increase	Decrease	No effect	\$50–\$450	Use where fuel loads are light. May substantially increase surface fire behavior in areas where slash is concentrated.
Cut, pile, and burn	Decrease	Decrease	No effect	\$275–\$1,500[3]	
Chip and scatter	Decrease	Decrease/ no effect	No effect	\$500–\$1,500	
Mowing	Decrease	Decrease/ no effect	No effect	\$40–\$150	Feasable only in fine fuels (e.g., bitterbrush)
Slash-busting/ mastication	Temp. increase	Decrease	Decrease/ no effect	\$250–\$700	
Utilization	Decrease	No effect	No effect	Offset costs or produce a small profit.	Labor intensive

[1] Depending on slope and other terrain factors, stand density, tree size, equipment, etc. [2] Depending on height and number of trees pruned.
[3] Major cost is piling.

forest floor may result in the re-growth of small trees and brush, which over time become new ladder fuels, so understory maintenance is needed from time to time. Other issues with very wide tree spacing include increased risk of blowdown, reduced timber yields, and potential for triggering reforestation requirements (if, for example, tree stocking is reduced below State stocking thresholds). These trade-offs should be considered in making decisions about tree spacing.

Timing

Pay attention to timing when thinning in pine stands. Green pine slash larger than three inches in diameter generated from winter through mid-July can provide breeding material for ips bark beetles, which may emerge to attack healthy trees. Avoid thinning pine species during this time period or make sure slash is rapidly cleaned up. In some areas, there may be additional concerns with Douglas-fir beetles, fir engraver beetles, or spruce beetles breeding in larger-diameter green slash or downed logs.

Utilization

During thinning, trees are felled, limbed, and bucked into logs of various lengths. These logs can often be utilized rather than left in the woods. Small log utilization includes the sale of commercial products, such as sawlogs, posts, and poles, as well as production of firewood and other materials for home use. Sales of products may help offset the costs of treatment, and thinning of larger-diameter logs may even generate a profit. When markets are available, utilization of biomass also may help offset costs.

Pruning

Pruning can be combined with thinning or done as a stand-alone treatment. Pruning removes lower tree limbs, increasing the height of tree crown bases (Figure 10). A good height to shoot for from a fire-resistance standpoint is 10 feet, though pruning even higher (12 to 15 feet) is beneficial. The pruning slash should be disposed of through piling and burning, chipping, or if surface fuel loads are light, cut-and-scatter. There are a wide variety of pruning tools, including hand-held saws, loppers, pneumatic shears, power pruners, and ladders. You may also be able to use your chainsaw in some situations. To maintain tree vigor, pruning should leave at least a 50 percent live crown ratio (the ratio of the length of the tree crown to the total height of the tree). Pruning is particularly effective in young stands where tree crowns have not yet lifted (gradual death and branch shedding of lower tree branches from shading) on their own.

Mechanical fuels reduction (mastication)

Mechanical fuels treatments utilize several different types of equipment to chop, mow, or otherwise break apart (masticate) ladder fuels such as brush and small trees into relatively small chunks or chips, forming a compact layer of woody material that is distributed across the site. The material varies in size but is usually coarser than that produced by most chippers. Compared to more loosely arranged fuels, the available oxygen supply in this dense fuel bed is reduced, resulting in potentially slower rates of fire spread than would have occurred if the area were left untreated. The intensity and ***duration*** of fire in masticated fuels may be higher than in other types of fuels treatments.

Mechanical fuels reduction equipment includes slash-busters, brush mulchers, mowers, and other devices. The slash-buster is a rotating cutting head mounted vertically on a tracked excavator. The brush mulcher consists of a cutting drum mounted horizontally to the front of an all-terrain vehicle (Figures 11a and b). One attraction of mechanical treatments is their relatively low cost compared to hand treatments or chipping (Table 3). Drawbacks include the potential for wounding trees if the operator is not careful or skilled, and soil compaction if operating when soils are very moist.

Slash disposal

Once you have utilized all the material that is practically and economically possible, the next step is to treat the remaining slash. There are three primary slash disposal methods: cut-and-scatter, pile-and-burn, and chipping. It's critical to consult your state forestry agency in advance to determine if the proposed slash disposal method will result in acceptable slash levels.

Cut-and-scatter

Cut-and-scatter is most appropriate for stands with light or patchy fuel loads or in areas that are a low priority from a wildfire management perspective. Understory trees, branches, brush, and other fuels are simply cut, sectioned into smaller pieces, scattered across the immediate area, and left to decompose. This technique does not eliminate fuels—it just redistributes them. Cut-and-scatter temporarily increases the total amount of surface fuel and also creates a patchy layer of fuels across the ground. Although ladder fuels may be reduced, overall fire hazard may be temporarily increased. As the material decays over time, the fire hazard declines. A common problem in dry forests is that the slash may take a decade or more to decompose to the point where it no longer poses a significant fire hazard. In higher elevation areas with a winter snowpack, or in higher precipitation

Chris Schnepf, University of Idaho

Figure 10. Pruning increases the height from the ground to the base of the tree crown. The slash should be treated.

Chris Schnepf, University of Idaho.

Max Bennett, Oregon State University.

Figures 11a and 11b. Mechanical fuels reduction.

zones, decomposition proceeds more rapidly. Regardless of the climate, getting the material into contact with the ground will speed decomposition.

Ideally, cut and scatter the material to a depth of 18 inches or less. Do not use this method of slash disposal within your home's defensible space (30 to 100 feet). Use in low-density stands where existing surface fuels and ladder fuels are light, where decomposition will proceed rapidly (i.e., western Oregon), and where a potential short-term increase in fire hazard is acceptable. Also, consider slash levels in adjacent stands. A common practice is to use cut-and-scatter in areas with light slash loads and use hand piling, discussed below, in areas with heavier slash concentrations

Pile-and-burn

Pile-and-burn is a common method for reducing surface fuels generated in thinning and pruning. With pile burning, you have the option to cut, pile, and immediately burn ("swamper burning"), or cut, pile, cover, and burn later in the fall and winter months when the forest is moist and the pile is dry (See "Guidelines for pile burning" on page 12).

Chipping

Chipping is effective but also labor intensive and requires good access. It is probably best suited to homesite and defensible-space treatments. Many contractors, including arborists and tree service companies, have large chippers that can process relatively large-diameter material efficiently. Self-propelled, whole-tree chippers have been developed and may be available for contract work in some areas. Large piles of chips are a fire hazard from spontaneous combustion, and can interfere with soil air and water movement. The chips can be scattered across the ground or, better yet, used as mulch for covering skid roads and trails. Avoid piling chips uniformly across the site. Instead, spread them in a mosaic so that some areas have no chips.

Prescribed Burning

Prescribed burning is the controlled use of fire to achieve specific forest and resource management objectives. It consists of two general categories: slash burning and prescribed underburning. Slash burning reduces fuels after various silvicultural treatments and is usually done by (1) broadcast burning in larger units, usually

Key points: Prescribed burning

- Prescribed burning, especially underburning, is risky, with high potential liability!
- A professionally developed burn plan is a must.
- Contact your state fire control agency well in advance to discuss your plans to burn and obtain needed permits.

clear-cuts; or (2) piling and burning. Prescribed underburning is the use of fire in the forest understory. The primary objective of underburning is often fuels reduction, but it is also used to achieve other objectives such as thinning, wildlife habitat improvement, and control of unwanted vegetation. Prescribed underburning has become more common as the understanding of the ecological role of fire has increased.

Prior to initiating any prescribed underburn, a professionally developed burn plan is a must for an interested landowner. Good planning helps minimize the chance of an escaped burn. An important part of any burn plan is a prescription carefully designed to meet predetermined objectives. Key elements of prescriptions include the following:

- A clear description of the stand or vegetation to be enhanced by underburning and expected outcomes for that vegetation.
- Data on fuel amount, distribution, and moisture content, as well as the topography and desirable weather conditions on burn day.
- Predictions of fire behavior and fire spread based on the above factors.
- Ignitions patterns and arrangements for holding (maintaining the fire within the desired area).
- Timing and seasonality of the burn.
- Smoke management guidelines.

The prescription is part of the larger burn plan, which should include a map of the unit to be burned, the various types of equipment and other resources needed to implement the project, needed permits, backup contingency plans in the event of an "escape," medical and communications plans, public awareness and coordination with other agencies as needed, and postburn plans for "mop-up" and monitoring. Often the area to be burned will need some type of pretreatment in order to meet objectives. This could include tree felling and brushing of unwanted vegetation (particularly on the perimeter) in order to carry a fire, or raking/pulling slash away from desired leave trees to increase their likelihood of survival during the burn. Careful and constant monitoring of weather on the burn day and/or constant contact with a local weather service is imperative; sudden changes in weather can rapidly change fire behavior, increasing the risk of escape.

Because of its complexities and the associated liability, prescribed underburning is rarely done on private, nonindustrial woodlands. The cost of an escaped burn can be considerable, as it includes not only the cost of suppression, but also the cost of reimbursing any neighbors whose properties may be damaged. The risk of escape is higher with underburning than with piling and burning. The need to reduce liability exposure points to the importance of good planning and documentation, including the development of a burn plan.

Before conducting any burning, contact your state forestry agency to see what kind of notification or permits you will need. Your state forestry agency may also be a source for technical and logistical assistance, and occasionally may be able to assist in the implementation of a well-planned prescribed burn.

Maintaining your investment

Fuels reduction is an ongoing process. The effects of thinning and other fuels treatments are temporary (15 years or less). New trees and brush grow in the understory and develop into ladder fuels. When cut, many brush and hardwood tree species re-sprout vigorously from root crowns and rhizomes. Other species, such as manzanita and several species of ceanothus, have seeds that remain viable in the soil for many years, even decades, and germinate readily when soils are disturbed. Follow-up treatments will be needed to maintain the desired effects, but they should be less expensive than the initial treatment. Fuels reduction re-treatment research in Idaho has demonstrated that machines, hand treatments, herbicides, and goats all achieved acceptable initial control of woody brush. (See "Fuels re-treatment options" on page 12.)

Guidelines for pile burning

Figure 12. Stand thinned and piled, ready for burning when weather conditions are right.

- Carefully evaluate locations of piles. Place at least 10 to 20 feet (depending on pile size and slope) away from trees, stumps, brush, and logs, and 50 feet from streams. Stay well away from snags (standing dead trees), structures, power lines, and so forth.
- Construct the piles so they will burn easily. Put small branches, twigs, and brush (less than one-half inch in diameter) at the bottom of the pile to provide kindling, then lay larger limbs and chunks of wood parallel to minimize air pockets. For hand piles, four feet by four feet is a good size; machine piles may be much larger.
- When machine piling, use a *brush blade* or excavator to avoid getting soil in the pile. This helps prevent "holdover" fires that smolder for weeks, suddenly flaring up when winds and temperatures increase.
- Cover piles if not immediately burned. Cover when pile is about 80 percent complete, placing remaining material on top to hold the cover in place. In Oregon, you must remove the cover prior to burning unless it is made of pure polyethelene plastic (not all plastic is pure polyethelene). Cover only enough of the pile to keep it dry in the center so it will burn easily.
- Burn when wet or rainy with little wind during daylight. Burning on warm and/or windy spring days is risky. Piles with soil and piles constructed by stumps may smolder for days or weeks, igniting a fire when temperatures warm up and the wind blows.
- Avoid piling green pine slash (more than three inches in diameter) in the late winter through mid-August due to the risk of attraction the pine engraver beetle (sometimes referred to as the ips beetle).
- Make sure you have a burn permit from the state forestry office, fire warden, and/or other local authority that regulates open burning.
- Some areas have a system to identify good burn days based on a ventilation index. Make sure you are in compliance.

Fuels re-treatment options—research results

Fuels reduction retreatment research in Idaho showed that, with some variation, machines, hand treatments, herbicides, and goats all achieved acceptable initial control of target vegetation, primarily woody brush species.

Herbicide application achieved the best control on target species, and was the only selective method (that is, non-target vegetation was not affected). After one growing season, goat grazing, the most expensive option, resulted in increased height and cover of the target species. Herbicides had the most lasting control over target species, but some less hazardous species increased in cover and height. In addition, herbicides left dead stems, some of them dense and tall enough to still constitute a fire hazard.

Machine-mechanical control was spotty because the machines missed some plants on irregular terrain and could not get as close to trees and other desired residual vegetation. Hand-mechanical control using a variety of tools was very effective initially. After the next growing season, it became evident that all alternatives caused some shift in vegetation composition, especially an increase in grass species and a temporary decline in shrub dominance.

Several operational and environmental factors not under the control of this experiment may have affected the results. The goat retreatment would have been more effective if there were two entries. That is, the goats could be grazed in early summer and again in late summer to have a greater impact on nutrient stores and re-sprouting vigor in the shrubs. Or, if the animals had been left on site longer and forced to eat the stems, perhaps the treatment would have been more effective.

Herbicides had the most consistent control of target shrub species while avoiding collateral damage of nontarget shrubs. The herbicide retreatment also was the least costly method.

