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Prescribed Fire: Weather

► In this third installment of a four-part series, you will learn how weather influences prescribed fire behavior.

When planning a prescribed fire, you have many things to consider. Fuel type, fuel load, and topography are usually static and straightforward to assess. Weather, however, is always changing and can take practice and thought to evaluate when planning for a prescribed fire. To be an effective prescribed fire manager, you should become familiar with weather patterns in your area and how weather can change for a site in different seasons and even at different times of the day.

Often people are unsure about the difference between **climate** and **weather**.

Climate is the long-term normal weather for a location over a specified interval of time. Climate data are used to assist with forest management decision-making: planting, fire, use of chemicals, and harvesting.

Weather is the current or recent state of the atmosphere and is used to produce climate data.

One way to remember the difference: **Climate** determines how many jackets you own. **Weather** determines if you should wear one today or not.

Basic elements of weather that influence prescribed fire include (1) temperature, (2) relative humidity, (3) precipitation, (4) atmospheric stability, and (5) wind. In this document, we will discuss how these weather factors influence the moisture content of fuels, smoke management, and fire behavior.

Temperature

Air temperatures in Alabama range from an average low near 36 degrees F in January to a high of about 93 degrees F in July. Temperatures are typically lower in the morning, increase during the day, and then decrease again in the evening. Prescribed fires heat the air around trees and vegetation increasing the ambient air temperature. In general, overstory plants can be scorched or killed when exposed to temperatures of around 140 degrees F, even for a short period. Remember that the higher the air temperature the less heat from fire it will take to affect vegetation on a site.

Temperature can also affect fuels and fuel moisture. In winter months when temperatures drop below freezing, moisture in and on fuels will freeze. More heat is needed to change ice to liquid water and then to steam. This will make your fire move more slowly, and fire intensity will be lower. You may also find that some areas do not burn well in these conditions. High temperatures dry out fuels making for hotter and potentially faster moving fires.

You should know the topography of the site because it can have microclimate effects on temperature. Microclimate is the atmospheric condition of a localized area that is different from the surrounding area. For example, you can expect a 3.3-degree F temperature decrease for every 1,000-foot increase in elevation. Slope aspect, or the direction a slope faces, also affects

measured air temperature. East-facing slopes are warmer in the morning and cooler in the afternoon. The opposite is true for west-facing slopes. North-facing slopes stay relatively cool compared to south-facing slopes.

To manage understory vegetation on a site without damaging more heat-sensitive, mature overstory trees consider conducting your burn on a day when the air temperature is less than 60 degrees F. This increases the likelihood that the combined effect of the air temperature and prescribed fire will not raise the ambient temperature to a level that could stunt or kill the overstory. A growing season burn when air temperatures are warmer—around 70 to 80 degrees F—often provides better control of understory vegetation, but fire tolerance of overstory species must be considered.

Relative Humidity

Because of our proximity to the Gulf of Mexico, we in Alabama usually experience mild and humid winters and relatively consistent but very warm and very humid summers. So we are familiar with humidity! In general, humidity levels are higher in the morning. Humidity decreases during the day and then increases again in the evening. These changes can influence fire behavior and should be considered as part of the planning process. Relative humidity is the amount of moisture in the air, *relative* to temperature and atmospheric pressure. Levels of humidity in the air are measured by the dew point.

Dew point is how cool the air temperature must be for the air to be saturated. When the dew point is high, there is more water vapor in the air. If the temperature and the dew point are the same, or close to the same, then there will be fog or heavy dew. Dew points change most dramatically when a cold front passes through an area. The temperature and dew point that follow will both be lower leaving cooler, drier air behind.

Relative humidity affects fine fuel moisture levels. Fine fuels dry quickly in periods of lower relative humidity. Elevated fuels (needles, leaves, and branches) that are not in contact with saturated ground will also dry more quickly with lower humidity. In periods of higher humidity, fuels will not burn as well. Fires will be less intense, and the result could be a patchy burn. Unburned areas that remain can be difficult to burn later because connecting fuels are consumed, leaving “islands” of vegetation that will continue to grow and impede future management and burns.

Micro-climate conditions influence relative humidity on a site as well. Humidity levels are usually higher under a dense tree canopy because of lower temperatures and increased fuel moisture. This can cause unpredictable fire behavior if humidity is lower above the tree canopy. In general, it is best to burn when relative humidity ranges from 30 to 55 percent. Lower humidity levels can lead to dangerous burning conditions. With higher humidity levels, forest stands are less likely to burn well.

