

Wildfire Behavior and Emergency Response

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When dry conditions and high winds follow periods of rain that grow dense grass, wildfires can ignite easily and spread rapidly. Under such conditions, fires can carry for long distances, cause extensive property damage and even result in loss of life. Periodic fires were common before European settlement. But the frequency of large wildfires (greater than 1000 acres) became very rare through most of the 1900s as a result of extensive suppression.¹ Researchers found that these suppression efforts resulted in greater fuel density and continuity leading to large fires that increased the total acres burned by a factor of 3.5 to 4 between 1985 and 2014. Given the likelihood of wildfires throughout Texas, landowners need to be aware of the threats they pose. When wildfire occurs, preparation and timely action can determine how well you and your property fare. Primary considerations include: 1) safeguarding against wildfire, particularly structures; 2) factors affecting fire behavior; and 3) emergency actions to take when a fire front approaches. The following covers wildfire behavior and emergency responses to wildfire that can help protect your property and help you stay safe when wildfire occurs. A companion publication “Safeguarding Against Wildfire” provides guidelines to help you safeguard your property from wildfire and stay safe when they occur. It can be downloaded free from the Texas A&M AgriLife Extension Bookstore.

Factors affecting fire behavior

Wildfire dangers include hot gases, smoke, and flames. As the size and intensity of a fire increase, so do each of these. Wind speed, temperature, and relative humidity all affect fire intensity and rate of spread. Higher winds can increase the rate of spread, along the ground and through windblown embers that start fires in front of the head fire.



Figure 1. Wildfire dangers include hot gases, smoke, and flames. Most people are aware of the danger presented by flames, but often discount heated gases and smoke even though these can be just as deadly.

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Figure 2. Fire intensity and rate of spread are determined by the amount, continuity, structure, and type of fuel available.

Fuels have to reach the heat of combustion before they ignite. Higher ambient temperatures enable fuels to reach the heat of combustion more quickly. Temperature also contributes to fire intensity by reducing relative humidity. The higher the relative humidity, the slower a fuel will heat—moisture must be driven off before combustion temperature is reached. Generally, for every 20°F rise in temperature, relative humidity is decreased by half. As the relative humidity drops, fire intensity and rate of spread increase.

Fire intensity and rate of spread are determined by the amount, continuity, structure, and type of fuel available. Anything with a pungent odor (cedar, sage, etc.) is usually rich in volatile oils that will make hotter fires, with embers that can be wind-driven. Fuels with taller structure cause longer flame lengths. Fires moving along the ground need continuous fuels, and if the continuous fuels (like grass) are taller, the fire will spread more rapidly. Decreasing the amount, height, or continuity of the fuels will decrease fire intensity and rate of spread.

If a fire is spreading along flat ground only by combustion of the material within reach of the flames, the rate of spread (even downwind) may be relatively slow. However, even that is too fast to outrun for long, especially in rough terrain and when conditions can change rapidly. A fire carried by blown embers can spread faster than the speed

of the wind. This is because the rate of spread along the ground is added to the speed at which the wind-borne embers can be carried out in front of the fire. A helicopter pilot dropping retardant on the fires near Canadian, Texas, in 2017, clocked the head fire at more than 70 miles per hour. In a situation like that, you could have fire starting in front of you and catching up to you rapidly from behind at the same time.

With wildfire, it is important to plan ahead. Because radiant energy from the flame front pre-heats fuels ahead, fire will travel much faster up a hill than on flat ground or downhill. It will go even faster up a draw, gully, canyon, etc., because heat is confined and concentrated by their sides. Before the fire comes close, identify escape routes and safe zones where you could take shelter if a fire came roaring through the area. In the case of your home, working facilities, and other infrastructure, it is best to identify and develop these safe zones and escape



Figure 3. Before the fire comes close, identify escape routes and safe zones where you could take shelter.

routes well in advance to ensure that damages are minimized. Safe zones include rivers, lakes, or large, level, open spots away from combustible material like grass, trees, shrubs, etc. Heat rises, so the safest zones are those that are downhill of the fire or on areas that have already burned with no residual fuel left to reignite (referred to as “the black”). Keep in mind, however, that the ambient temperature of the scorched earth, rocks and ash in the black will feel like an oven if it has freshly burned. Burned-over areas that still have fuel remaining are not safe. These fuels may be drier and burn hotter and more easily.

Strategies for dealing with an approaching fire front

Be sure to keep abreast of conditions through the news media, police scanners, and with people you know via telephone. If wildfire is likely—for example, when “red flag” warnings are frequent—it is a good idea to have heirlooms, pictures, family records, etc., in a bug-out-bag so you can get them quickly and escape if a wildfire approaches or evacuation is ordered. If there is room in your bag, you may want to include bottled water, toiletries, snacks, and a change of clothes. Wind-driven rangeland fires in high densities of fine fuels are often the most dangerous type due to rapidly changing fire intensity, direction of spread, etc. Therefore, being aware of your situation at all times is crucial.

Just because you see a column of smoke and feel safe because you know which way the wind is blowing where you are, doesn’t mean the wind won’t be coming from a different direction soon. Intense fires often make their own wind because of the updraft from the flames. And that wind may be driving the smoke column along the ground for some distance before it rises—the fire may actually be much closer than the smoke column. Think of the high winds that suddenly come up and change direction around a convection shower in the summer. When a wildfire occurs, the only safe places to be are far upwind or in the black, in that order.