Although the hand-mechanical retreatment was very effective at controlling target shrubs, it was the most expensive of the treatment alternatives. Without killing the individual shrubs, there will be re-sprouting from remaining stems, rhizomes, and root crowns in the goat, hand-mechanical, and machine-mechanical retreatments. A combination of herbicide and machine-mechanical would reduce the fuel hazard and prevent resprouting. The retreatment cost would be cheaper than hand-mechanical retreatment alone and should have long-lasting, effective results.

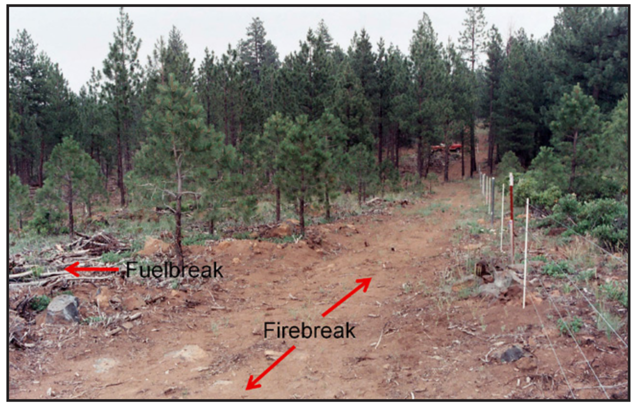
4. Firebreaks and Shaded Fuelbreaks

You often hear the terms firebreak and shaded fuelbreak used interchangeably, but there is a big difference between the two (Table 4).

Firebreak

A firebreak is an area where all vegetation and organic matter is removed down to mineral soil, thereby removing the fuel leg of the fire triangle. The purpose of a firebreak is to deny a fire any combustible material. Firebreaks are used to prevent advancing surface flames from coming in direct contact with outbuildings or other important resources on your property. A firebreak may be 2 to 15 feet wide. A firebreak should be two to three times as wide as the height of the nearest surface vegetation (fuel), such as grass and shrubs (Figure 13a). Firebreaks may require annual maintenance (removal of invading vegetation). In addition, because mineral soil is exposed, there is a high probability of creating conditions for invasive weeds to establish.

To prevent weeds from establishing in a firebreak and to reduce future maintenance, consider using a landscape fabric in the cleared zone and placing a layer of crushed or ornamental rock on top of the fabric. This reduces the germination of invasive plants, prevents erosion, and reduces maintenance, and the rock provides a fireproof mulch that is much more attractive than mineral soil (Figure 13b). This option is particularly useful in protecting structures on your property.



Stephen Fitzgerald , Oregon State University.

Figure 13a. A perimeter dirt road serves as a firebreak. The area immediately to the left is a fuelbreak where young pine have been thinned and flammable shrubs have been mowed.

Stephen Fitzgerald , Oregon State University.

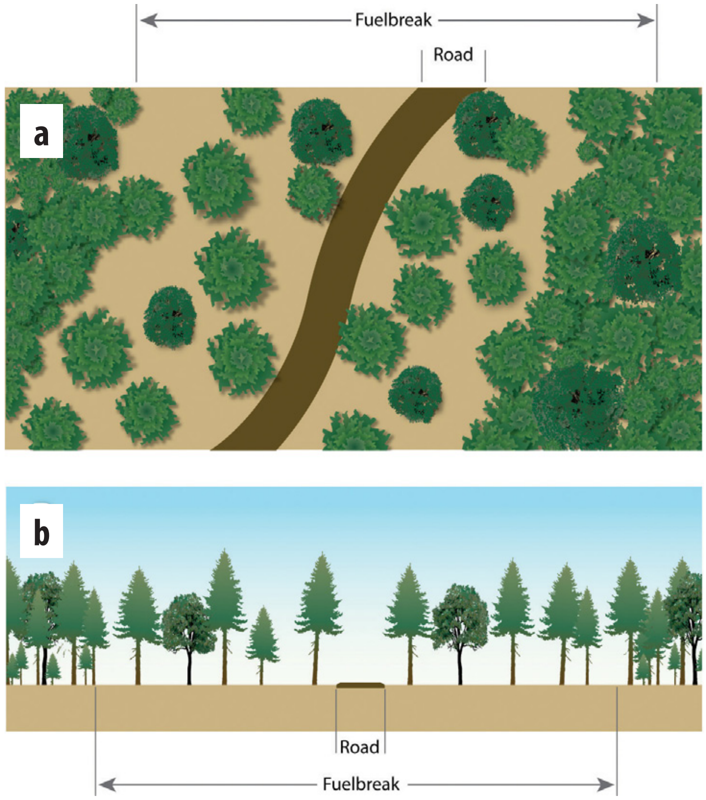
Figure 13b. Firebreak next to house.

Shaded fuelbreak

A shaded fuelbreak is a strip of land where fuel (for example, living trees and brush, and dead branches, needles, or downed logs) has been modified or reduced to limit the fire's ability to spread rapidly (Figure 14a).

Table 4. Pros and cons of constructing fire- and fuelbreaks.

Firebreak	Shaded fuelbreak
Pros	**Pros**
• Deprives the fire of fuel and reduces radiant and convective heat transfer. • Prevents flames from coming in direct contact with structures.	• Aesthetically pleasing. • Less costly to construct on per area basis. • Sale of merchantable trees can offset costs. • Tree health and vigor are improved.
Cons	**Cons**
• Expensive to construct and maintain on a per area basis. • Invasive weeds may establish unless non-combustible mulch (e.g., crushed rock) or herbicide is used. • Aesthetically, they look unnatural.	• Fires can burn through the fuelbreak, although at reduced intensity and rate of spread. • Effective shaded fuelbreaks need to be much wider than firebreaks. • Need to be retreated aproximately every 10 years depending on site productivity.

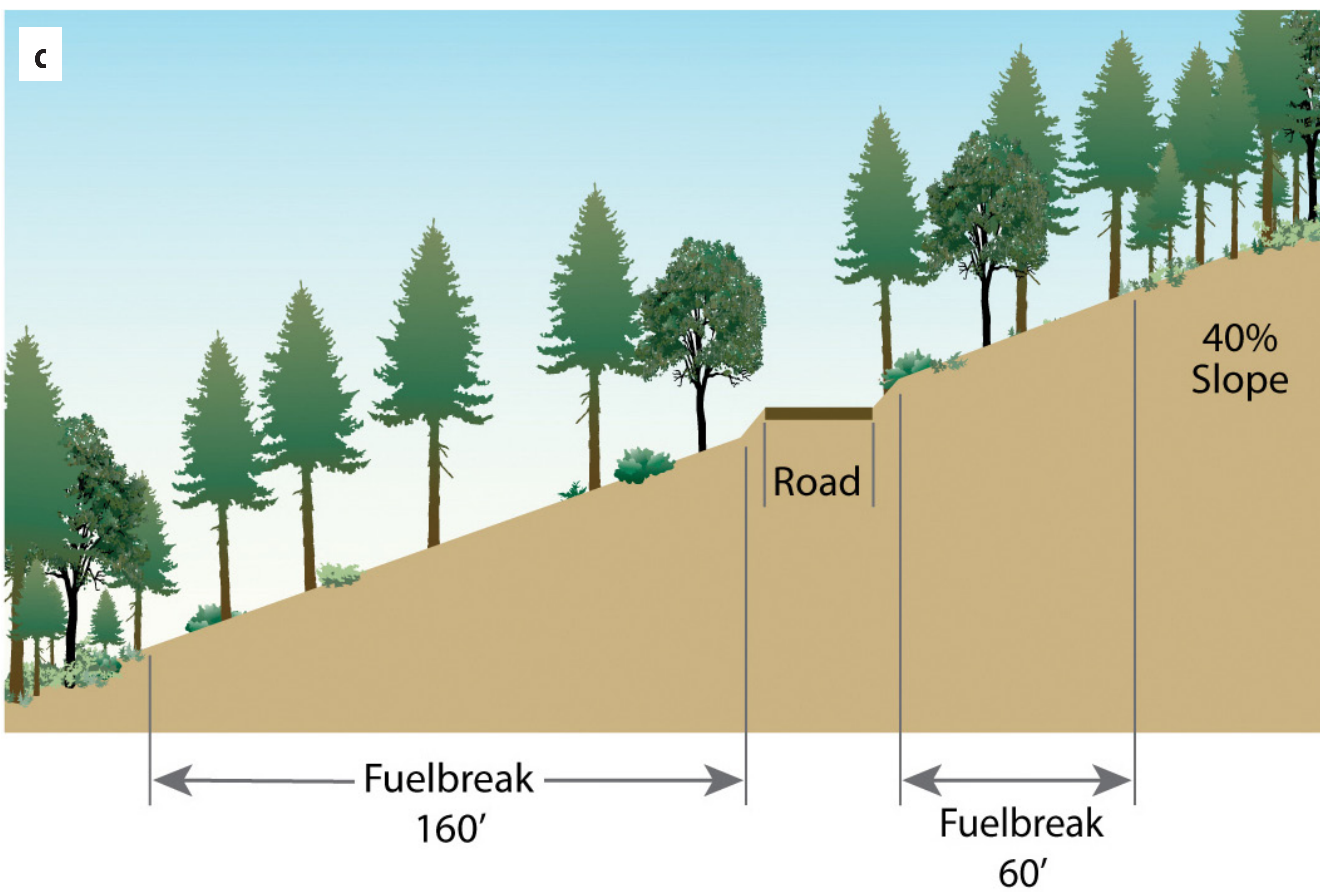


In addition, shaded fuelbreaks maintain cooler and moister understory conditions and understory vegetation remains greener longer into the growing season. This helps to reduce fire spread within the fuelbreak.

The need for a shaded fuelbreak on your property and its width depends on the following:

- The potential or risk of ignition either from people in subdivisions, roads, railroads, and so forth, and homes below or adjacent to your property, or from lightning in your area.
- The type of forest (Douglas-fir vs. ponderosa pine), stand density, amount and arrangement of fuels.
- Slope and terrain.

Within the shaded fuelbreak, overstory trees are thinned to reduce crown-to-crown overlap, particularly between conifers. Some crown overlap may be acceptable. Thinning can be done just in the fuelbreak area or as part of a larger thinning operation in adjacent stands. In the area of the shaded fuelbreak (for example, the first 100 feet from the edge



Stephen Fitzgerald, Oregon State University.

Figure 14. Fuelbreak, (a) bird's-eye and (b) ground-level views. (c) Fuelbreak above and below a road.

of the stand), space trees (thin them) wider than the rest of the stand. In addition, within the shaded fuelbreak, understory trees and combustible shrubs (e.g., ladder fuels), heavy ground fuels, and snags should be reduced or removed. Thinning and cutting small trees and shrubs can create a lot of slash, so for an effective shaded fuelbreak, remove this fire hazard (refer to the "Fuel Reduction Methods" section).

In western Oregon and Washington, deciduous hardwood tree species such as red alder, bigleaf maple, and Oregon white oak are often present within Douglas-fir forests. These species are generally fire resistant because of high water content in their leaves. It takes a lot of heat to drive off water within a hardwood tree's canopy, and the biomass left in shriveled leaves does not contribute much in the way of additional fuel to the fire. A hardwood canopy can absorb and deflect a lot of radiant heat and possibly reduce the potential of crown combustion of conifers, which have more flammable foliage. In western Oregon and Washington forests, consider leaving, or even planting, hardwoods in your fuelbreak. Some understory deciduous shrubs, such as vine maple, can be left for the same purpose, adding to the diversity and naturalness of your fuelbreak.

Shaded fuelbreak width depends on the type of forest, fuel loading, and terrain steepness. To improve their effectiveness and to take advantage of a noncombustible road surface, shaded fuelbreaks are usually placed above and below existing roads (Figure 14c) or in other strategic areas, such as adjacent to wet meadows, streams, and rocky outcroppings. In drier forests in parts of eastern Oregon and Washington and in Idaho, the minimum recommended width for a shaded fuelbreak is approximately 200 feet. Topography matters: On a steep slope of 40 percent, for example, a fuelbreak of 160 feet below and 60 feet above a road should be created. In flat terrain, a shaded fuelbreak of 100 feet on both sides of a road may be sufficient. Table 5 provides recommendations for above- and below-road shaded fuelbreak widths given the percent of slope. In very steep areas with heavy fuels, consider increasing the shaded fuelbreak beyond 200 feet.

Specific shaded fuelbreak guidelines have not been developed for western Oregon and Washington. Forests in western Oregon and Washington are much taller and denser than forests in eastern Oregon, Washington and Idaho; because they are often in very steep topography, consider a shaded fuelbreak of 300 feet or more. These are only general guidelines. Consult your state stewardship forester for advice on shaded fuelbreak widths for your particular situation.

Under moderate weather conditions, shaded fuelbreaks can provide easy access and a good line of defense for firefighters. Shaded fuelbreaks under normal or moderate weather conditions can slow an advancing fire (fire spread) and reduce fire intensity. For example, in a number of recent wildfires that have burned into shaded fuelbreaks or other areas where fuels have been reduced, the fire dropped to the ground where it was more easily suppressed by firefighters. Shaded fuelbreaks also provide important areas for firefighters to attack and suppress a wildfire. For example, fire lines can be anchored or tied into your shaded fuelbreak.

