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Science & Policy Brief

Fire and Fuels: Does Thinning Stop Wildfires?

Key points:

- Fuels, topography, and weather all affect fire behavior, weather most of all.
- Different forest types develop different fuel loads under different climates.
- Fuel treatment can affect fire behavior, but it can't stop wildfires.
- Fuel treatment near communities can help save homes.

Fuels, topography, and weather all affect fire behavior, weather most of all.

The classic "fire triangle" requires three conditions for combustion to occur: fuel, oxygen, and sufficient heat. This rule applies, whether the setting is a chemistry lab or a wilderness. In wildland settings, though, another combination of factors — topography, weather, and wildland fuels — directly influences the behavior of wildfire. So important is this latter combination that it has come to be known as the "fire behavior triangle."

Topography can dramatically affect fire behavior. When fires burn on steep slopes, advancing flames pre-heat the uphill vegetation, increasing the rate of spread. Fires burning uphill are capable of spreading very fast with great intensity. Conversely, fires backing down a slope may burn with much shorter flame lengths and may have little effect on the vegetation.

Unlike topography, which does not change, *weather* fluctuates tremendously, and those fluctuations have big effects on fire behavior. High temperatures reduce relative humidity and bring the fuels closer to the ignition temperature, making combustion easier. Winds increase the supply of oxygen and can increase the rate of spread by blowing burning embers ahead of the flaming front. Drought results in dry fuels, which are easier to ignite. When these factors come together, extreme fire behavior will result, almost without regard to fuels or topography.

While weather is the most important determinant of fire behavior, it is not subject to manipulation the way *fuels* are. The nature of fuels — whether fine or coarse, continuous or disrupted, heavy or light — can have a major effect on fire behavior, changing, for instance, a surface fire into a crown fire. Thinning (the cutting of small trees) can break the continuity of fuel from the ground to the canopy or from tree to tree.

Prescribed burning (the intentional use of fire) consumes the fine fuels, making an unwanted fire less likely in the future. Through the application of fuel treatments, managers can change the nature of fuels and thereby change fire behavior — as long as the weather cooperates.

Different forests, different fuels.

Almost every vegetation type in North America has been touched by fire. Where conditions supporting fire occur frequently, as with grasslands and some pine forests, frequent, low-intensity fires burn harmlessly through the understory, keeping the ground free of fuel buildup. In other places such as cool, moist forests, fires are infrequent, occurring every few centuries. There, large amounts of fuel naturally build up in the form of dead leaves, branches, and down logs. When weather conditions supporting fire finally do occur, fires burn hot, killing large patches of trees or shrubs. These characteristic patterns of fire — the natural "fire regime" — help create and maintain various types of forests. Over the past century, land use and land

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management practices have altered some natural fire regimes but not others.

For example, ponderosa pine forests in many parts of western North America historically experienced cleansing surface fires every 2 to 20 years. As a result of excessive livestock grazing, which eliminated the grass that carried surface fire, logging that removed large, fire-resistant trees, and fire suppression over the past century, the natural fire regime of these forests has been disrupted. In many locations, these forests now contain unnaturally high densities of small-diameter trees, very few large trees and snags, severely suppressed plants, and excessive quantities of well-connected live and dead fuels. The result can be an unnaturally hot, lethal fire when fire inevitably returns.

In lodgepole pine and spruce-fir forests, where fire was naturally infrequent due to climate, fire regimes have not been substantially altered by human activities. Therefore, the historical dynamic of high fuel buildups and a natural fire regime characterized by weather-dominated, lethal fires has not changed significantly. In these types of forest, fires occur only when the weather is right. Dense, compact fuels that only burn under extreme weather conditions ensure a natural fire regime of large, infrequent crown fires.

Fuel treatment can affect fire behavior, but it can't stop wildfires.

There are two reasons why weather is more important than fuel in fire behavior.[1] First, weather is more strongly associated with the mechanisms of fire (for example, wind speed affects both radiative and convective heat transfer rates; fuel moisture, which is a function of weather, affects the heat of combustion). Second, fire weather is much more variable over time than fuel loads are among stands, ensuring that extreme weather is more likely than extreme fuels.

Nevertheless, it only stands to reason that reducing fuel loads through thinning or prescribed fire is likely to change fire behavior under certain conditions. Unfortunately, very little research has been done on how fuel treatments affect or control fire behavior. The few studies that have been done found that fuel treatments can affect wildfire behavior, but the combined results vary widely and again reinforce the paramount importance of weather.

Pollet and Omi[2] evaluated the severity of four wildfires that burned over treated areas in ponderosa pine forests in Oregon, Washington, California, and Arizona. Analyzing treatments that included thinning and burning 1 to 11 years prior to wildfire, the authors found that fire severity was lower in treated stands. However, in all cases, results varied, and treated areas did not control or stop the wildfires from burning through them.

Omi and Martinson[3] continued the previous study and investigated the severity of four recent wildfires that burned into existing fuel treatment areas located in Mississippi, Colorado, New Mexico, and California. Treatments included repeated prescribed fires, single prescribed fires, debris removal, and mechanical thinning both with and without debris removal. All treatments were accomplished less than 10 years prior to wildfire occurrence. The

1 Bessie, W.C. and E.A. Johnson. 1995. The relative importance of fuels and weather on fire behavior in subalpine forests. *Ecology* 76: 747-762.

