GOOD OAK ecological services'

Beginner's Guide to Prescribed Burns

By Frank Hassler

Introduction:

Fire is essential to maintain the health of prairies, woodlands and wetlands in America. Historically in the midwest most fires were ignited by Native Americas, with some occasionally lit by lightning. Fire not only invigorates native plants which have been happily co-existing with fire for thousands of years, but it also damages or kills many weeds and invasive species. Many aggressive woody species are weakened by fire, especially if these burns are repeated several years in a row.

Prescribed burns can be safe and fun, but extreme care must be taken to ensure safety. Each member of the burn crew must wear clothing that is safe around and in open flames. Fuel and weather conditions must be carefully monitored in order to better understand how the fire will behave. The perimeter of the burn unit should be well defined with a fire break and hazards should be removed from the burn area, or closely observed. Then, based on conditions on the ground that day, the fire can be planned and executed in a safe and responsible manner.

Essential Personal Gear:

1) sturdy boots
2) sturdy gloves
3) hat or hard-hat
4) protective eyewear
5) bandana or face mask
6) long pants and sleeves
7) dress in layers
8) drinking water & snack

Clothing:

It is essential that you wear natural fibers (cotton, wool, leather, etc.), and fire resistant clothes are recommended. Footwear should be sturdy boots made of leather; tennis shoes will melt and burn. **Steel-toed boots are not recommended** since the metal can transfer heat from the fire to the foot and cause burns. Dressing in layers is important because you will need to adjust to many different temperatures as the fire heats up and cools down. Even if the weather is warm you should always wear long pants and long sleeve shirts. **Sturdy cotton or (preferably) leather gloves are necessary** to protect your hands from injury and heat. Wearing **a hat or hard-hat is essential to protect your head** from falling ashes. Hats with brims provide shielding to your face from extreme radiant heat. Remember to **tie back and cover long hair.** You should have a bandana or face mask available to cover your mouth to help reduce smoke inhalation. All of these precautions must be taken even if you will be wearing a Nomex suit or other fire resistant fabrics.

Safe Fabrics:	Unsafe Fabrics:
-Nomex	- polyester
- cotton	- nylon
- wool	- polypropylene
- leather	- Capoline
- natural rubber	- plastic
	- Gore-Tex

Synthetic fibers (polyester, nylon, polypropylene, plastic, etc.) should NEVER be worn on a fire line as they can melt in the occasional intense heat of a wildland fire. In case of an accident, synthetic fibers can actually melt onto your skin, greatly increasing the severity of a burn. **Avoid wearing ripped or frayed clothing** such as an old pair of jeans. These frayed pieces of fabric are more likely to catch fire or smolder.

Weather Conditions:

Wind serves two purposes: it moves the fire in a specific direction and provides the fire with oxygen. Low speed, steady winds are preferred since they drive the fire in a predictable direction at a steady pace. **Ideally wind speeds should be between 3 and 12 mph**, or slightly higher for woodland burns. On some sites burns can only be conducted when the wind is out of certain directions due to nearby hazards such as roadways and residential areas.

Understanding **temperature** and **relative humidity** is critical to understanding fire behavior. **The higher the temperature the more intensely a fire will burn** since the fuel is already closer to its ignition temperature, though this effect is slight. **Higher relative humidities will dampen fire behavior.** The amount of moisture in light fuels such as grasses and leaves is closely tied to the moisture in the air. Moist fuel burns less readily since the fire has to heat up and evaporate the water away before it can burn the fuel. Assuming the dew point remains the same, as the temperature increases during the day, the relative humidity decreases, and the amount of moisture in light fuels decreases in lock step. Thus the warming of the air on a typical afternoon compounds the effects of temperature and humidity, resulting in a much more excited fire behavior. The lowest humidity is typically between 2-5pm.

Humidity is the single most important weather condition for determining fire behavior but it can be deceptive since it is not readily sensed by people like wind and temperature. Here in the midwest we are usually looking for the lowest humidity possible when conducting a burn in order to provide active fire conditions for an effective fire. However very low humidity can cause a fire to be volatile and difficult to control. **An appropriate relative humidity for a burn is between 20% and 60%.**

In the same way we feel warmth in sunlight, **Sunny conditions can increase the intensity of a fire slightly compared to shady conditions** by warming the surface of the fuel in advance of the fire. Sunny conditions will also dry fuel more quickly than fuel in shade.

Site Conditions:

Site conditions can generally be divided into **topography** and **fuel type**. The terrain must be considered when planning a burn. Since heat rises **fire will tend to burn quickly as it travels uphill** and slowly downhill. South slopes often burn more intensely than north slopes since they receive more direct sunlight and are often dryer.