Shaded fuelbreaks must be maintained periodically. How often you need to retreat your shaded fuelbreak depends on your forest's productivity (which affects how fast fuels re-accumulate) and how open a condition you want to maintain. Maintenance of a shaded fuelbreak may include cutting, piling, burning, grazing, or herbicide treatments to reduce or prevent fuel accumulation. Develop a retreatment plan and do a little maintenance every year.

Table 5. Minimum fuelbreak distance uphill and below road depending on percent slope.[1]

Percent Slope (%)	Uphill Distance (feet)	Downhill Distance (feet)	Total Fuelbreak Width (feet)
0	100	100	200
10	90	115	205
20	80	130	210
30	70	145	215
40	60	160	220
50	50	175	225
60	40	190	230

[1] Measurements are from the toe of the fill for downhill distances and above the road cut for uphill distances. All distances are measured along the slope. The minimum recommended fuelbreak is approximately 200 feet. Because fire spread and intensity increase as slope increases, however, the fuelbreak width must also increase. Adapted from "Fuelbreak Guidelines for Forested Subdivisions" (Dennis 1983).

5. Roads & Access Considerations

Roads provide critical access to your property so that firefighters can extinguish wildfires while they are still small and do the least damage. Fire and fuelbreaks can be more effective if anchored to a good road system. If you live on your forested property, roads also are critical for your escape and for fire trucks to get to and protect your home.

Here are some proven design criteria to consider for your road system.

1. Plan and design an access strategy for your property. Your property may already have roads on it. Do these roads provide access to all parts of your property? Are they in good enough condition that firefighting equipment can negotiate them? If not, begin developing adequate access to all areas of your property. Be sure you know your county's standards and guidelines on roads, bridges, and so on. Talk to your local fire chief to get advice on building a transportation system that meets all your needs. A good map or aerial photo of your property will help. You can draw preliminary roads on the map and check them in the field to see if the locations make sense. Because road construction is expensive, road development can be done gradually as time and money permits. Income from timber harvests can help offset the cost of constructing new roads. Check with your state forestry agency about rules regarding road construction before you begin.

2. Develop exit routes. Fires can easily make a road impassable, so make sure you have at least two good exit routes. This is especially important if you live on your forest.

3. Make it easy to find your property. A quick response from firefighters can make the difference between disaster and being safe. If firefighters can't find you, critical time will be lost. To facilitate getting firefighters to your property in the event of a wildfire, you should do the following:

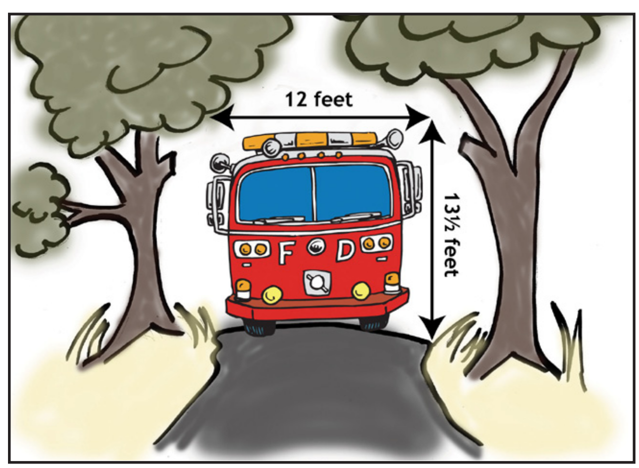
- Always check with your fire chief for local sign standards.
- Post road name or numbered nonflammable signs so they are easy to see and read. Every road intersection should be visibly signed with reflectorized signs.
- If you have a residence at the property, post your address at the beginning of your driveway or on your house if it is easily visible from the road.
- Make sure your road names are not duplicated elsewhere in the county.
- Post road restriction signs such as dead-ends and weight and height limitations.
- Gates are important for restricting unwanted visitors and reducing the potential for human-caused ignition, but be sure firefighters can get through. Provide them with a key or use a double-lock arrangement.

4. Design a good road system. Your road system should allow quick access for emergency vehicles to your home and all other parts of the property. Table 6 provides minimum road design standards for structural and wildlife fire-fighting vehicles. The latter are capable of traversing roads accessible by pickup trucks. For initial attack engines the primary concerns are keeping roads free of obstacles such as downed logs and heavy encroachment of brush into the roadway.

5. Treating vegetation along roads. Firefighters might not enter even a well-designed road if it is overgrown with vegetation. To create a fire-safe road or driveway that allows firefighting equipment to access the area and also helps slow the fire's spread, a landowner should consider the following guidelines from

Bob Parker, Oregon State University.

Figure 15. Turnaround adequate for fire pumper.



Oregon Department of Forestry.

Figure 16. Driveway standards for SB 360.

Sandy Shaffer.

Sandy Shaffer.

Figure 17. Road (a) before and (b) after treatment. Note that slash has been chipped.

Oregon's SB 360 requirements and the International Fire Code (Figure 16):

- Create a fuelbreak that extends 10 feet from the centerline of a roadway. Ensure the ground cover adjacent to the road is substantially reduced (Figures 17a and b).
- Provide a minimum vertical clearance of 13.5 feet in the driving area. This provides an unobstructed view for firefighters and rids the road or driveway of obstructions that might prevent access by firefighters.
- Provide a minimum horizontal clearing distance of 12 feet in the driving area.
- Thin and prune trees and shrubs adjacent to the road.

6. Road maintenance. Access roads require maintenance to keep them functioning properly.

- Gravel and dirt roads need periodic grading to keep the surface in good shape, particularly when used heavily.
- Drainage structures such as water bars, ditches, and culverts should be regularly inspected to be sure they are clear of obstacles and able to function effectively. Blocked ditches and culverts can result in substantial damage to the road when water flows across it. And this isn't just a winter weather problem. Summer thunderstorms can both cause wildfires and damage roads at the same time due to intense rains and lightning.
- Road cut-banks may need to be seeded with grass or other vegetation to stabilize the soil, prevent damage to the road from erosion, and minimize movement of sediment into nearby streams. Clear downed logs and other obstacles from the roadway and brush from the edges of the road.

Table 6. Minimum road design standards for structural and wildlife fire-fighting vehicles.

Item	Structural fire vehicles	Wildland fire/initial attack vehicles
Road width	20–24 feet	12 feet
Road grade	< 5–10%	< 15%
Surfacing	Packed gravel or asphalt	Gravel or dirt
Turnarounds (Figure 15)	45–55 foot radius	45–55 foot radius
Bridges (weight limits)	40–70,000 lbs	40–70,000 lbs

Note: Roads and bridges must be able to support heavy equipment loads, including bulldozers carried on a truck.

6. Water Sources

Water sources are an important part of an overall fire protection strategy, but don't rely on water alone—fuels reduction is more important in most cases.

Since many rural properties lack fire hydrants, firefighting vehicles designed for rural areas typically have water tanks, ranging in size from a hundred to thousands of gallons of water. This water can be quickly depleted. Access to nearby streams, ponds, wells, swimming pools, and even water troughs allows firefighters to quickly refill the tanks and get back to fighting the fire. Access to water facilitates a fast initial attack on the fire, which can make the difference between getting the fire under control while it is still small or letting it become an unmanageable conflagration.

The two basic types of firefighting equipment are ground-based and aerial, each of which has its own special considerations for accessing available water sources.

Ground-based fire engines

Ideally a fire tanker can quickly drive up to a water source, fill its tank, then return to the fire (Figure 18). Fire tankers range from pickup trucks with slip-in 80- to 120-gallon tanks, with pumps and hoses, to fire engines or water tenders that carry from 200 to 1,000 gallons or more. A hard, durable-surface road that can get the tanker close enough to the water source to reach it with a 12-foot-long drafting hose is preferred. Roads that are soft or wet from seeps or other causes can create real problems for heavily loaded vehicles. Some trucks carry portable pumps, allowing them to pump from a water source up to 200 feet away, but that is much more time-consuming and less desirable.

Requirements

Tanker trucks need only one to two feet of depth to pump water, so they can use a wide range of potential sources, such as streams, ponds, and stock tanks. Consider posting signs along the road system that lead fire trucks to available water.

Aerial-based firefighting equipment (helicopters)

Helicopters are frequently used for fighting wildfires in rural areas and can quickly deliver high volumes of water to very precise locations, particularly if a good water source is at hand.

Helicopters most often are equipped with a large bucket hanging from a long tether line, which is used to dip water out of a pond or other water source (Figure 19). A prime consideration for both large Type I helicopters (which carry more than 700 gallons) and smaller Type II helicopters (300 to 700 gallons) is their approach to and departure from the water source. Tall obstacles such as trees, buildings, and power lines close to the water make it more difficult for the helicopter to descend safely. Once their buckets are filled, even the bigger helicopters have limited ability to lift heavy loads straight up for very far. Thus, to generate the lift needed to maximize their load capacities, they need to begin flying forward as quickly as possible, necessitating a clear flight path.

Requirements

Large helicopters using big buckets need fairly deep water to dip from—around 10 to 12 feet. Smaller helicopters can work out of water sources as shallow as 3 to 5

U.S. Forest Service.

Figure 18. Fire pumper filling from creek.

New York Army National Guard.

Figure 19. Helicopter filling from water source.

Stephen Fitzgerald, Oregon State University.

Stephen Fitzgerald, Oregon State University.

Figures 20a and 20b. Pump chance.

feet. The source needs to present a big enough target or "bulls eye" for the pilot to hit it accurately, about 12 feet minimum width. Small ponds and even swimming pools may work very well, if the flight path is acceptable. Keep debris, such as fallen logs, boats, or other obstructions out of the pond if possible.

Water availability

If your water source is a well, consider having an emergency generator to operate the pump during power failure. Auxiliary power should be located separately from the home or outbuildings.

Ponds and creeks can provide water for firefighting and be used for stock water, irrigation, recreation, wildlife habitat, and fishing (Figures 20a and 20b). Before you construct a pond, check with your state water resources department, local Natural Resources Conservation Service office, or other regulatory authority, as permits may be required to construct a dam, depending on its size. Specific construction requirements must also be met.

Developing and diverting spring water into a tank or cistern also provides a valuable water source. For the purposes of firefighting, a 2,500-gallon capacity or more is excellent, although even 500 gallons can be very beneficial. If you do not have a spring, a large tank or cistern can be filled with rainwater shed from the roof of a home or outbuilding, or from a well (Figure 21). Some landowners develop a gravity-feed system to a pressurized hydrant that can be hooked up directly to a fire truck, eliminating the need to pump water. Swimming pools can also be an excellent source of water.

Stephen Fitzgerald, Oregon State University.

Figure 21. Buried water tank.

Adequate access to water sources is critical, so consider the following recommendations:

- Ensure all-weather rocked road access to within 12 feet of the water's edge.
- Provide a 45-foot minimum radius turnaround close to the water source.
- The road grades listed in Table 6 apply.
- Post permanent signs indicating the location of the water source.

No matter what kind of system you have, be sure your hookups utilize hydrant and hose connections that are compatible with firefighting equipment. Consult with the appropriate state or local fire agency for specifications. Additionally, make sure the water sources meet your local fire chief's recommendations.

7. Case History: The Epstein Property

Up to this point, we've given you background information and provided principles for making your forest more fire resistant. We have also discussed improving roads, access, and water sources so firefighters can more effectively respond to a wildfire on or near your property. There is a lot to consider and digest.

Even if you recognize that you have a high fire risk, how do you get it all done and who can assist you in doing it? We introduced you earlier to Bill and Sarah Epstein. The following example is from their property in southwestern Oregon. They, like you, recognized that they were at high risk for a wildfire. Their property was a virtual "postage stamp surrounded by a sea of fuel." They worked with a consulting forester to develop and implement a plan that would reduce their risk while sustaining and promoting other values and objectives for their land. (Although in less detail, other landowner examples are provided in Appendix C.)

Marty Main, Small Woodland Services.

Figure 22. One way the Epsteins addressed fire ignition risk was through ongoing work with the public to reduce illegal trespass, such as along this trail that runs through the property. Access was maintained, but carefully monitored.

Introduction

Dr. William (Bill) and Sarah Epstein's 400-acre property is located about one mile south of the urban area of Ashland, Oregon. It is located at the very easternmost edge of the Klamath-Siskiyou province at elevations that range from 2,500 to 3,500 feet. The climate of the area is characterized by long, hot, dry summers, with only about 15 percent of the annual rainfall occurring during the months of May through September. Annual precipitation averages 25 to 29 inches.

Fire history

Because of dry, hot summers in this region and the propensity for lightning strikes, fire season generally lasts from early June through October and large-scale, high-severity wildfires are a distinct possibility. In fact, this has occurred several times in the past 100 or more years. In 1901, nearly all the Epstein property was involved in a wildfire. Again, in 1973, the 750-acre Hillview Fire, started nearby by an arsonist, burned close to 200 acres of the Epstein property.

