

FIRE BEHAVIOR

How a fire behaves or burns is important to understand. That knowledge helps us control the fire. Fire behavior can change the way a fire effects plants, soil or animals. This fact sheet covers:

- basic aspects of fire behavior
- how fire moves across an area
- managing fire behavior

Fire behavior can be broken down into three parts:

- how hot,
- how fast, and
- how long it burns.

Fire behavior changes with




- different fuels,
- weather, and
- topography or terrain.

Describing Fire Behavior

How hot a fire burns and how fast it moves are important parts of fire behavior. How long it burns in an area, or residence time, is important in effects to plants, soil and animals.

Fire Intensity – How Hot is the Fire?

The size of flames is a good measure of fire intensity. The hotter a fire is burning, the bigger the flames. The more intense a fire is, the more heat it puts out in front of the flames, on all sides and above the flames. Higher intensity fires are harder to control and can but not always have greater impacts to plants, soil and other things. In general, for most landowner, small burns, flames less than 2 feet is a good target for low intensity fires that are easy to control.

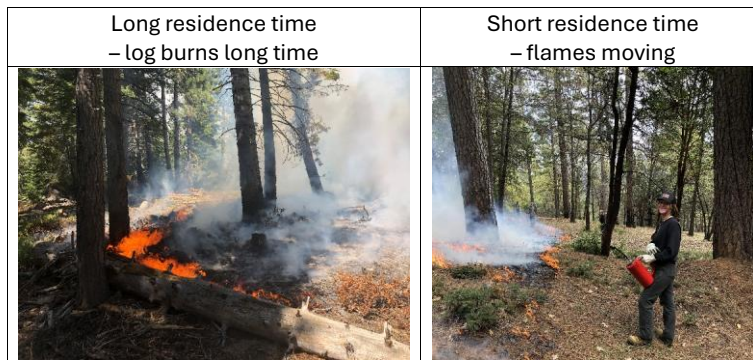
Low intensity – small flames	Moderate intensity	High intensity – big flames
		

Rate of Spread – How Fast is the Fire Moving?

How fast a fire is moving across an area is described as rate of spread. Can you walk faster than the fire? If so, its slow. Is it moving faster than you can? Then the rate of spread is moderate to high. Extreme wildfires move very fast. For most prescribed burns by landowners, a slow rate of spread is the best. It is easy to control.

Residence Time – How Long is the Fire Burning?

The effects of heat on you, plants, animals or soil depends a lot on how long that heat lasts. You can pick up a hot pan quickly and you won't get burned or not badly. But if you hold onto that hot handle for too long, then your skin starts to get too hot and damaged. How long a fire resides in any one spot is one of the most important factors on how it can affect plants, animals or soil. A log burning next to a tree for a long time can damage the trunk and roots, sometimes even killing the tree. The longer a fire burns, the more smoke it can produce. In prescribed burns, water, tools and firing patterns are used to control residence time.







Fire Type

There are four types of fire.

- Surface fire,
- torching or passive crown fire,
- crown fire, and
- smoldering.

Surface fires are on the ground, or surface and are the lowest intensity. Almost all prescribed fires, especially by non-professionals, are low intensity surface fires.

<p>Smoldering or creeping ground fire <i>flames are not visible and fire burns like coals, with glowing combustion.</i></p>	
<p>Surface fire <i>- flames in the understory or on the forest floor.</i> - Ideal prescribed fire</p>	
<p>Torching or passive crown fire <i>- mostly surface fire but one or a group of trees may burn up in the crown.</i> <i>- May occur on larger professional prescribed burns or wildfires.</i></p>	
<p>Crown fire <i>- fire is burning up into the top of trees</i> <i>- also used for chaparral fires burning through the tops of tall shrubs</i></p>	

