Prescribed Fire:
The Fuels Component

► **In this second of a four-part series, you will learn the importance of the fuel component in prescribed fire.**

A common science experiment in grade school is to light a candle, place a glass jar over the candle, and watch the flame go out as the oxygen is consumed. This demonstrates the fire triangle of heat, oxygen, and fuel (figure 1). A prescribed fire is a working example of the principles of the fire triangle.

In conducting a prescribed fire, you are either working to move a fire across the land or working to extinguish a fire. In either case, good fire lines are critical for containing the fire within a specific area (figure 2). Fire lines remove the fuel side of the fire triangle. Without the fuel, there is no heat and the fire goes out.

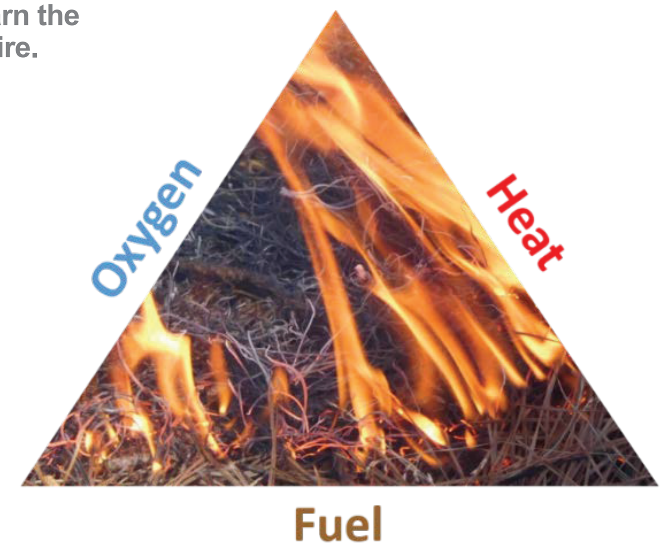

Figure 1. The three components needed for a fire to occur are oxygen, heat, and fuel. These make up what is called the *fire triangle*. Remove one of the sides from this triangle and a fire cannot occur or will be extinguished.

Fuel Components

The way a fire burns depends on a number of characteristics of the fuel. An often forgotten component is the predominant species of the fuel. Not all grasses burn the same; neither do all hardwood leaves or even pine needles.

For example, leaves in an upland hardwood stand tend to curl on the ground and retain moisture (figure 3). This can make it difficult to sustain a fire. Most fires of this fuel type are low intensity and slow to spread (figure 4).

In a mature pine plantation, the pine needle layer is matted and mostly flat, with the exception of the top layer (figure 5). Due to rosin in pine needles, the needles will ignite with little heat and carry fires of greater intensity (figure 6).

Fuel Type

There are three types of fuels: ground, surface, and aerial. Ground fuels are flammable material found below the surface litter (tree roots, duff, peat). Surface fuels are those found on the forest floor (leaves, needles, cones, barks, twigs). Aerial fuels are those located in the understory and forest canopy and separated from the ground by more than 4 feet (dead branches, draped needles, snags [standing dead trees]).

Fuel Volume

The volume of fuel in the area affects the behavior of the fire and the amount of smoke it produces. Large volumes of fuel pose a significant risk for creating a fire that is difficult to control. More heat and greater fire intensity are produced when there is more fuel to burn.

Figure 2. A good fire line is needed to conduct a prescribed fire (right side of photo). The width of the fire line can be as narrow as a plowed line or as wide as several feet.

Figure 3. An example of loosely compacted fuels. The dried hardwood leaves often curl up or have rough margins that create a good amount of air space between the leaves..

Figure 4. Loosely compacted fuels can make it difficult to achieve effective fire movement. These fires may move slower unless a strong wind is pushing the flames.

Figure 5. An example of matted or compacted fuels. The pine needles mat down among each other, forming a more compact layer of fuel than with hardwood leaves or a layer of pine needles mixed with hardwood leaves.