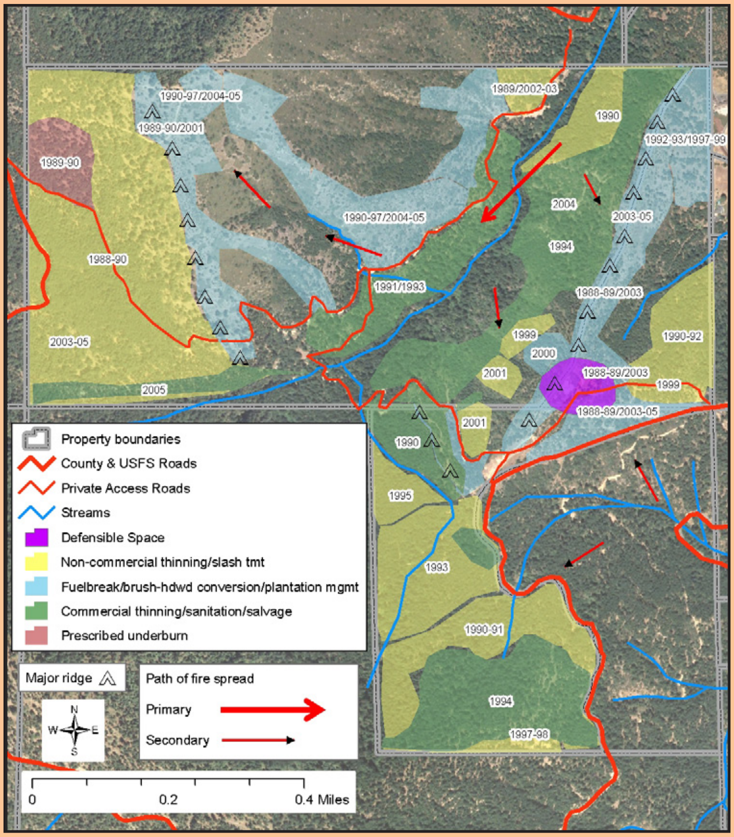
These two high-severity wildfires were much more severe than the relatively frequent, low- to moderate-intensity surface fires that historically burned in this area. Such high-severity fires have led to the conversion of forests to more fire-prone brush fields, setting up the area for a repeating sequence of high-intensity fire.

Vegetation

The existing vegetation reflects the disturbance history and resulting changes that have occurred since 1850. When Bill Epstein purchased the property in 1987, dense and extremely wildfire-prone brush fields, dominated by white-leaf manzanita and Pacific madrone, covered most of the southerly aspects that had burned intensely in both 1901 and 1973. More northerly aspects were also dominated by brush fields, but with a greater percentage of deerbrush ceanothus, Pacific madrone, and some naturally regenerated Douglas-fir. Conifer stocking was low to nonexistent throughout most of these areas. Regions that did not burn in the 1973 Hillview fire were largely dominated by extremely dense stands of noncommercial and small merchantable Douglas-fir poles. Overly dense tree stands resulted in mortality caused by bark beetles affecting both ponderosa pine and Douglas-fir, adding to the potential and ultimate severity of wildfire.

Most of the property is located on moderate to steep topography with slopes of 35 to 75 percent, another factor that can contribute to intense wildfire behavior (remember the fire behavior triangle: fuel, weather, topography). The property is underlain by highly erosive, coarse-grained, decomposed granitic soils. In both 1974 and 1997, major storms produced flooding and sediment delivery to houses along Hamilton Creek in Ashland, a mile below the Epstein property. A wildfire can accentuate erosion problems on these soils when the vegetation is killed and soils are exposed.

Case History: The Epstein Property

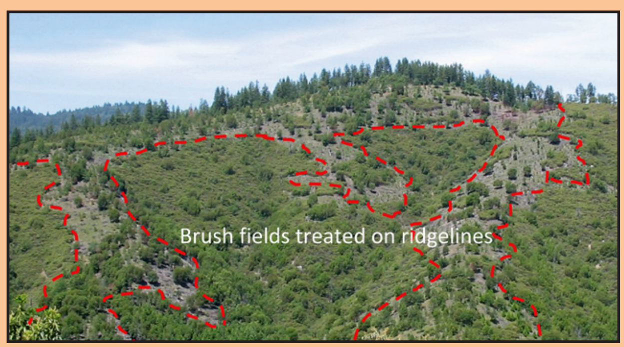


Max Bennett, Oregon State University; Marty Main, Small Woodland Services.

Figure 23. Treatment map showing types and dates of treatments on the Epstein property (not all treatment dates shown).

Marty Main, Small Woodland Services.

Figure 24. Stand after thinning. Tree thinning made the Epsteins' stands more fire resistant by increasing the distance to the base of tree crowns, by spacing out tree crowns, and by retaining larger trees with thicker bark. Thinned tree tops and limbs were piled and burned to reduce surface fuels.



Marty Main, Small Woodland Services.

Figure 25. Brush field treatment. Treatments involved brushing, piling, and burning resulting slash, then planting with conifers, vegetation control, and pruning. The objective is to shift vegetation from wildfire-prone brush fields to more resistant conifer forests in strategic locations such as ridgelines.

Case History: The Epstein Property


Marty Main, Small Woodland Services.


Marty Main, Small Woodland Services.

Figures 26a and 26b. (a) Before and (b) after noncommercial thinning, release, and slash treatment. Larger material was used for posts or sold as firewood. Remaining slash was piled and burned.

Forest management and fuel modification

Although the Epsteins originally intended to maintain their property as a forest reserve with little or no management, they soon realized that doing nothing was perhaps the least desirable of a host of management choices. In 1988 they began implementing forest management activities with the primary goal of reducing both the likelihood of fire ignition and the potential for high-intensity fire behavior. This shift in understanding was the result of the realization that almost all the values of importance to the Epsteins, if not the entire Ashland wildland-urban interface area, would be negatively affected by another large, high-severity wildfire.

The Epsteins hired a consulting forester to help them formulate and implement their plan as they did not have the experience, skill, or equipment to get it done. The consulting forester guided the Epsteins through several management activities to achieve their goals. They included the following:

Reducing ignition risk

Fire ignition risk was addressed through ongoing work with the public to reduce illegal trespass. Instead, the Epsteins offered to maintain important trail access through one highly used and carefully monitored portion of the property.

Working with neighbors

From 1990 to 1995, Dr. Epstein was involved in the Hamilton Creek Coordinated Resource Management Plan, which provided one of the first attempts at developing coordinated, multiresource management plans across mixed ownerships. Fire management planning among neighbors at the watershed and landscape level was an important outgrowth of that process.

Developing a safe homesite

The Epsteins live on their property. Protecting their home was a primary goal. The home is a model of fire-safe building construction and was carefully located to minimize potential impacts from wildfire (Figure 23, green area). Road access was developed and/or upgraded to provide fire truck access across the Hamilton Creek drainage.

Prioritizing ridgelines and other key topographic locations for treatment

Places with topographical advantages for wildfire suppression (for example, ridgelines) were addressed first. These are important locations to maintain more open tree and vegetation conditions that could be utilized in a wildfire for fire retardant drops, firefighter access, anchor points for back-burning, and other fire suppression techniques. Areas that could be easily treated to reduce fuels and could also tie into vegetation and fuel reduction areas on neighboring parcels were also prioritized.

Creating more fire-resistant forests

Specific vegetation and fuel reduction prescriptions varied with the diversity of vegetation and fuel types on the property. Brush fields that posed a significant risk were cleared, creating a mosaic of openings of various shapes and sizes (Figure 23, yellow areas). Brush field treatments were located on ridgelines and other topographically favorable locations (Figure 25). Approximately 20 acres were cleared by dozers on gentle, non-erosive sites and 80 acres by hand on steeper slopes. All brush slash was piled and burned during winter and early spring. More than 25,000 conifer seedlings have been planted with the objective of shifting the vegetation away from wildfire-prone brush fields to more

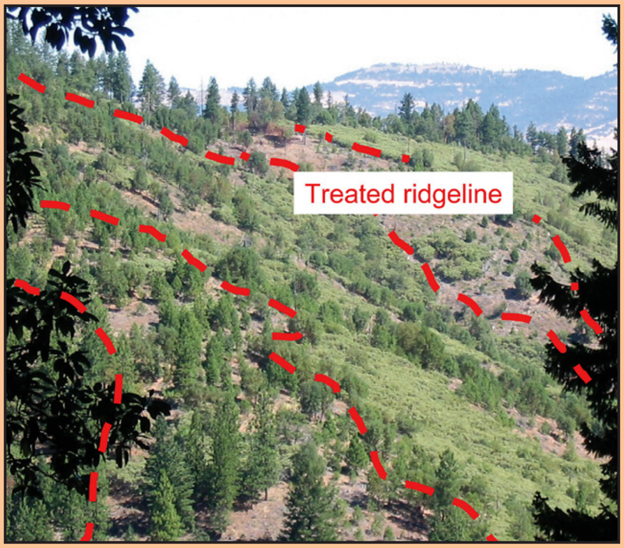


Figure 27. Fire-prone vegetation at the Epsteins', such as brush fields and dense stands of trees, was modified by breaking up continuous layers of fuels which could sustain and spread a high-severity wildfire. Not every acre could be treated, so priority went to ridgelines, roadsides, and other strategic locations.

Figure 28. The Epsteins worked to aggressively utilize small-diameter material to reduce fuel that would otherwise be left in the woods as an added fire hazard. Over 500 cords of firewood were sold, as well as many posts and poles for fencing and other products.

fire-resistant conifer forests. Ongoing control of re-invading competing vegetation has been a major thrust of the project, not only to insure survival and growth of the planted seedlings, but to maintain reduced fuel loads in these strategically important fuel reduction zones.

Pruning has been used to increase the height of tree crowns above the surface fuels, to reduce the potential for crown fire. Young conifer plantations were pre-commercially thinned to a wider spacing and pruned to increase the height of the tree crowns. Grass was seeded to discourage brush field development. These activities have maintained effective fuel reduction zones in these locations.

Reducing stand density

More than 175 acres have been noncommercially thinned on the Epstein property (Figure 23, purple areas; Figures 26a and 26b) to reduce stand densities, improve growth and vigor of the remaining trees, increase height of the tree crowns by removing intermediate and suppressed trees, and eliminate ladder fuels. In the absence of thinning in this area of southern Oregon, considerable bark beetle–related mortality can occur when stands are too dense, often killing entire stands and subsequently creating more fire-prone conditions.

Reducing fuel loads

The key to the long-term success of this sequence of management actions from a wildfire management perspective has been the aggressive utilization of thinning and brushing slash. For example, more than 500 cords of firewood have been sold from this slash, as well as numerous posts and fence rails. Additional slash has been piled and burned. In one key location (Figure 23, red area), 10 acres were underburned following thinning and firewood cutting to further reduce fuels.

Using timber harvests as a fire management tool

Timber harvesting has been used as a proactive fire management tool. As stands have grown and matured, thinning has produced higher-value logs rather than poles and firewood as a by-product of the forest restoration activities. Ongoing salvage of dead and dying trees caused by bark beetles has also provided income to help offset the costs of creating a more fire-defensible property. Snags have been retained for wildlife habitat in areas that are less important from a wildfire management perspective. Merchantable Douglas-fir trees heavily infected with dwarf mistletoe have been targeted for removal, as the tree's response to this parasite creates dense accumulations of foliage, known as witches'-broom, that can rapidly allow a surface fire to

Figure 29. Piling and burning was the method used most often at the Epsteins' to reduce surface fuels generated in thinning and brushing. Extreme care was taken to minimize the risk of escaped burns or *holdover fires*.

Figure 30. After careful consideration, the Epsteins chose to use prescribed underburning on a small area of the property. A burn plan was developed and executed by an experienced professional forester, and the Oregon Department of Forestry was involved throughout the process.

become a crown fire. However, these brooms also have important wildlife habitat values and are, like snags, retained in areas where they are less likely to spread the mistletoe or contribute to elevated fire behavior (for example, at low spots in the topography, particularly along draws and in riparian habitats). In some cases, mistletoe brooms and infected branches have been removed by climbing and pruning.

Six different harvests have occurred on the Epstein property in the past 17 years, each carefully planned and applied to accomplish multiple objectives, including reducing the risk of wildfire (Figure 23, blue areas). Logging systems have included horses, farm tractor, track crawler (dozer), rubber-tired skidder, small feller/processor with a cut-to-length head, and helicopter logging. In virtually all situations, retention of a well-stocked stand of vigorous larger trees (by "thinning from below") has been a primary objective. As these stands have grown, trees have developed larger diameters, thicker bark, and higher crowns, and thus increased fire resistance.

Work Implementation

Almost all of the work on the Epstein property has been completed under contract, primarily with a local forestry consulting and contracting company that oversaw and implemented forest management activities. Logging has also been contracted with local operators, overseen and administered by the consulting firm. Dr. Epstein, who lives on the property, has been intimately involved in management decision making, and actively participates through regular monitoring and recreational use of the property. Management costs have been paid by four primary sources: (1) revenue from timber sales; (2) revenue from aggressive marketing of traditionally noncommercial by-products, most notably firewood and posts, poles, and rails; (3) government cost-share assistance for noncommercial activities through various programs available to small woodland owners; and (4) tax credits and careful income tax planning. To date, income has offset management costs, while the size of the investment (timber volume) has increased considerably and risk to that investment (fire and insect-related damage) has been substantially reduced.