Fuel type: Here in the midwest we are generally burning prairie grasses and forbs or the leaves of oaks and other trees. These are all considered **light fuels,** meaning that **they will ignite quickly and burn intensely** and then extinguish and cool down just as quickly. That said, not all of these light fuels burn equally. **Prairie grasses burn the most intensely. Prairie forbs and oak leaves burn less vigorously, exotic species typically burn poorly, and exotic cool-season grasses (pasture and lawn grasses) typically burn poorest** because their vegetation is often green when the burn is being conducted.

Though less flammable than light fuels, woody plants and debris are sometimes ignited during prescribed burns. Often it is best to allow shrubs and smaller pieces of wood to burn, but **larger logs and snags can smolder and burn for days, and therefore must be extinguished before the fire crew leaves the site.** Often this requires that the burn crew prevents them from catching fire in the first place (see “Preparation” below).

Fuel moisture: Obviously if fuels are drier they will burn more readily. Some fuels such as matted leaves dry more slowly than looser, more upright fuels such as prairie grasses. Heavier fuels, such as wood, dry and moisten more slowly than any of the light fuels we typically burn.

Each of the above factors, wind, temperature, relative humidity, sunlight, topography, fuel type and fuel moisture effect the behavior of the fire. The goal is to find

Intense Burning:	Moderate Conditions:	Poor Burn Conditions:
- strong winds	- moderate humidity	- weak winds
- high temperatures	- moderate temperatures	- low temperatures
- low humidity	- shade	- high humidity
- sunlight	- flat terrain	- fire traveling downhill
- fire traveling uphill	- herbaceous plants	- weeds
- prairie grasses	- oak leaves	- maple leaves
- dry fuel		- woody material
		- cool season grasses
		- moist fuel

a set of conditions where a fire will be vigorous enough to ignite and spread but no so vigorous that it will be too intense, unpredictable and hard to control. Sometimes the burn boss must make the unpopular decision to postpone a burn until conditions will be safer. As a beginner at prescribed burning you are not expected to predict fire behavior, but for your safety it is important for you to understand how the above factors will affect the intensity of the fire while the burn is being conducted.

Tools:

There are several types of tools specific to prescribed burning. A drip torch is a special canister filled with a mixture of 3 parts diesel fuel to 1 part gasoline. You simply ignite the wick at the end of the metal shaft (the shaft is coiled so flames cannot flashback into the canister) let it 'warm up' for a few seconds and then travel along dripping fire as you go. Care must be used when handling this tool as it is easy to accidentally drip flames off the torch as you walk. Always extinguish the wick when the drip torch is not in use.

Prescribed Burn Equipment

- drip torch
- flapper
- backapack sprayer
- rake

A **flapper** is essentially a truck mud flap attached to the end of a mop handle. Flappers are our primary fire fighting tool and they are used to put a fire out by stamping or padding the fire out with the flap, thus cutting off the fire's oxygen supply. They work well for back fires and flank fires but are not effective against head fires where large amounts of water is needed. Do not leave the flap of the flapper in the fire for long since it can melt. Also, do not lean on the flapper for support as the head of the tool is prone to bending.

The **backpack sprayer** is more typical of what one thinks of as a fire fighting tool. It is a metal canister carried on the back that can hold up to five gallons of water. Water is sprayed via a simple pump action on the brass hand pump. There are typically two tips to the nozzle; the single hole produces a steady stream and is only used when the fire is at a distance. The nozzle with two holes produces a wide spray of water and is more useful for suppressing fire at a close range. Water in the backpack sprayer should be filled to about one inch above the baffle in the middle of the tank. The lid of the tank is not "air tight" so be careful not to lean over too much while wearing it or you will end up with a cold, wet back. Always keep track of how much water is in the backpack sprayer you are using so you don't find yourself out of water when you need it.

Rakes are perhaps the most useful burn tools. They can be used to clear and manage fuel as any rake is used. They can be used to 'rub' the fire out. By collecting and igniting fuel they can also be used to 'drag' the fire in the absence of a drip torch. Some people use leaf rakes as fire rakes, but we prefer garden rakes. In either case, the rake blades must be made out of metal and the handle must be made out of metal or wood since plastic components will melt.