Leaving the vicinity of the fire long before it arrives is always your best option. No one can out-

run a fire under extreme conditions—initiate escape plans well before the fire approaches. If fire fighters, law enforcement officers, or neighbors tell you evacuation is necessary, leave immediately. The rapidly changing conditions associated with wildfires may quickly cut off logical escape routes, resulting in tragedy. Choose downhill routes if possible. Remember, fire travels much faster up a hill than on flat ground or downhill, due to preheating of fuels by the fire front.

Be sure to communicate your intentions and escape routes with loved ones and others who may be worried about you. Be sure you know their location, intentions, and routes, also. Clearly communicate where you will meet. Clear communications help ensure that everyone knows they should leave, that nobody is left behind, or mistakenly continues looking for someone. Don’t try to save property. Property, including buildings, livestock or vehicles, is replaceable; lives are not.



Figure 4. Wind-driven rangeland fires in high densities of fine fuels are often the most dangerous type of fire.

When wildfire is possible, remember the following:

- Plan ahead to help you to keep calm, think clearly, and act decisively and correctly in the face of rapidly changing conditions.
- Use news coverage, scanners, telephone, and mass alerts to stay informed regarding fire front locations, weather conditions and forecasts, and rate of fire spread to plan well in advance based on current and potential fire behavior.
- Prepare for escape that may be required on short notice.
- Follow instructions of professional fire-fighting personnel quickly and accurately.
- Identify escape routes and safety zones, and make them known to others well before the fire approaches.
- Give clear instructions and ensure they are understood, particularly regarding evacuation procedures, routes, and rallying points.

Be ready for the unexpected

Many wildfire emergencies are indirectly related. These can include equipment failure, changing conditions, and panic. Common emergencies include vehicle engines dying, a flat tire, getting stuck in a ditch, gulley, or deep cow trail, or getting disoriented in the smoke. These situations, in the face of oncoming fire can cause people to panic and make poor decisions.

If you find yourself in the path of an oncoming fire, the three things you must protect against are hot gases, smoke, and the radiant heat from flames. If possible, find a nearby safe zone. This could be a large bare or rocky area, especially with a tall, nonflammable barrier like a road cut on the side toward the fire front to protect you from the fire's radiant heat. If these are not available, even a low spot such as a ditch with an embankment on the side of the oncoming fire is better than being in the open. Stay low and protect yourself from the heat and hot gases by covering yourself with fire resistant materials like wool or cotton clothing or even soil and mud. In addition, protect yourself from the smoke and hot gases by using natural-fiber clothing or a bandana as a make-

shift respirator. If your clothes catch fire, remember to Stop, Drop, and Roll to smother the flames.

If you are in a vehicle and looking for a safe zone, visibility is likely to be low because of smoke—keep the lights on and use your horn frequently in case other vehicles are nearby. If you are on an established road, it would likely be better to stay in the vehicle on the side of the road away from the oncoming fire and allow it to pass.

Little research exists regarding what to do in a vehicle when overtaken by a flame front, however, in this situation we do know that radiant heat is the most dangerous aspect. We all know how fast the interior of a vehicle can heat up on a sunny day. Idaho Fire Wise provides the following suggestions regarding wildfire safety if overtaken in a vehicle.²

- Stay in the vehicle in the safest place you can find.
- Stay below the level of the windows and leave the lights on.
- Close all windows and doors, shut off the air vents, and turn off the air conditioner to keep smoke out of the vehicle.
- Cover yourself with natural-fiber clothing to insulate yourself from the heat and provide some protection from the smoke. Wool is the most fire-resistant common material. One hundred percent cotton is also fire resistant (but neither are fire-proof).

Try to remain calm—the passing of the fire front is likely to be noisy, hot, and accompanied by heavy wind. Wait until it has passed, and the temperature has dropped before going into the black as a safe zone and call for assistance. Below are some additional situations that may present increased danger and may increase the need for emergency procedures described previously.

Some wildfire situations are particularly dangerous. If you find yourself in any of the following circumstances, watch out, be alert, and be safe.

- Unfamiliar territory without full knowledge of the location of fire safe zones or transportation routes, especially at night
- Unfamiliar with weather and local factors that may influence fire behavior
- No communication with others in the area

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- Ahead, downwind, or uphill of the fire
 - Unburned fuel between you and the fire
 - On a hillside, where rolling material can ignite below
 - Weather getting hotter and drier
 - Wind increases and/or changes direction or relative humidity dropping
 - Terrain and fuels make escape to safety zones difficult

The key to safety in any wildfire event is to plan ahead, be aware of your situation, and not panic.

Works cited

- 1 Donovan, V.M., C.L. Wonkka, and D. Twidwell. 2017. Surging wildfire activity in a grassland biome. *Geophysical Research Letters*. 44: 5986-5993. Doi: 10.1002/2107GL072901.
- 2 Idaho Firewise. N.D. Evacuation If You Get Trapped. <http://idahofirewise.org/evacuation/if-you-get-trapped/> Accessed Nov 20, 2017.

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