Summary

With the assistance of a consulting forester and clear management goals, the Epsteins were able to reduce fire risk around their home, create strategic fuelbreaks, improve the health and vigor of their timber, and establish new forests on their property. The property is now in a condition where it will continue to increase in monetary value from timber growth, as well as in ecological value.

Ultimately, the Epsteins' objective is to continue to manage their property to create more mature forest conditions. This will provide opportunities to reduce the risk of wildfire and increase the ease of control should their property be threatened by fire. As the landscape becomes more fire resistant, the Epsteins hope to increase the use of prescribed underburning, and to restore fire to its historic role. Refer to Appendix C for two other case study examples of fuel reduction.

8. Integrating Fuel Reduction with Other Management Objectives

Forestland owners typically have several management objectives, and increasing fire resistance is only one of them. Actions to reduce risk and increase fire resistance must be integrated with these other priorities. Fortunately, wildfire management is usually compatible with wildlife enhancement, timber production, forest health, aesthetics, recreation, and other common objectives. Some ideas for integrating wildfire management with these objectives are discussed next.

Wildlife enhancement

Management for fire resistance tends to reduce forest density and the amount of understory vegetation. As with any change in forest conditions, this may be detrimental for some species and beneficial for other species. In practical terms, here are some things you can do to provide wildlife habitat while addressing wildfire concerns:

- When treating brush fields and areas with dense ladder fuels, leave patches of brush and other understory vegetation, isolated from other patches, for nesting and hiding cover for birds and small mammals (Figure 31).
- Leave isolated clumps of unthinned trees for cover.
- Increase thinning and fuels reduction intensity in key topographic locations, such as ridgetops and along roadways. Decrease thinning intensity to retain more understory vegetation in more fire-resistant locations, such as riparian areas and north-facing slopes.
- Retain deciduous shrub species, which contribute little to fire hazard.
- Retain some snags, particularly those that are more than about 11 inches in diameter at breast height. Two or three per acre is a common target, but more may be appropriate for some habitat objectives. More than 100 wildlife species use snags for roosting and foraging. The larger the snag, the more valuable it is for habitat, since it can be utilized by a larger number of species. Once ignited, however, snags can be a source of burning embers, which can ignite spot fires. For this reason, it's a good idea to remove snags in fuelbreaks and on ridgelines, while leaving snags in riparian areas, draws, and other less elevated locations. In addition, snags are a major safety hazard to firefighters.
- Retain large, downed logs. Large logs, as previously noted, contribute little to fire spread. However, large logs do contribute to fire intensity if they burn for a long time, impeding mop-up activities. Overall, retention of low to moderate levels of snags and logs (two to three per acre of each) provide habitat without substantially increasing fire risk.

Timber production

In many cases, family forestlands can be managed to increase fire resistance without negatively impacting timber production. Conflicts between these objectives are most likely in situations when thinning for fire resistance would call for wider spacing between trees than would be optimal from a timber production standpoint. These problems can be reduced by carefully designing fuels treatments for tactically important locations such as near roads and along ridgetops. For example, thinning more widely near a road for 200 to 500 feet above and below the road can create an effective shaded fuelbreak. Beyond this distance, stands can be thinned according to other objectives.

Forest health

Forest health is a major concern for most landowners. Not only is this objective very compatible with managing for fire resistance, but fuels reduction treatments may actually improve forest health. Trees in overly dense stands are often stressed and vulnerable to attack by bark beetles and other pathogens, especially on dry sites. Beetle-killed trees increase fuel loading. Thinning these dense stands "from below" reduces competition among trees and leaves the largest, healthiest trees standing, improving individual tree and overall stand vigor, and hence increasing resistance to beetle attack.

Sustaining site productivity

As noted previously, an important principle in creating fire-resistant forests is to reduce surface fuels. Small, decomposing material—leaves, needles, and branches—makes up much of this surface fuel load, but it also contains many important nutrients. Reducing these fuels can potentially reduce nutrient levels and thus, site productivity. The extent of nutrient reduction, however, depends on existing site productivity, the amount of material removed, and how often treatments are repeated. Thinning, pruning, cut-and-scatter, and mechanical fuels treatments typically rearrange fuels but do not remove biomass from the site. As the material decomposes, nutrients return to the soil. Since larger branches and logs contain relatively small percentages of key nutrients such as nitrogen, removal of log-size material will likely have a small effect on site productivity. Some larger material should be retained, however, for wildlife habitat and to provide organic matter. Piling and burning and prescribed underburning consume some fine material, but nutrient loss is usually too small to measurably affect site productivity. However, repeated, intensive piling and burning of slash or "hot" prescribed underburns could result in substantial nutrient loss on some sites, especially those with relatively little organic matter and low initial nutrient levels.

Aesthetics and recreation

Thinning, pruning, and other fuels reduction methods typically create more open forests, though the visual impacts can range from subtle to dramatic. Some owners prefer a more open, park-like appearance while to others it may seem unnatural. Visual impacts can be mitigated by leaving untreated buffers in some locations, and by varying the spacing between trees and/or brush in fuels reduction treatments. These measures often dovetail well with wildlife habitat considerations, described earlier. By creating more open forests, recreational access may also be improved.

Marty Main, Small Woodland Services.

Figure 31. Leave clumps of brush for wildlife.

9. Adding Fire Management to Your Stewardship Plan

If you have a management plan for your forest property, considering adding a fire planning section to it. If possible, bring your state forestry or fire agency or your local fire protection association (FPA) out for a look at your forest to discuss potential firefighting strategies. This is your chance to show fire protection personnel the locations of your gates, special resources to protect, roads, water sources, and fuelbreaks. Take notes during your meeting. These can serve as the basis for a fire plan for your property.

The fire plan should be included in your overall stewardship plan. Key areas to discuss include the following:

- Creating or improving water sources for firefighting.
- Improving property access for firefighting equipment.
- Structure and home protection (defensible space).
- Firefighting and other equipment available or needed.
- A map identifying locations of homes and outbuildings, power and utility lines, fuel and chemical storage, roads and bridges (including weight limitations), water sources, gates, thinned areas (including slash accumulations by year), fuelbreaks and firebreaks, and other relevant items.

Going through the process of creating a fire plan will help you systematically evaluate your property and identify ways to reduce fire risk. It can also help you communicate with your state forestry or fire agency and your rural fire protection association, as well as neighbors.

Remember, wildfire behavior can escalate rapidly, and quick decision making in the event of a fire can greatly increase the likelihood of control and/or minimize negative effects. Having necessary information in a fire plan easily accessible for firefighting personnel can be very important to reducing risk of damage to homes and other improvements, as well as to important forest resources and values.

10. Working with Your Neighbors

Working with your neighbors to address wildfire management issues can be as simple as agreeing to maintain a common driveway and as complex as developing a landscape management plan that encompasses your property and that of your neighbors. While much can be accomplished on individual properties, working at a neighborhood scale can yield even greater benefits. Neighbors may include other private landowners, as well as the Bureau of Land Management (BLM) and the U.S. Forest Service (USFS). These agencies have mandates to work with local communities to address wildfire risk and fuels concerns. Take advantage of this!

Specific activities you can undertake on a neighborhood basis include the following:

- Develop an emergency phone tree. List all residents (those wishing to participate) and their phone numbers. Have an agreed-upon procedure for contacting those on the list. This can be a great way of disseminating information during a wildfire and other emergencies.
- Develop a neighborhood evacuation plan. Identify a safe zone (for example, an open field) where residents can congregate in case evacuation is needed. Address special needs (evacuation of animals, elderly residents, etc.).
- Share equipment.
- Identify and map firefighting resources (ponds, ***pump chances***, equipment, and so on).
- Work with local agencies to identify key neighborhood resources at risk and develop plans to protect them. Create a map showing location of roads, water sources, bridges, and tactically important locations.
- Create a neighborhood-scale fuels reduction plan. Identify tactically important locations for fuels treatments such as ridgetops, major access roads, and the like. Identify areas that are particularly vulnerable, for example a group of dwellings on a steep, overgrown access road.
- Work with neighbors and other stakeholders to develop a Community Wildfire Protection Plan (CWPP), if one has not already been developed for your area. A CWPP identifies and prioritizes hazardous fuels treatments in a community and recommends measures to reduce structural ignitability. It is prepared through a collaborative effort involving local and state government representatives, federal agencies, and other interested parties. CWPPs help communities obtain federal grants for fuels reduction projects. They also influence how federal agencies address fuels reduction treatments in the wildland-urban interface.
- Update your plans on an annual basis.

Marty Main, Small Woodland Services.

Figure 32. Neighbors work with a professional forester to discuss fuels reduction options.

For More Information

Publications

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Schnepf, C., R. T. Graham, S. Kegley, and T Jain. 2009. Managing Organic Debris for Forest Health. PNW 609. Moscow, ID: University of Idaho Extension.

Schnepf, Chris. 2001. Logging Selectively. PNW 534. Moscow, ID: University of Idaho Extension.

Websites

Landowner Fire Liability at: http://egov. oregon.gov/ODF/PUBS/docs/Landowner_Fire_Liability_reduced.pdf

Oregon Department of Forestry general fire page: http://egov.oregon.gov/ODF/FIRE/fire.shtml

Oregon State University Extension forestry fire page: http://extension.oregonstate.edu/emergency/wildfire.php

Senate Bill 360 at http://www.odf.state.or.us/divisions/protection/fire_protection/prev/sb360/default.asp

Washington Forest Stewardship Program (info about technical, financial, and educational assistance): http://www.dnr.wa.gov/BusinessPermits/Topics/SmallForestLandownerOffice/Pages/forest_stewardship_program.aspx

Washington State University, "Basic Hand and Power Forestry Tools": http://ext.nrs.wsu.edu/handtools/index.htm.

Technical assistance

Technical assistance for creating fire-resistant forestlands is available primarily through private consulting foresters and foresters with state forestry and fire agencies in Oregon, Washington, and Idaho. Your local rural fire protection district is also a good source of information about fire protection.

Financial assistance

The availability of grants and cost-share funds for fuels reduction and other forestry activities changes frequently and varies by locality. Your best source of information about financial assistance is your state forestry or fire agency.

Glossary

Brush blade. A blade with "teeth" that allows brush to be uprooted and piled without also moving large quantities of topsoil to the pile.

Defensible Space. The natural and landscaped area around a structure that has been maintained and designed to reduce fire danger. This defensible space reduces the risk that fire will spread from the surroundings to the structure and provides firefighters access and a safer area to defend it from. Firefighters sometimes do not attempt protecting structures without adequate defensible space, for personnel safety and their effort less likely to succeed (adapted from Wikipedia).

Fire behavior. Fire behavior means its rate of spread (in feet/hour) and its intensity (that is, how hot it burns and how long its flame is).

Fire intensity and duration. Intensity refers to the amount of energy released by the fire, typically measured as flame length. Duration refers to the length of the period of combustion. Densely arranged fuels, such as chips, and larger fuels such as large logs, often have slower rates of fire spread than fine, loosely arranged fuels, but have greater intensity and duration due to the larger amount of fuel.

Fire severity. Fire severity describes the effects that wildfire has on soil, plants, fuel, and watersheds. Fire severity is determined by either visually estimating or measuring damage.

Fire-resistant forest. A forest that is resistant to, and unlikely to experience, a damaging wildfire. In many cases, fire-resistant forests have characteristics such as low levels of surface and ladder fuels, separation between tree crowns, and large, thick-barked trees that allow them to survive surface fires without significant mortality, and that make initiation of crown fires unlikely.

Fuel profile. The amount and arrangement of surface, ladder, and crown fuels. A forest's fuel profile has a major influence on fire behavior, along with weather and topography.

Holdover fires. A fire that smolders for days or weeks, then springs to life with higher temperatures and/or winds. Holdover fires are most common in slash piles that contain a significant amount of soil. It is always recommended to use a brush blade when creating a slash pile with equipment.

Ladder fuels. Small trees, brush, lower limbs of large trees, and other live and dead fuels that allow a fire to climb from ground level into the tree canopy.

Pump chance. A pond or creek that provides access to water for fire-fighting.

Resistance to Control. The effort needed to suppress a wildfire.

Surface fuel. Combustible material on the forest floor.

Thinning from below. An approach to thinning that removes primarily smaller, less vigorous trees (typically focusing on trees in the suppressed and intermediate crown classes) while retaining larger, more vigorous trees.

Vegetation mosaic. A pattern of vegetation occurring across the landscape, in which patches of vegetation occur in a variety of different stages and conditions, side by side. For example, a patch of older trees may occur next to a patch of younger trees and an open area. In landscapes in the western U.S. that historically experienced frequent wildfire, forests typically occurred in such a patchy mosaic, resulting in discontinuous fuels. Following decades of fire exclusion, many of these same forests now have more continuous layers of fuels, and are thus more likely to sustain and spread a high severity wildfire.