Precipitation

Depending on the time of year, precipitation may be in the form of rain, snow, sleet, hail, or freezing rain. Precipitation increases moisture levels in the soil and fuels. The amount and timing of precipitation before a prescribed fire and size of fuels also influence fire effects.

Rains that are heavy but short in duration will not saturate soils like a rain event that produces the same amount of rain but persists over several hours. Fuels are also affected by precipitation. Smaller fuels will become saturated very quickly, while larger fuels can take hours to become saturated. Fuels in open areas, such as a clear-cut, will become saturated more quickly than similar fuels under a tree canopy. For more information on fuel moisture, see “Prescribed Fire: The Fuels Component,” FOR-2064.

Depending on objectives, it is generally recommended that the fine fuel moisture levels be between 8 percent and 15 percent. Levels less than 7 percent can cause damage to overstory plants and make spot fires more likely. Moisture levels greater than 15 percent can cause burns to be patchy and ineffective. High levels of moisture also cause fuels to produce large amounts of white smoke when burned, which reduces visibility. Long-term drought conditions influence prescribed fire effects too. Check forecast information from the National Weather Service or state forestry commissions for short- and long-term forecast information to help you with prescribed fire decision making.

Atmospheric Stability

Understanding atmospheric stability is key to prescribed fire smoke management. If the air is stable, it resists upward movement. Think about an early morning fog. Cold air at ground level produces a stable atmosphere keeping ground moisture from rising and producing a lingering fog. This forms an inversion layer – where temperature increases with height keeping clouds or fog from rising. The distance from the ground to this inversion is called *mixing height*. As the sun rises, it heats the ground and an unstable atmosphere is created. As this happens, the inversion layer breaks apart and the fog is dispersed. Mixing height increases throughout the afternoon but can quickly decrease after sundown.

A stable atmosphere, such as the one described above, usually means poor burning conditions and limited smoke dispersion. In an unstable atmosphere, smoke rises rapidly and makes a well-defined column. This rising air causes more air to be pulled through the burning area more rapidly and increases fire intensity. While this is beneficial, it can also cause unpredictable fire behavior and spot fires.

Visual measures of atmospheric stability:

- Stable air.
- Unstable air.
- Thick layers of heavy clouds (stratus clouds).
- Puffy clouds high in the sky (cumulus clouds). May have a flat base
- Smoke columns drift apart, do not rise.
- Smoke columns rise and stay together.
- Poor visibility, smoke, haze.
- Good visibility.
- Fog.
- Fire whirls and dust devils.
- Steady winds.
- Gusty winds.

The atmospheric dispersion index (ADI) is included as part of fire weather reports. Low ADI values indicate poor dispersion. The best ADI range for daytime burning is between 40 and 60. Values higher than 60 can mean good dispersion is expected, but safety is a concern as fire behavior can be very unpredictable.

Wind

Winds influence fire direction and rate of spread. It also helps disperse heat from fires helping to reduce crown scorch. Wind also influences smoke direction and dispersal. When looking at wind directions provided in weather forecasts, remember that it is the direction that the wind is coming **from** that is reported. There are generally two types of winds prescribed burners monitor— transport winds and surface winds.

Transport winds are important for smoke management. They are the average wind speed and direction from the ground to mixing height. Surface winds are measured 20 feet above the average height of any obstruction. In prescribed fire management, stand conditions, such as understory composition, tree density, and height of tree canopy, influence surface winds at the stand level.

In general, in-stand winds (measured at eye level) of approximately 1 to 3 miles per hour work well in most situations. But topographic factors, sea breezes, thunderstorms, and frontal systems all influence wind speed and direction. Monitor stands regularly before the day of burn to become familiar with wind behavior.

Conclusion

We have reviewed how the weather elements of (1) temperature, (2) relative humidity, (3) precipitation (4) atmospheric stability, and (5) wind influence moisture content of fuels, smoke management, and fire behavior. You should become familiar with and understand weather patterns associated with areas you wish to manage with prescribed fire. The Alabama Forestry Commission provides daily fire weather forecasts and other helpful planning information available at http://www.forestry.alabama.gov/Pages/Fire/BurnManager.aspx.

Land managers should also be mindful of micro-climate conditions on the day of the burn. Check local weather forecasts regularly, but remember that actual site conditions may vary. Handheld weather devices can be useful when monitoring in-stand wind speed, humidity, and temperature as part of prescribed fire planning and day-of-burn conditions.

As with any land management activity, consult a professional to assist with prescribed burning activities. Alabama state law requires that a prescribed burn be supervised by a certified prescribed burn manager and "conducted pursuant to state law and rule applicable to prescribed burning" to have liability protection.

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