What Causes Different Fire Behavior

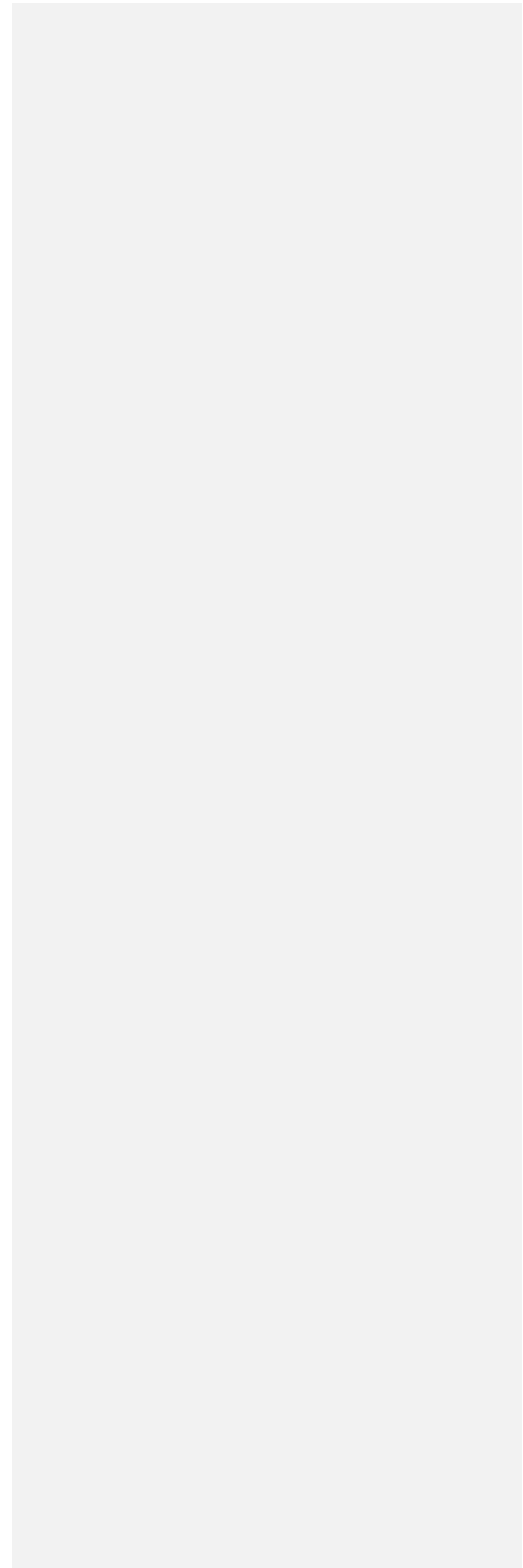
How a fire behaves is largely determined by three factors. Weather, fuels and topography.

Weather

How hot, dry and windy the weather is, directly affects fire behavior.

- The hotter the temperature is, the more intense and faster the fire is.
- More wind increases fire speed and intensity.
- Drier air makes fire burn hotter and faster.

Fuels



Anything that will burn in a fire is fuel. For prescribed burns, all of the fuel is from vegetation, either dead or alive. Homes, boats and other household items are also fuels but are not part of prescribed burns. Campfires are a good way to think about how fuel affects fire behavior. Wet wood does not make good campfires. It may be hard to light. Dry wood lights easily and burns hotter. The bigger the pile of wood, the higher the flames and the hotter it burns.

<i>Dead fuels</i>	<i>Live fuels</i>	<i>Mixed dead and live</i>
		

Types of fuels include:

- Dead fuel includes: leaves, needles, twigs, sticks, branches, logs and any other dead plant parts like blackberry canes.
- Live fuels include grasses, shrubs, vines, or trees. The foliage and branches can all burn.

Drier fuels burn more easily, hotter and faster. If branches sound like potato chips when you walk over them, then they are very dry. They will ignite easily and burn hotter and faster than they would wet.

Topography or Terrain

Topography includes how steep slopes are, which way the slopes are facing, and where on a mountain or landscape a place is. How it burns depends on the topography.



- Fire burns hotter and faster on steeper slopes.

The hottest part of a flame is above the tip. This is where the hot gasses come out. Think of a match or lighter. Can you put your finger closer to the side or top of the flame? The top is hottest. Flames lean with a slope so that they are closer to the ground and the hot gasses heat the fuel ahead of the flames. These pre-heats them and makes them easier to burn.