Appendix A. Pacific Northwest Laws Pertaining to Forest Fire Protection

Overview

Family forest owners in Oregon, Washington, and Idaho are subject to a variety of state and local laws related to forest fire protection. Any forest operation that involves burning, such as igniting slash piles or using prescribed fire, has inherent risks for creating uncontrolled wildfire, particularly during the closed fire season. Fire conditions vary from year to year and from place to place, depending on specific weather patterns such as how much rain or snow an area receives and when.

Fighting fire is expensive and no landowner would want to be found liable for the costs of suppressing a fire, even a relatively small one. Most states hold landowners and people who start fires liable for the costs of fighting those fires if they do not follow the state's regulations. Therefore, anytime landowners conduct management activities on their property, such as thinning, harvesting, burning, and so on, they should include an effective plan for preventing an uncontrolled forest fire. By doing so, landowners reduce their own risks and help keep fire budgets and fees low.

The financial stakes are very high, so landowners should protect themselves by obtaining adequate insurance, regardless of whatever insurance their contractor may have. When hiring a contractor, it may also be advisable to require proof of insurance up to a coverage level the landowner feels is adequate. Often $1 million in coverage is used as a standard. Private insurance companies also offer coverage, so check with your insurance carrier. Note that insurance is generally not available for the value of the timber itself.

Burning associated with forest management activities (burning slash) can introduce significant amounts of smoke into the atmosphere which, depending on weather conditions, the amount of fuel being burned, and proximity to population centers, can present serious air pollution problems. By coordinating who is burning how much fuel and when, these kinds of problems can be minimized.

Wildfire in the wildland-urban interface is becoming an increasing problem in the Pacific Northwest as more and more people choose to live in rural forested neighborhoods outside of urban areas. Due to excessive amounts of fuel in the form of wooden houses and the vegetation surrounding them, fire suppression organizations are challenged to provide adequate protection. Local municipalities have zoning regulations related to such regions. If your forestland is within city limits, there may be city regulations that affect how you manage fire risk. For example, some cities require logging slash to be chipped or hauled away rather than burned. Check with the appropriate authorities for regulations that may apply in your area. Local forestry agency officials who oversee fire regulations are usually aware of these regulations or guidelines.

Fuel reduction activities often create bare mineral soil, particularly if there is burning involved. This can provide a very favorable environment for invasion by non-native weeds. All three states have laws designed to reduce the spread of these weeds. For more information on these laws, consult your state or county's noxious weed office.

Oregon laws summary

Notifications and Permits

Most commercial forest operations require notification to the Oregon Department of Forestry. The purpose of this "Notification of Operation" is to ensure that forest operations comply with forest practices laws and rules. All burning of slash requires this notification.

Additionally, most forest operations also require a "Permit to Use Fire or Power-Driven Machinery." This requirement originated in the 1930s following the Tillamook Burn, which was caused by a timber harvest operation. Its purpose is to reduce fire risk by allowing Oregon Department of Forestry personnel the opportunity to inspect forest operations for compliance with fire laws. These laws mandate specific requirements for fire prevention and fire suppression equipment and tools.

The Notification of Operation and the Permit to Use Fire or Power-Driven Machinery are combined on one form and available at local Department of Forestry and Forest Protection Association offices.

Burn permit

Oregon prohibits prescribed fires during the burning season and requires permits for forestry burning whatever time of year it is done.

Oregon smoke management plan

To provide effective coordination, Oregon requires smoke management plans to be filed in conjunction with burn plans. Smoke management plans require information such as estimated fuel quantities and acreage to be burned; this information is evaluated against the forecasted daily weather and specific smoke sanction guidelines to determine whether burning is permissible.

Fire season and regulated closure

When forest fuels become dry and local climatic conditions create fire hazard conditions, Oregon Department of Forestry may declare a fire season and/or regulated closures to minimize the risks of someone accidentally igniting a wildfire.

The declaration of fire season initiates special requirements for commercial operation including fire tools, water supply, and fire watch services. For operations west of the summit of the Cascade Mountains, Industrial fire precaution levels further regulate the use of power-driven equipment. The declaration of regulated closures influences nonindustrial activities of public and private landowners. These requirements vary by locality but typical restrictions ban open fires except in approved areas, restrict nonindustrial chainsaw use, and confine motorized vehicles to improved roads. Should fire conditions continue to deteriorate into an extremely hazardous situation, the restrictions can be elevated to require entry permits or complete closure of certain forest areas.

Landowner liability

Landowners incur an increased responsibility for fire suppression costs and actions when conducting or allowing forest operations on their property. This includes operations such as timber harvests or burning activities. Fires that result from negligent activities, such as not complying with fire rules and laws, subject the landowner to paying the total cost of fire suppression. Operation fires that do not result from negligent acts still subject the landowner to liability for a maximum of $300,000 of suppression costs. Fires started as a result of forest operations are statutorily assumed to be caused by the operation, if no other cause can be established by the state's investigation of the fire.

Additionally, to avoid full liability, Oregon law requires every landowner and their forestry contractor to make "every reasonable effort" to control a fire that starts on their woodland property, from either burning or operation activities. This means that all available resources of the landowner must be used to fight the fire. Again, failure to perform "every reasonable effort" voids the $300,000 maximum liability and opens the door to full liability for fire suppression costs. See the publication Landowner Fire Liability at: http://egov.oregon.gov/ODF/PUBS/docs/Landowner_Fire_Liability_reduced.pdf

The Oregon Small Woodlands Association (www.oswa.org) offers discounted firefighting expense liability insurance to its members.

The subject of fire liability is complex and each fire situation is unique. If you have questions regarding potential liability, contact your local Oregon Department of Forestry or Forest Protection Association office. For more details on the laws regarding fire suppression costs liabilities, refer to Chapter 477 in the Oregon Revised Statues (ORS).

Senate Bill 360 (SB 360)

If you have a home on your woodland property this act may apply to you, so it is important that you be aware of it and understand its provisions.

In 1997, to help ameliorate the danger of wildfire, the Oregon legislature passed the Oregon Forestland Urban Interface Fire Protection Act, which recognizes that homeowners also have a responsibility to protect their homes. In addition to establishing legislative policy on fire protection, the act defines specific fire safety standards so homeowners can manage fire hazards and risks by reducing fuel availability on and around their homes.

The Oregon Department of Forestry was directed by the legislature to implement the act, and a more complete and thorough explanation of the regulations can be found at its website: http://www.odf.state.or.us/divisions/protection/fire_protection/prev/sb360/default.asp.

Idaho laws summary

Landowner liability

All forest owners in Idaho are responsible to provide protection against forest fires. They can provide their own protection (currently only USFS, BLM, and Tribes do this), join an association of landowners that provides protection (currently there are two Timber Protective Associations in Idaho with more than 60 members that do this), or rely on the Idaho Department of Lands (IDL) to provide the protection, for which landowners are charged a fee that is paid along with their property tax bill.

Fire hazard from logging

Laws governing fire hazard created in forestry activities are administered by the IDL and are structured differently for fire hazards associated with logging and for fires resulting from other forest management activities. Fire hazards associated with logging are administered under the Idaho Forestry Act and Fire Hazard Reduction Laws (Idaho Code Title 38, Chapters 1 and 4).

Anytime someone harvests timber and sells it, the person who is responsible for treating the slash must obtain a one-page "Certificate of Compliance—Fire Hazard Management Agreement—Notification of Forest Practice" (sometimes referred to by loggers as a "brush permit"). The completed form must be provided to the purchaser of the logs and to the local IDL office. The person who signs the agreement (usually the logger) is legally liable to reduce slash from cutting forest products to an acceptable level to release the landowner or operator from liability for any forest fires that start on or move through the property.

The agreement has five possible options to reduce the fire hazard. The most commonly used option requires the contractor to post a cash bond (a holdback) to assure that the slash will be treated. The bond is usually paid to the state from log delivery payments made by the mill that purchases the logs. The money goes back to the contractor after they have reduced the slash to an acceptable level, though a small portion is permanently withheld for fire suppression and forest practice act administration. Generally, the slash must be treated within two years but this can vary for different types of jobs, depending on negotiation with the local IDL fire warden.

If the slash is not treated by the agreed-upon expiration date, the contractor is liable for the costs of any wildfires started on or passing through the slash area for five years after the agreement expiration. The contractor can pay an additional fee, however, for the state to assume the remaining fire suppression liability.

Fire hazard from forest management practices other than logging

Fire hazards for practices other than timber harvest (for example, pre-commercial thinning and prescribed burning) are regulated under the Idaho Forest Practices Act (Title 38, Chapter 1). Anytime a forest owner harvests timber, constructs or maintains forest roads, plants trees, uses chemicals, thins, prunes, or uses prescribed fire, they should check with the local IDL office to see whether they need to file a Certificate of Compliance—Fire Hazard Management Agreement—Notification of Forest Practice. If they do need a notification, the local IDL forest practice advisor will determine the activity's potential fire hazard and the hazard reduction plan needed, if any.

Landowners generally have 12 months or less to reduce the fire hazard. The landowner is released from liability when they have met all the requirements set in the agreement. Forest owners can sometimes negotiate with the fire warden for an extension of the time to finish the treatments.

Open and closed burning seasons, burn permits

Idaho has a closed burning season from May 10 to October 20. During periods of very high fire risk, closed burning seasons can be extended, so it is a good idea to check with the local fire warden before you burn.

Burn permits are not required during the open burning season. During the closed season, landowners must get a permit to light any fires, except for campfires in designated areas. Burn permits are available through local fire protection districts, are typically good for up to 10 days, and spell out the conditions under which burning is permitted.

Forest owners who are doing some type of prescribed burning (e.g., a broadcast burn or an underburn) must file and follow a prescribed burn plan which must be approved by the local fire warden.

Fire tools

Everyone working in Idaho forests must have one basic, functional, accessible firefighting cache for each 10 persons working, consisting of two axes, five shovels, three pulaskis, and two water buckets. The fire cache tools must be in a closed box marked "For Fire Use Only."

Each piece of power equipment used in Idaho forests must have one chemical fire extinguisher rated by the Underwriters Laboratory as not less than 4-BC. Anyone using a chainsaw must have immediately available (1) a fully charged operable fire extinguisher of at least eight-ounce capacity, and (2) a functional round-pointed size zero or larger shovel.

Spark arrestors

Chainsaws, skidders, or any other machine with an internal combustion engine being used in Idaho forests must have a properly functioning spark arrester. Your local fire warden can assess whether what you have is adequate. Passenger vehicles and light trucks with a well-functioning muffler and tailpipe are usually exempt from this.

Air quality

Private forest landowners and a variety of state and federal agencies have created the North Idaho and South Idaho Airshed Groups to voluntarily manage smoke from their burning activities. Each spring and fall, weather and proposed burn data is gathered daily to help fire weather forecasters determine if burning could impact major population centers in eastern Washington, northern Idaho, and western Montana. Forest owners can get this information by visiting the Montana/Idaho Airshed Group website (http://www.smokemu.org). In northern Idaho, air quality and burning information may also be obtained from the Department of Environmental Quality's hotline, 1-800-633-6247, or the DEQ's web site at www.deq.idaho.gov.

For more details on laws to protect Idaho forests from wildfire, refer to the Idaho Forestry Act (Title 38, Chapter 1) and the Rules Pertaining to Forest Fire Protection (IDAPA 20.04), accessible through the Idaho Department of Lands website section on fire at http://www.idl.idaho.gov/bureau/firemgt.htm.

Washington laws summary

Washington has numerous agencies that regulate the use of fire. Agency jurisdiction is determined by location and the type of material being burned. Homeowners can technically fall under three different agency jurisdictions when planning to burn on their property.

Agricultural burning, such as field burning and row burning, is regulated by the Department of Ecology. Yard and garden burning is regulated by the Department of Ecology or, in some areas, by county government or a local air pollution agency. Yard and garden burning is typically the burning of material that is generated from the maintained portion of your property such as gardens, corrals, and your yard. To learn more about agricultural and yard and garden burning contact the Department of Ecology.

Silvicultural (forest land) burning

Silvicultural burning is the burning of forest debris on forested land. Outdoor debris burning is subject to state and local fire safety and air quality regulations. The Washington Department of Natural Resources (DNR) is the authority responsible for the control of silvicultural debris burning in order to reduce the risk of fire spreading from an area and to determine when lives or buildings may be in danger (Revised Code of Washington 76.04.015). This section provides an introduction to rules and regulations for the use and control of fire on private forestland in Washington State, but it does not include all relevant laws and is limited to silvicultural burning and operations. Forest owners are advised to contact the DNR for complete information and direction to other potential authorities for the use and control of fire. For information and assistance, contact the Resource Protection Division, Washington State Department of Natural Resources, 360-902-1300, RPD@dnr.wa.gov, or one of the regional offices listed below .

Debris burning is the leading cause of wildfire on state and private lands. The DNR regulates silvicultural burning. The DNR may suspend all outdoor burning during times of high fire danger due to weather conditions, wildfire conditions, lack of firefighting personnel, or to protect air quality.