Figure 6. Pine needles ignite rapidly and carry fire more readily due to rosin in pine needles.

Fuel Arrangement

Flammability is affected by oxygen availability among the fuels in the burn area. Compacted fuels have less available oxygen and wind dispersion among the fuel; thus, it takes longer for the fuel to dry out and successfully burn.

Fuels loosely arranged ignite faster and burn more intensely. Vines, brush, limbs, and foliage that are growing up trees or are suspended are a part of the fuel arrangement (figures 7a and 7b). These “fuel ladders” are off-the-ground fuels that can carry fire from the forest floor into the canopy.

Fuel Shape

Common fuel shapes include needles, leaves, limbs, logs, palmetto fronds, and peat. The shape of fuel affects the flammability and behavior of fire. Fuels that are flat, such as leaves and needles, have high surface-to-volume ratios. They can dry out faster than fuels with low surface-to-volume ratios, such as logs, because they have more surface area for heat to enter. Ignitability is therefore greater in flatter fuels, because less heat is needed to dry out the area. Flatter fuels also burn more rapidly, creating a more intense fire.

Fuel Size

The size of the fuel affects fuel moisture and the rate at which fuel dries. Smaller fuels ignite more freely than larger fuels. As with the shape of fuel, the time needed to heat fuel is dependent on the surface area in relation to the fuel’s volume. Smaller fuels have a greater surface area-to-volume ratio than larger fuels. As a result, they have a greater probability of ignition.

Fuels are broken up into four size categories:1-hour fuels are 0 to ¼ inches in diameter (figure 8a); 10-hour fuels are ¼ to 1 inch (figure 8b); 100-hour fuels are 1 to 3 inches (figure 8c); and 1,000-hour fuels are 3 to 8 inches in diameter (figure 8d).

Smaller fuels dry out faster than larger fuels. Grasses, leaves, needles, and small twigs are examples of 1-hour fuels. Larger fuels, such as tree limbs or fallen logs, are classified as 100-hour to 1,000-hour fuels.

Figure 7a. This illustrates a potential fuel ladder, where vines are growing up trees and into the forest canopy.

Figure 7b. This illustrates draped fuels, where pine needles are draped on limbs and shrubs. They can readily ignite and carry fire into the treetops.

Fuel Moisture Content

The amount of moisture in fuel can range from saturated (the maximum water-holding capacity) to being completely dry (often referred to as oven-dry). Depending on the amount of moisture in the fuel, the area could burn completely, partially, or not at all. Each of these circumstances affects fire behavior differently.

Air temperature that affects relative humidity and the ability for fuel to dry determines fuel moisture content. The higher the temperature, the faster the fuel dries. However, specific fuel moisture content, regardless of the rate of drying, also depends on the arrangement, shape, size, and shading of the fuel.

The moisture content of fine fuel is typically of most importance across the South, as this is the fuel that

Figure 8. Examples of different fuel sizes that may be encountered when using prescribed fire in a southern forest: 1-hour fuels (A); 10-hour fuels (B); 100-hour fuels (C); and 1,000-hour fuels (D).

carries the fire during a prescribed burn. In the South, fine fuel moisture content, ranging from 6 to 10 percent, is effective for a prescribed burn. A fine fuel moisture content of 5 percent or less may become too intense and difficult to control; greater than 10 percent will likely be too moist to carry fire well.

A good indication that dead leaves or pine needles will burn is if the leaves crunch into small pieces or the pine needles break when you pick up a handful and twist them. The drier and deeper the fuel load, the more intense the burn will be.

Summary

A number of factors play a role in the ignition of a prescribed fire and how well it may carry. This makes the fuels component of a prescribed fire the most difficult issue to deal with.

It is critical to know your fuels, the number of days since a rain event, the duration and amount of rain of the event, and the relative humidity and wind. Anyone conducting a prescribed fire should be aware of these factors prior to conducting a prescribed burn.

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