A variety of **power tools** may be used to conduct burns as well. Weed whips and mowers are used to cut fire breaks. Chainsaws can help cut up smoldering logs. Leaf blowers can be used to move fuel to help clear fire breaks and they can also be used as a mini wind factory to drive the fire. Gas powered water pumps put fires out, and are most useful for post fire 'mop up' work when large volumes of water are useful for putting out smoldering woody debris. Occasionally wildland fire-fighting specific tools such as a Pulaski, McLeod, or Council fire rake are used, especially during the mop-up phase of the burn to break up smoldering woody debris. In the absence of these tools, axes, shovels, mattocks or pick axes will work fairly well.

Site Preparation:

Fire breaks are the first and most critical safety feature that prevents fires from getting out of control. Essentially they are strips around the perimeter of the burn unit which are cleared of all flammable material. Fire breaks are also cleared within the burn unit around any objects that we don't want to burn such as fence posts, small oak trees, utility poles, etc. Firebreaks are also used to divide large areas into smaller, more manageable burn units.

Pre-Fire Checklist:

1) secure fire breaks
2) determine safety zone
3) define hazards
4) confirm weather conditions

Typically, **fire breaks should be 1.5 times wider than the expected flame height. A typical firebreak in a prairie would be between 6-10 feet, in woodlands they are typically 2-5 ft wide.** To clear a fire break, first cut any plant stalks in the break down as close to

the ground as is possible. Then rake the resulting debris to the side of the break that you will be burning. Be sure to spread this fuel widely into the burn unit rather than creating clumps of fuel near the edge that might flair up. We will use natural firebreaks as much as possible in order to avoid the labor of constructing a fire break. Suitable "natural" fire breaks include roads, streams, farm fields, or duff-free mowed paths. **There should be a fire break of one kind or another around the entire burn unit before the fire begins.**

Hazards on the site such as power lines, buildings or anything else that might catch fire or be damaged by heat should be evaluated well ahead of time and should be recognized by all crew members on the day of the burn. Any trash within the burn unit should be removed. Logs and dead standing trees have a potential to smolder and burn for long periods of time. In many cases small fire breaks will have to be cleared around dead wood in order to avoid to prevent them from catching on fire.

All persons on site should be aware of where the '**safety zones**' are. **Safety zones are areas preferably upwind from the fire and are areas that will not burn, such as asphalt, gravel or lawn where people can move in case of an emergency**. Though there is rarely a need to utilize a safety zone during our midwestern fires, it is important that everyone in the area of the fire be aware of them "just in case". **After the fire has begun, anywhere out of the smoke and "in the black" can be considered a safety zone** since there is no fuel left there to burn. The blackened earth behind a fire cools very quickly and can be safely occupied within a minute or two of the fire front passing.

Immediately before igniting the fire, we check the weather conditions for a final confirmation that conditions meet the needs for that burn. If it is decided that the burn is a go, the last thing to do before lighting the fire is to wet down firebreaks and anything we'd rather not see scorched such as buildings, vehicles and fence posts, as a final precaution.

Conducting the Burn:

There are three different types of burn methods that we use: head fires, back fires, and flank fires. A **head fire** travels along with the direction of the wind; this fire is quick, hot, big, and difficult to control. A **back fire** spreads slowly against the direction of the wind; this fire is preferred because it is smaller, easier to control and typically fuel is burned more completely. A flank burn travels at a right angle to the wind; it is faster than a back fire but not as hot as a head burn.

A prescribed burn starts simply with a lighter or matches. We will usually then 'drag' the fire with a drip torch or rake, along the downwind edge of the burn unit. **Prescribed burns always begin with back fires** in order to 'burn out' an area to increase the size of a fire break and create a 'safety zone'. Typically, as the fire is first ignited along a strip it is a single flame, but as it consumes the fuel in the middle, it moves outward developing into two fire fronts. One heads into the burn unit into the wind, and the other towards the fire break with the wind pushing it. Once these two fire fronts are distinctive, the one heading towards the fire break is extinguished, typically with a flapper. The other is allowed to burn into the unit and becomes the back fire.

Once the back fire has created a sufficiently large burn out area (typically 2-3 times the width of