Silvicultural burning can be done with or without a permit depending on how much is being burned. Before doing any silviculture burning call 1-800-323-BURN. A written burn permit is not required by the DNR if the following conditions are met:

- Follow the notification instructions specific to your county as given on the 1-800-323-BURN message or shown on the website at http://fortress.wa.gov/dnr/firedanger each day you plan to burn.
- Burn no more than one pile at any time; each pile must be completely extinguished before lighting another.
- Create a firebreak around the pile by constructing a barrier to bare mineral soil with no flammable material.
- Keep a shovel and connected water hose or at least five gallons of water nearby.
- A person capable of extinguishing the fire must be in attendance at all times while burning.
- Burn only in calm or light winds.
- A fire that does not require a written permit has established size limitations based on time of year and the county within which the burning occurs:
  - From July 1 to October 15, individual pile size in all counties shall be limited to no larger than four feet, except pile size in Clallam and Jefferson counties is limited to ten feet.
  - From October 16 through June 30 individual pile size in all counties is limited to ten feet; except pile size is limited to four feet in Island, King, Kitsap, Mason, Pierce, San Juan, and Spokane counties.

If these conditions cannot be met, a DNR permit is required. Additionally, a permit is required for the following:

- Burning of any machine-piled material.
- Burning within 500 feet of forest slash piles or within 50 feet of structures.

To request a burn permit, contact the appropriate regional office.

Washington State has additional laws to protect lands from fire. Forest owners should also be aware of the Extreme Fire Hazard Law and Industrial Forest Precaution Level.

Extreme Fire Hazard Law (RCW 76.04.660)

It is against the law to create a condition that increases the hazard for wildfire on your forest and adjacent lands. This additional hazard is defined as "a condition existing on any land in the state covered wholly or in part by forest debris which is likely to further the spread of fire and thereby endanger life or property." Both the landowner and the person creating the additional hazard are required to take reasonable measures to reduce the risk of fire spreading from this area.

The Extreme Fire Hazard Law applies to specifically defined additional fire hazards. Slash isolation, reduction, or abatement is required when the DNR determines there is an extreme fire hazard according to law. Examples include within 100 feet of a public roadway or railroad, within 500 feet of any building valued over $1,000 on neighboring property, or within 500 feet of any area used by the public, such as a school, park, or campground. If the landowner and person creating the additional hazard do not abate the risk, the DNR has the authority to conduct mitigation measures and charge the landowner and operator for the service.

Landowners should contact the DNR prior to generating slash that may meet the definition of extreme hazard to discuss their options.

Washington State Precaution Levels

By law, the Washington Department of Natural Resources (DNR) uses two closure systems for reducing the risk of wildfires on 12 million acres of private and state forest land that receives fire protection from the department.

Activated when needed during the summer fire season, one closure system applies to woods workers and other forest industrial users. The other set of protections is aimed at the general public, but also includes local residents, landowners, recreationists, and forest workers.

Woods workers are required to observe both sets of restrictions as fire danger dictates. Other land users only need to follow the public use restrictions.

Industrial Precautions

The DNR, U.S. Forest Service, Bureau of Land Management, and Bureau of Indian Affairs all use the same four-level industrial regulation system. This system, which helps prevent wildfires by regulating work in the woods, is known as the Industrial Fire Precaution Level (IFPL) system.

Below are the levels and what they mean (see Table 7):

Level I: Closed fire season: Fire equipment and fire watch service is required.

Level II: Partial hootowl: Limits certain activities to between the hours of 8 P.M. and 1 P.M.

Level III: Partial shutdown: Prohibits some activities altogether and limits other activities to between the hours of 8 P.M. and 1 P.M.

Level IV: General shutdown: All operations prohibited.

Public use restrictions

The DNR also administers public use restrictions, which limit activities on forest land during periods of high fire danger. Following are the restrictions and what they mean:

Summer Fire Rules. From April 15 through October 15, or longer if the fire danger warrants it, the following restrictions are in place:

- Cigarette smoking on forest land is only allowed within vehicles.
- Fireworks may not be lit on forest land.
- Nonindustrial use of chain saws must follow IFPL requirements.

Fire watch services

The purpose of the fire watch is to stay after the day's work is over and report any fire starts to the proper authorities. The fire watch is required to be on duty after the last power-driven equipment used by the operator has been shut down for the day. The fire watch must be on duty a minimum of one hour. During periods of high fire danger, DNR recommends the fire watch be on the operation site longer than the mandated one hour.

A fire watch must do the following:

- Visually observe all parts of the operation area on which industrial activity has been in progress.
- Be physically capable of fighting a fire and experienced in operating firefighting equipment.
- Have on-site communication (CB radio, cellular or radio phone) to summon help in the event a fire breaks out. Transportation is also required in case radio or phone communication doesn't work.

Closed Entry Areas. When high fire hazard conditions exist, the DNR may designate certain areas as regions of extra fire hazard and post them accordingly. Land designated as closed to entry is only open to local residents and woods workers carrying out industrial jobs. All other land uses, including recreation, are restricted. The DNR typically designates these areas in the spring, posts signs accordingly, and keeps them closed to entry during the entire fire season. Most closed entry designations occur by landowner request on private land west of the Cascades.

Forestland Closure. When very extreme fire weather conditions exist, the DNR may issue an order restricting all access by all people to all activities on certain private and public forest lands. These closures, which are very rare, may even restrict local residents from returning home if the fire danger warrants it.

Table 7. Operation rules for types of power saws during fire precaution periods.

Precaution level	Landing	Tractor/skidder	Other wood saws
I. Closed season	Fire watch	Fire watch	Fire watch
II. Partial hootowl	Fire watch	Hootowl[1]	Hootowl[1]
III. Partial shutdown	Hootowl[1]	Hootowl[1]	Prohibited
IV. General shutdown	Prohibited	Prohibited	Prohibited

[1] Operation can only take place from 8 p.m. to 1 p.m.

Fire behavior—its spread and intensity—is affected by topography, weather, and fuel (Figure 2). Fuel is the only factor that you can change, but let's take a closer look at how all three of these factors interact.

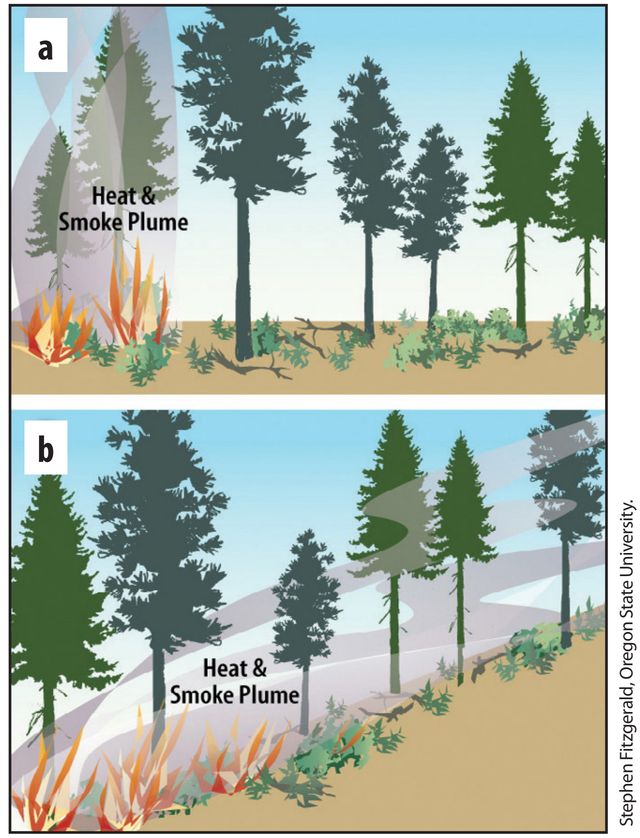
Topography

Topography is the most stable variable in the fire behavior triangle. Slope, aspect, elevation, and topographic features influence fire spread (how fast a fire moves in feet per hour). For example, fires tend to spread faster up a slope than down one. As heat rises in front of the fire, it more effectively preheats and dries upslope fuels, making for more rapid combustion (Figures 33a and 33b).

Aspect (direction of the slope) affects how much solar radiation a site receives and also the vegetation type. South- and west-facing slopes tend to have less vegetation and lighter fuel loads, particularly in lower-elevation forests. South slopes receive much higher solar radiation and are warmer, so fuels tend to dry out sooner and more thoroughly during the fire season. In contrast, north slopes have more vegetation and hence heavier fuel loads. North slopes are cooler and more shaded, thus delaying the drying of fuels long into the fire season. Because of their higher fuel loading, however, heavily vegetated north slopes can experience more severe wildfire. In western Oregon and Washington, fuel loads can be heavy on both north and south slopes because of higher rainfall and forest productivity.

Elevation affects fire behavior by influencing the amount and timing of precipitation, as well as exposure to prevailing wind. Elevation also affects the seasonal drying of fuel. In lower elevations (where most private land is located), fuels tend to dry out earlier in the year because of higher temperatures and lower precipitation. The opposite is true for fuels at higher elevations. There is also a tendency for more lightning strikes and subsequent ignitions at higher elevations.

Landscape features like narrow and wide canyons, ridges, and saddles can dramatically affect fire behavior. These features can change prevailing wind patterns by funneling air, increasing wind speed, and thereby intensifying fire behavior. Fires on lateral ridges (those coming off a main ridge) can burn in any direction and be affected by wind moving up through canyons and saddles. Other features, including rock outcroppings, streams, rivers, lakes, and roads, act as fire barriers and can be used as anchor points for developing fuelbreaks. Firefighters can take advantage of these natural and man-made features in attacking and suppressing wildfires. By analyzing a topographic map of your property, you may identify topographic features that can be used to your advantage.



Figures 33a and 33b. Fire spreads more rapidly uphill. As heat rises in front of the fire, it more effectively preheats and dries upslope fuels, making for more rapid spread.

Weather

Weather influences how fast and to what degree fuels dry out during the fire season. Weather is the most variable factor in the fire behavior triangle, and it can change quickly.

Extended periods of low relative humidity and high winds can quickly dry fuels. Extended drought periods leave fuels with very low moisture content, often resulting in increased fire activity and intensity. Under a given set of wind conditions, the intensity and rate of spread of a fire can change on a daily basis due to fluctuations in temperature and relative humidity. For example, during the warmer part of the day, fires spread more rapidly and burn with greater intensity, often producing a large smoke column. Lower temperatures and higher relative humidity late in the afternoon and early evening, however, increase moisture in the fine fuels, reducing the rate of spread and fire intensity, and collapsing the smoke column. During the summer months in mountainous terrain, wind often shifts daily, moving upslope during the afternoon when most heating occurs and downslope during the evening when the land has cooled.

Some wildfires are wind-driven, meaning that wind is pushing the fire rapidly in one direction (often with high intensity), resulting in a cigar-shaped fire with a long, narrow fire front. A subsequent change in wind direction can create a very long fire front that is difficult to control. In contrast, a change in weather from hot and dry to cooler, moister conditions reduces fire intensity and rate of spread. Often firefighters have to wait for a change to cooler weather with higher relative humidity before they can safely attack a wildfire head-on.

Fuel

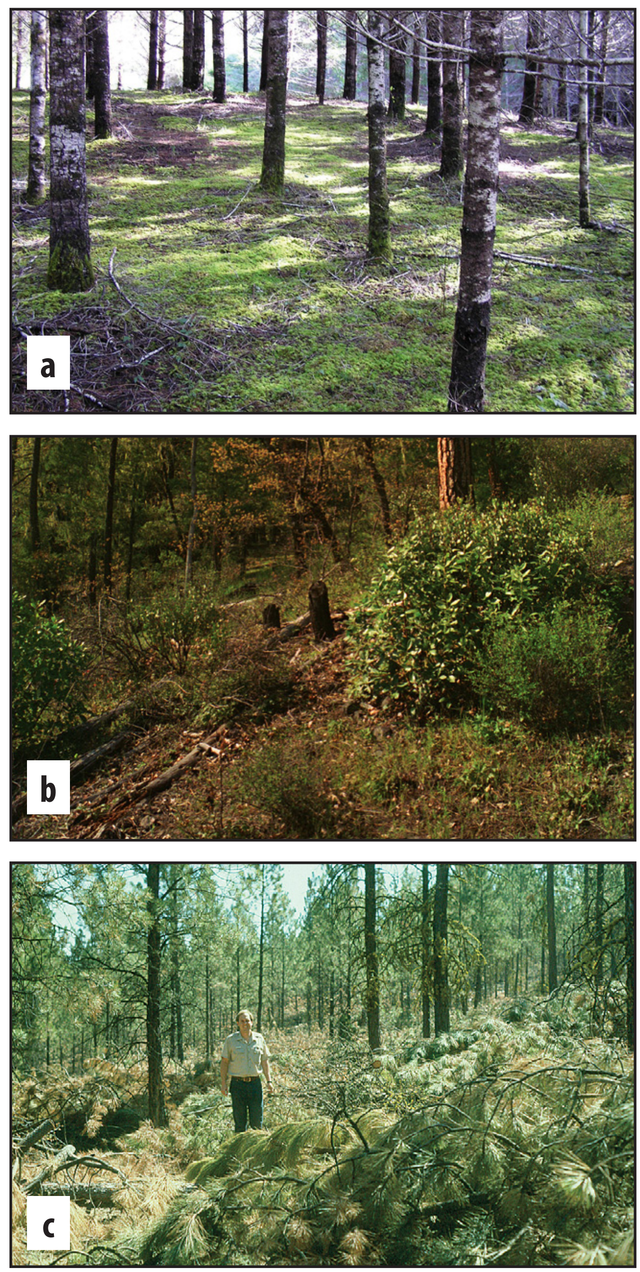
Fuel is the third leg of the fire behavior triangle, and the only leg that landowners can influence.