- South or west aspects burn hotter than on north or east aspects.

The aspect, or direction a slope is facing affects fire behavior. South or west-facing slopes get more sun and are hotter and dry out faster. This makes fuels there easier to ignite and burn faster and hotter.

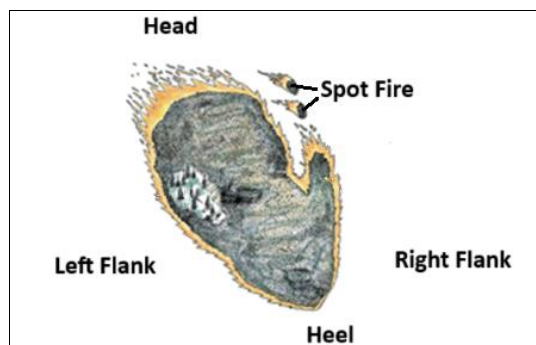
- Ridges: fires on ridges often burn the fastest.

They get more wind and sun and dry out faster.

- Drainages, ravines or canyons: winds funnel and often increase speed. The windier conditions leads to hotter and faster fires. Just like in a river, there can be eddies of wind in drainages. This can cause fires to burn more erratically and switch directions.

Fire Movement and Location

If a spot is ignited, fires will naturally move in a general pattern like a tear drop. The heel of the fire is where it starts and moves from. The head of the fire is where it is heading toward the fastest. This is generally in the direction of the wind or slope. This is the most intense or hottest burning part of the fire. Flanking fire is where it spreads to the sides. This fire burns in between the way head and backing fires do. With prescribed fires, backing and flanking fires are the most commonly used because the heat and spread is most easily controlled.



Commented [JF1]: would leave out the pocket, finger and island on the diagram. Those are more advanced and detract from the main parts

Head Fire – moving forward with the direction of the wind or upslope	Backing fire – moving back down a hill or against the direction of the wind	Flanking Fire – fire spreading from the sides
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Managing Fire Behavior

Planned, controlled fires happen when we manage fire behavior. Fires are managed by

- choosing what weather conditions to burn in or
- how fuels are pre-treated or
- how the fire is ignited and spread

Prescribed burning is an art as much as a science. It all comes down to watching what the fire is doing and adjusting as needed to keep the flame size and fire speed the way you want. Managing the heat and spread of the fire.

Weather Prescriptions

Burn “prescriptions” are weather conditions within which fire behavior will be readily controllable and get the desired effects. Examples might be: temperatures between 40-80 degrees, relative humidity between 20-50%, and eye-level winds less than 8 miles per hour. In areas prepared for burning, this will usually result in flames averaging 2 feet or less.

Choosing to burn when the weather is cooler, less windy, and more humid will make the fire slower and less intense. If the fuels are damp from recent rain or snow, it may burn best in warmer, drier or breezy conditions.

Pre-Treating Fuels

Having fuels that are at a level and arrangement that keeps fire on the surface is very important in managing fire. It is what we can manage the most. Removing ladder fuels, small trees, lower branches or shrubs that can carry fire from the surface into tree crowns is critical. Piling and burning or removing large fuel accumulations, such as logs, can keep fire intensity low and prevent long residence time that is more likely to damage trees.

Fire Ignition Patterns

Lighting a fire at the top of the hill and letting it back slowly down results in low intensity, slow moving fires. Lighting strips, one at a time from the top to the bottom can produce hotter and faster moving fires. That is because there is a mix of head and backing fire.

Backing fire	Strip firing – combination of short bursts of head fire and steady backing fire	Dot pattern - combination of mostly flanking with a little head and backing fire
		

Backing fire	Strip firing – combination of short bursts of head fire and steady backing fire	Dot pattern - combination of mostly flanking with a little head and backing fire
You can use the one I just sent backing down below the house	Can you find one of our strip fires	Can you find one of our spot fires

In general, the slower a fire moves, the more fuel that is consumed. Since backing fires are usually the slowest, they often consume the most fuel. But if the fuels are dry, then head fires can consume a lot.