2 Pollet, J. and P. N. Omi. 2002. Effect of thinning and prescribed burning on wildfire severity in ponderosa pine forests. *International Journal of Wildland Fire* 11: 1-10.

3 Omi, P. N. and E. Martinson. 2002. Effect of fuels treatment on wildfire severity. Final report submitted to the Joint Fire Science Program Governing Board, March 25, 2002.

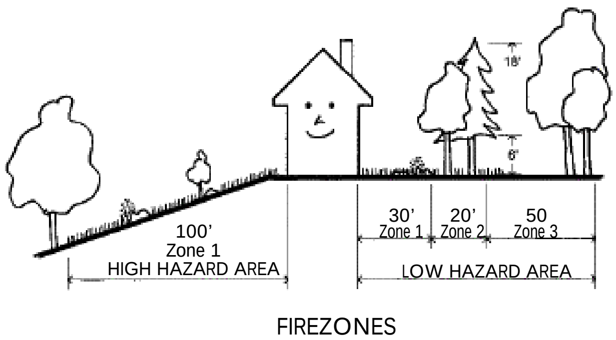
researchers found that treated plots had significantly lower fire severity ratings than untreated plots across all four sites.

Martinson and others[4] found that under extreme environmental conditions (high winds, low humidity, and low fuel moisture) the 2002 Hayman fire, near Denver, Colorado, overwhelmed most fuel treatments in areas burned by the heading fire. One area experienced a timber harvest, two prescribed fires, and one wildfire before the Hayman fire burned through. Toward the end of the fire's big run, it encountered areas that had burned in a wildfire and a prescribed burn within the previous year. In those areas, the recent reduction in surface fuels appeared to moderate fire behavior allowing weather and suppression efforts to slow or halt the fire's progress. Except for these recent fires, Martinson and others found little evidence that fuel treatment affected the behavior of the weather-dominated Hayman fire.

Though fuel treatment appears to have little effect on fire behavior under extreme weather, it can be effective under more moderate conditions. One situation in which fuel treatment may provide great benefit is where once-open forests are now choked with small diameter trees that can carry a fire into the canopy where it will kill large trees. In these cases, thinning can remove the "fuel ladder" and allow low-intensity fire once again to burn safely across the forest floor under moderate weather conditions. In forests where fire is naturally an infrequent event, efforts to reduce fuels by mechanical thinning and/or prescribed burning would produce an unnatural forest structure and could be detrimental to wildlife and watersheds.

FIGURE 1.

This diagram from the Firewise program illustrates the importance of treating fuels within 100 to 200 feet of homes.



Fuel treatment near communities can help save homes.

While fuel treatments cannot stop a wildfire under the extreme weather conditions that typify large fires, they can change fire behavior enough to prevent homes from burning. Research by the Forest Service[5] has shown that, in combination with proper building materials and maintenance, fuel modification within 100 to 200 feet of a home can change wildfire intensity and duration enough to prevent a home from igniting, even under extreme weather (Fig. 1). Under more moderate weather, such treatment can create "defensible space," allowing firefighters a safer place to work.

The Firewise program (www.firewise.org) provides abundant information that can be used to protect homes from wildfire. Protecting the area immediately adjacent to homes must be the highest priority for fire managers. Unless this "Community Protection Zone" (CPZ) is

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4 Martinson, E., Sheppard, W. D., Omi, P. N., and B. M. Collins. 2002. Report 3: Effects of fuel treatments. Pages 62-92 in Report on fire behavior, fuel treatments, and fire suppression, Interim Hayman Fire Case Study Analysis (R. T. Graham, tech ed.). USDA Forest Service, Rocky Mountain Research Station, November 13, 2002.

5 See, for example, Cohen, J. 2000. Preventing disaster: home ignitability in the wildland-urban interface. *Journal of Forestry* 98: 15-21.

treated, thinning for forest restoration outside the CPZ will have no effect on community safety. The CPZ can be extended one quarter to one half mile from communities to facilitate a cooperative approach among landowners.

Different forests, different tools.

The foregoing discussion demonstrates that different fuel management strategies are appropriate in different places, depending on forest type and proximity to homes. As Table 1 shows, near homes the priority must be on treating fuels for structural protection and firefighter safety. Outside the Community Protection Zone, the focus must be on restoring natural, healthy forest conditions. Which conditions are healthy depends on the natural fire regime of the vegetation. Where natural fires can be allowed to burn safely (wildland fire use), they should be encouraged. Where natural fire is unsafe, prescribed fire may be needed. Where fire regimes cannot be restored without modifying fuels, thinning may be necessary.

TABLE 1.

Fuel Management Strategies

		Natural Fire Regime	
		Frequent, low-intensity fire	Infrequent, high-intensity fire
Proximity to homes	Within the CPZ	Intensively manage wildland and manmade fuels to minimize risk to homes. Thinning, burning, landscaping, and proper building materials are all appropriate.	
	Outside the CPZ	Manage wildland fuels to facilitate the restoration of fire as an ecological process. Prescribed fire and wildland fire use are both appropriate. Thin where necessary to accommodate fire.	No treatment necessary. Plan for wildland fire use, where natural fires can be allowed to burn safely.

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