Fuels consist of dead woody material (needles, fallen branches, dried herbaceous vegetation, snags, and logs) or live trees and other vegetation, like shrubs. Fuels can be grouped in the following manner:

- Ground fuels: duff (decomposed needles and other organic material), buried punky (rotten) roots and logs, and accumulations of decomposing bark at the base of trees.
- Surface fuels: litter or undecomposed needles; moss; lichens; rotten and sound logs; woody debris and slash piles; stumps; low vegetation like grass, herbs, and small shrubs.
- Ladder fuels: large shrubs; small and medium-size trees; low-growing branches on medium to large trees that allow a surface fire to move up into the overstory tree crowns.
- Crown fuels: lichen, tree needles, and small branches that compose the forest canopy; and snags.

The amount of fuel—known as fuel loading and expressed in tons per acre—and its vertical and horizontal arrangement affect fire intensity and the ability of surface flames to begin torching tree crowns or support active crown fire. The size and the moisture and chemical content of fuels also influence combustion and fire behavior. Figures 34a, 34b, and 34c show low, medium, and high surface fuel loading. These photos do not quantify fuels above the surface, however.

Fuels are also classified according to their size and their ability to gain or lose moisture (see Table 8). The designation of 1-, 10-, and 100-hour fuel categories indicates the time required for fuels of different sizes to dry or to absorb moisture depending weather (relative humidity) and moisture within the forest floor over the spring, summer, and fall fire season. Assuming they are dry enough to ignite, 1- and 10-hour fuels are largely responsible for supporting ignition and initial fire spread due to their small size (or, more specifically, their high surface area to volume), which allows them to be easily preheated and combusted. The 100- and 1,000-hour fuels can support a self-perpetuating surface fire, but only when combustion of the smaller fuel sizes preheats and ignites them. Slash left after logging is composed of these smaller fuel sizes, and thus represent a high fire hazard. Larger 10,000-hour fuels typically don't influence fire spread much, but can affect what firefighters call ***resistance to control*** and fire severity, because once ignited (after the flaming front has passed), these larger fuels can burn for hours or days, heating the soil or, if adjacent to trees, killing tree roots and trees directly. Moreover, because large fuels can harbor smoldering fires for long periods, mop-up is more difficult and expensive.



Stephen Fitzgerald, Oregon State University.

Oregon Department of Forestry.

Stephen Fitzgerald, Oregon State University.

Figures 34a, 34b, and 34c. (a) Low, (b) medium, and (c) high surface fuel loadings.

The chemical content of fuels affects heat output and fire intensity. Some native shrubs such as bitterbrush, ceanothus, and manzanita contain volatile oils in their branches and leaves and have higher heat content and burn with higher intensity. Because shrubs also have many small branches and twigs, they readily combust when ignited and can produce long flame lengths.

Table 8. Fuel categories (size) and their contribution to fire behavior.

Fuel category	Diameter (in.)	Description	Impact on fire behavior
1-hour	0.00–0.25	Needles, twigs, moss, lichens, small shrubs and grasses	Easily ignited. Supports initial fire spread and the heating and combustion of larger fuels. Under dry conditions, these fuels are flashy and surface fires spread quickly.
10-hour	0.25–1.00	Small branches, shrubs	Supports fire spread and the heating and combustion of larger fuels. Under very dry conditions fires spread quickly.
100-hour	1.00–3.00	Medium-size branches	Supports fire spread and the heating and combustion of larger fuels.
1,000-hour	3.00–8.00	Large branches, small logs	Supports fire spread. Increases fire duration and influences fire severity, depending on loading.
10,000-hour	> 8.00	Large downed logs that are solid or moderately decayed	Ignites after flaming front has passed. Large fuel pieces do not support fire spread, but can increase fire duration and severity near the log. If fuel loading is high and distributed across the site (such as from beetle-killed trees), high fire severity can be more widespread and increase resistance to control and the duration of burning.
Snags	Variable	Bole only or bole with large branches, depending on snag condition	When snags combust, they can torch, lofting embers and firebrands ahead of the main fire, starting additional spot fires. Snags may increase resistance to control.

Appendix C. Additional Case Studies

In this appendix, we present two additional case studies of creating properties that are more fire resistant. One example, from Sumpter, Oregon, shows what multiple owners of small forested properties can do to reduce their risk of wildfire. The key to this example is that reducing fire risk improves as more people join in the effort because fuels in a larger area have been reduced. This concept is important since there are many recreational homes in the Sumpter area. The other example is from western Washington. Many people may not view western Oregon and Washington as being fire-prone because of moister forest conditions. In the summer, however, even areas west of the Cascades can get dry enough to burn. In this case, humans may cause the fire, not lightning. With increased development on the coast and in the Willamette Valley fringe areas, the threat of a human-caused wildfire is high.

Sumpter, northeastern Oregon

The town of Sumpter, founded in 1862, was named in commemoration of the 1861 shelling of Fort Sumter, which signaled the beginning of the American Civil War. Like other mining communities in the west, when gold was discovered in 1868, the community quickly grew to more than 30,000 residents. By the early 1900s, the gold had played out and the town dwindled. Today, there are more than 650 small forested properties but only about 120 year-round residents live within the roughly four square miles that comprise the city limits.

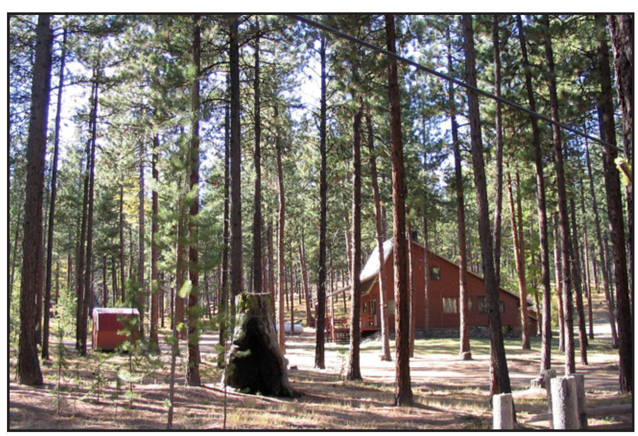
Sumpter is completely surrounded by national forest lands. The forests have progressively become overstocked with trees over the years and concerns about the risk of wildfire are high (Figure 35). Beginning in the late 1990s, the U.S. Forest Service began thinning trees, piling slash, and underburning on its lands around the town to minimize the risk of a high-intensity wildfire burning into Sumpter.

The Oregon Department of Forestry (ODF), recognizing the high fuel loads on private property within Sumpter itself, identified the community as a high-priority area for reducing wildfire hazards. The ODF began securing National Fire Plan grant money in 2000 and, over the next few years, obtained approximately $2 million for fuel reduction work in Baker County. Additionally, the ODF partnered with the City of Sumpter Fire Department and the Powder River Rural Fire Department to plan fuel treatment strategies and to motivate the landowners through public education. The local firefighting departments were instrumental in this effort, providing many individual home assessments and hosting community informational meetings. These departments have also worked to increase their firefighting capacities by purchasing new equipment and stepping up training for their personnel.

The ODF sent multiple letters to approximately 400 landowners, explaining the need for fuel reduction and the availability of grant funds to help pay for clean-up work. Within the next few years, around 30 percent of landowners treated their properties beyond the 100-foot "defensible space" zone surrounding their homes (Figure 36). More than half of this group performed additional work within the defensible space zone. These treatments included thinning, pruning, piling and burning slash (Figure 37), and hauling chipped material to a co-generation facility in Prairie City. The large number of absentee landowners created challenges, but those who did participate represented the majority of the highest-risk properties, and nearly 1,000 acres have

Bob Parker, Oregon State University.

Figure 35. Typical vegetation prior to treatment.



Bob Parker, Oregon State University.

Figure 36. Treated area around residence.

been treated to date. The properties that have not been treated yet are being closely scrutinized and the landowners are strongly encouraged by their fire departments and neighbors to take action.

Sumpter now has a Community Wildfire Protection Plan that emphasizes collaboration to guide the community through prioritizing and planning where future fuels reduction work will be focused. Thanks to the hard work by all the partners, the town of Sumpter has successfully transitioned from a community with a high risk for fire to one that is well positioned to survive a wildfire with minimal damage or loss.

Western Washington

The western hemlock zone of the Pacific Northwest is characterized by shade-tolerant western red cedar, western hemlock, and grand fir. In openings typically created naturally by wind or culturally through the harvest of timber, light penetrates the forest floor, stimulating rapid growth of Douglas-fir, red alder, and a variety of shrubs. Though wildfire is a rare event on the western slope of the Cascades and Olympic Peninsula, large stand-replacing wildfires have occurred. These fires were closely tied to climate and climate history; variations in precipitation and temperature effected the forest and its vegetation. In some cases on the Olympic Peninsula, the vegetation reflected that of northern Idaho, dominated by Douglas-fir, western hemlock, spruce, alder, and lodgepole pine, while the Puget Trough was dominated by Douglas-fir, alder, and oak, similar to Oregon's Willamette Valley today. Both historic vegetation suggest a forest where fire was present.

Greatly improved fire prevention techniques are responsible for the significant decrease in small and large fires today. In the absence of natural and human disturbance, which would change the density and composition of the forest stands, large fuel loads have created a wildfire risk for owners of family forests. This case study represents one forest owner's silvicultural practices executed for the purpose of protecting his home and forest from stand-replacing wildfire. Secondary management objectives included enhancement of wildlife habitat and viewshed enhancement.

Family forest owner Walt Megahan has a home on 20 acres near Sequim, on Washington's north Olympic Peninsula. His primary management objectives were to protect his home and forest from fire and to create a diverse forest attractive to a variety of wildlife species. In order to reduce the risk of wildfire and home ignition, Megahan implemented practices to create a defensible space around the home and decrease the fuel quantity and arrangement.

First, a defensible space of 30 feet on the east and west side of the house was cleared and replanted with grass. On the north and south sides of the home, where slope was much greater, a 150-foot grass landscape was created (Figure 38). For the next 100 feet beyond the lawn, trees 6 to 14 inches in diameter were thinned to a 20-foot spacing and the lower 18 feet of branches were pruned to create a shaded fuelbreak. Trees and branches removed were chipped and left on-site in several small piles. Bird boxes were hung to provide cover habitat for cavity-nesting birds and mammals.

The remainder of the 20-acre parcel was pre-commercially thinned using a variable-density thinning design aimed at creating a mosaic of openings as well as varied tree species composition and stand densities (Figure 38). Twenty percent of the parcel was thinned

Bob Parker, Oregon State University.

Figure 37. Treated stand.

Andy Perleberg, Washington State University.

Figure 38. Defensible space.

lightly with approximately 8-foot spacing; 60 percent of the parcel was thinned at traditional 12- to 15-foot spacing; and the remaining 20 percent was thinned heavily with 22- to 26-foot spacing between leave trees. Western red cedar was favored and patches of it were left untouched. Natural openings created by root disease were taken advantage of for creating treeless gaps in the forest. Where Megahan desired to preserve the view of the Straight of Juan De Fuca, he removed large trees and planted shrubs for wildlife.

The forest thinning, pruning, and wildlife enhancement practices were partially funded through the Forest Land Enhancement Program, a cost-share program helpful for landowners implementing their Forest Stewardship Plans and administered by the Washington Department of Natural Resources. The second phase of the fuels reduction project was cost-shared through the Environmental Quality Incentives Program (EQIP), which is administered by the Natural Resources Conservations Service.

As a result of the pre-commercial thinning, there was a tremendous amount of downed trees too small for commercial use but sufficiently large in size to risk carrying fire into the crowns of the leave trees. Downed trees also created access limitations for wildlife such as deer. The second phase consisted of lopping this downed material into one- to two-foot sections and scattering the material around the forest (cut-and-scatter), increasing the rate of decomposition of the downed trees and brush. Although EQIP did not fund the practice, a trail was created to provide a clear access path for firefighters. This loop trail has also given the landowner an improved means for exploring and monitoring his forest for health, productivity, and safety.

Pacific Northwest Extension publications are produced cooperatively by the three Pacific Northwest land-grant universities: Oregon State University, Washington State University, and the University of Idaho. Similar crops, climate, and topography create a natural geographic unit that crosses state lines. Since 1949, the PNW program has published more than 600 titles, preventing duplication of effort, broadening the availability of faculty specialists, and substantially reducing costs for the participating states.

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