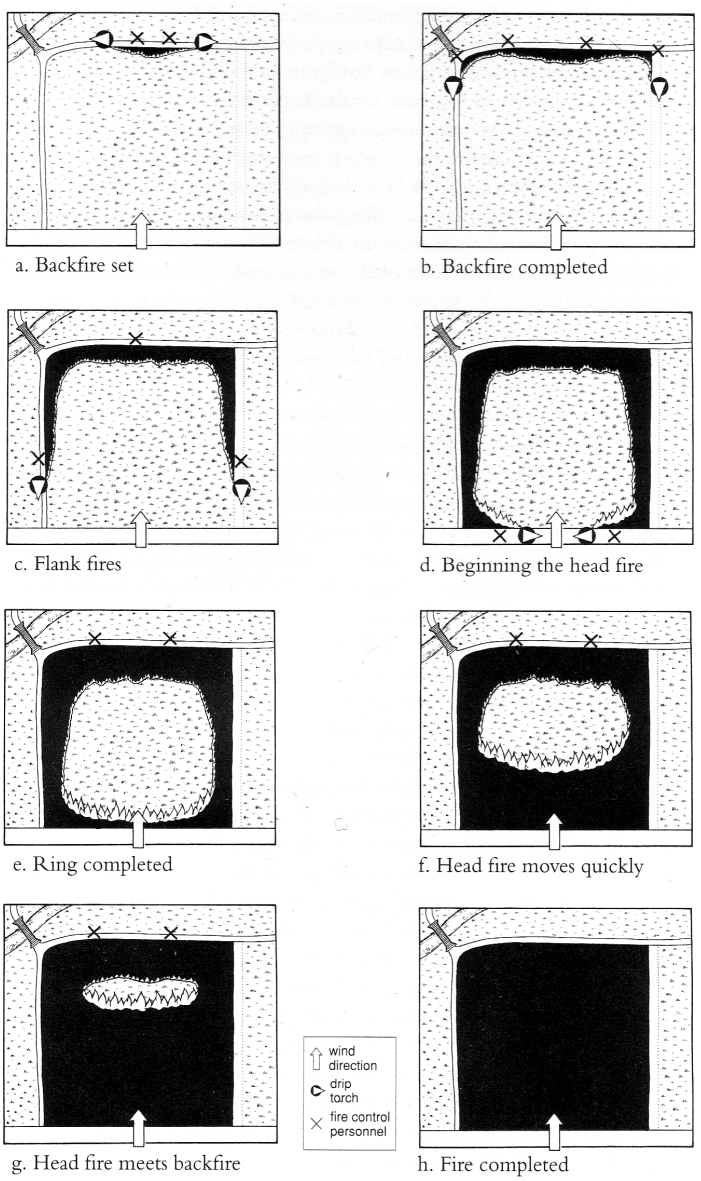
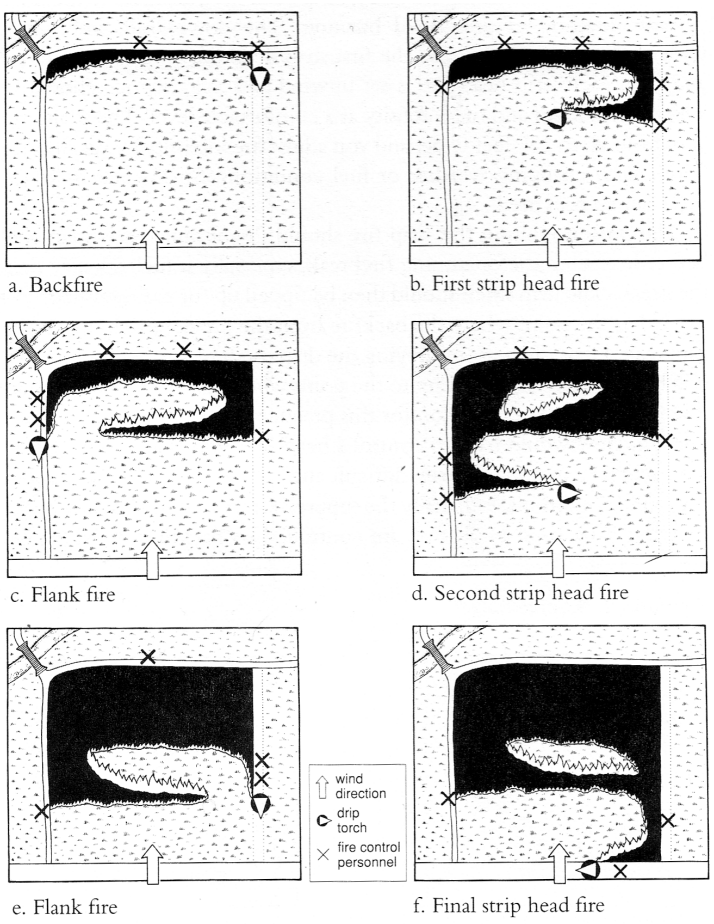


Figure courtesy of *The Tallgrass Restoration Handbook*, Stephen Packard &Cornelia F. Mutel, eds. 1997.



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the original fire break) the fire can be dragged around the corner of the unit to become a flank fire. The fire is moved up the flanks, pausing regularly to develop a safe "black" area around the perimeter of the unit. After a sufficiently wide area has been burned along the flanks of the burn unit, the fire can be dragged across the upwind side of the unit, creating a head fire. The fire will often proceed rapidly and dramatically across the burn unit creating intense heat and tall flames, and it becomes clear why careful preparation of the perimeter of the burn unit is so crucial. Once it is started it is nearly impossible to stop a head fire.

Sometimes in order to speed things up and/or improve safety a strip fire is set. Basically, the person with the drip torch drags the fire through the middle of the burn unit from one flank to the other. This results in a small head fire that burns towards the downwind fire break AND a new back fire upwind. This action breaks the burn unit into smaller pieces, building a larger safety zone down wind. It is used in cases when it might not be safe to allow a full sized head fire, but where it would be too slow to wait for the back fire to creep through the entire unit.

After the fire burns out, the mop up begins. Backpack sprayers are used to extinguish smoldering materials such as logs and trash. **The crew must be sure the fire is completely out before leaving the site or moving on to the next burn unit.** Flare ups in smoldering logs and other debris can reignite hours or even days later, potentially spreading fire to other areas, which is especially risky in urban environments.

Fireline Safety:

In addition to any hazards found on a site, the fire itself creates many potentially dangerous situations that every crew member must be aware of.

Smoke is the greatest hazard generated by the fire. Avoid breathing smoke as much as possible. Inhaling too much smoke can cause breathing difficulty, impede your judgement and even cause unconsciousness. Smoke can sting your eyes making it difficult to see, blinding you to nearby dangers. **The smoke generated from burning poison ivy is extremely dangerous.** The urushiol oil which causes the skin reaction remains volatile in the smoke. **The effects of poison ivy can spread not only to any exposed skin but also into your throat and lungs**, which can cause a life-threatening allergic reaction in susceptible individuals.

Any nearby **roads must remain clear of smoke** so that motorists can see where they're going. If there is an accident the burn crew is liable for any damages. Similarly, **large amounts of smoke cannot be allowed to blow into residential areas**. Many people such as small children, the elderly and people with asthma are sensitive to smoke and can be made sick if they breath too much of it. Again, the burn crew is liable for any illness caused by smoke inhalation. **If extremely thick smoke reaches high voltage power lines which are under heavy load a rare but extremely dangerous phenomenon called arching** can occur. Electricity can actually travel from the power line through the smoke to the ground potentially shocking or electrocuting anyone nearby. Dense smoke should not be allowed to blow into power lines, especially high-voltage lines.

Burn crew members should be aware of any hazards the terrain might offer such as steep slopes and rocks and other obstacles that might provide a tripping hazard. Rough terrain and steep slopes will

slow you down and tire you, making it more difficult for you to move quickly in an emergency situation. For example, fire moves faster upslope and people move slower. You cannot outrun a fire going uphill.

Another hazard is fire jumping a firebreak. This is often caused by burning embers being sent aloft in the hot rising air and then touching down and igniting fuel outside the burn area. **Burn crew members on the downwind side of the fire should be regularly checking nearby vegetation for spot fires outside the burn unit. If you notice a small spot-fire, it is important that you act quickly! Make everyone on the burn crew aware of the problem and extinguish the fire immediately.** Wind shifts can push the fire in unanticipated directions and may also cause the fire to escape. If one occurs we must shut down the fire and wait for conditions to stabilize and/or reformulate a new burn plan.

Finally, **dehydration and exhaustion are common problems among burn crew members** and smoke inhalation only exacerbates these issues. The heat of the fire and physical exertion involved in managing the fire can cause you to lose a lot of water and burn a lot of calories. Though we will have breaks between working on various burn units, each burn can take several hours to conduct. You should have a water bottle, canteen or camelback on your person at all times so you can take a drink whenever conditions permit. Drink no less then a pint an hour. Similarly, a snack item that will not melt in the heat is recommended. If you allow yourself to become dehydrated and exhausted you become a hazard to yourself and others, so eat and drink regularly and pay attention to how your body is feeling.

Conclusion:

Good Oak has an excellent safety record, with no injuries, escaped fires or property damage, and we intend to keep it that way. Maintaining safety during a prescribed burn relies on our experience and cautious leadership. However, it also requires the burn crew members to be disciplined, highly attentive and well prepared. Take the time to re-read this guide, and ask your burn boss about any aspects you do not understand. A basic tutorial and Q & A session will be conducted before the burn to help clear up any confusion and be sure everyone is ready. During the burn itself, be sure to focus on the work at hand, listen to instructions carefully, pay attention to your physical condition and the condition of those around you. Together we can make the burn experience, safe, effective and fun.

Notes: