



Prescribed Burning



Introduction

Prescribed burning can be defined as the thoughtful and skillful application of fire to a specific site under selected weather conditions to accomplish specific land management objectives. Prescribed burning is one of the most cost effective methods for managing plant communities and controlling natural succession. It can be used to reduce the invasion of woody growth in grassland habitats; control the spread of exotic and aggressive plants; remove thick litter layer accumulations that can inhibit wildlife mobility or smother the growth of beneficial grasses, forbs and legumes; stimulate the germination of beneficial plants like wildflowers through seed scarification (breaking down of the seed coat); reduce the accumulation of hazardous *fuel* loads; boost pasture productivity by releasing nutrients bound to dead organic material, and reduce the spread of plant diseases. Prescribed burning can also be used as a precursor to herbicide and tillage treatments to remove thick standing vegetation that would otherwise impede the efficient application of these practices.

Prescribed burning has been used as a tool throughout history. Native Americans used fire to maintain clearings and encourage the growth of plants for later harvest. Farmers have used fire to revitalize pasture, aid in crop harvest, and maintain fencerows and ditch banks. Forest managers have used prescribed burning to reduce hazardous fuel loads and encourage the growth of preferred tree species, and naturalists have used it to maintain natural communities such as prairies and savannahs. Wildlife managers, as well, have utilized prescribed burning to maintain early successional habitats for a wide variety of wildlife species. Prescribed burning can be a very useful, cost-effective and safe tool when properly planned and implemented.

Prescribed burns differ greatly from wildfires. Wildfires are accidental and uncontrolled. They threaten lives and property and can do great harm. Prescribed burns, on the other hand, are set intentionally after considering the safety of people and property. Prescribed burns are planned to achieve specific objectives in a specific area under specific weather conditions and at the right time of year. Fire control equipment and fire crews, as well as the use of natural or manmade barriers, are used to keep the fire under control.

Understanding Fire Behavior

In order to implement a safe and successful prescribed burn, it is important to understand how various factors influence fire behavior. Wind, relative humidity, temperature, soil moisture, fuel moisture, air mass stability, and topography are important elements to understand and consider when planning and implementing a burn. These elements influence flame height, rate of fire spread, how smoke produced from the burning vegetation will dissipate, and the overall success of meeting the burn objectives.

Wind - Prescribed fires behave in a more predictable manner when wind speed and wind direction are steady. Wind speed generally increases to a maximum in the early afternoon and then decreases to a minimum after sunset. Ideal *transport wind speed*, wind measured at 20 feet above ground level, should range from 6 to 18 mph for good smoke dispersion. The 20-foot wind speed, mentioned above, is the wind speed typically forecasted by local weather stations. However, the **preferred surface wind, or wind speed at eye level, should range from 1 to 3 mph** for most fuel and topographic situations. When conducting prescribed burning in vast, wide-open spaces, wind speed at surface or eye level can approach the 20-foot wind speed because there is nothing in the way to slow the surface winds down. Conversely, when conducting prescribed burning in areas where the landscape is dominated by forest cover, surface winds will most often be significantly lower than the 20-foot wind speed. Of greater importance than wind speed is the length of time the wind blows from one direction. Persistent wind directions occur most frequently following the passage of a cold front when winds are typically from the west or northwest. As these winds slowly shift clockwise over the next few days, they become weaker and less steady. Winds with an easterly component are generally considered undesirable for prescribed burning. However, topography, natural firebreaks, and locations of smoke sensitive areas may have a bearing on which wind directions are most favorable. Regardless of wind direction, wind steadiness is very important and should be forecasted to occur throughout the planned burn time.

Relative Humidity - Relative humidity has a strong influence on the moisture content of the vegetation (fuels) being burned. As relative humidity decreases, fuels become drier. As relative humidity increases, fuels retain more moisture and are less apt to burn. Relative humidity is an expression of the amount of moisture in the air compared to the total amount the air is capable of holding at that temperature and pressure. For each 20⁰ rise in temperature (which often occurs during the morning hours on a clear day), relative humidity is reduced by about one-half. Likewise, for each 20⁰ drop in temperature (which often occurs in early evening), relative humidity roughly doubles. When a cold front passes over an area, the air behind the front is cooler and drier. The result is a drop in both temperature and humidity. Preferred relative humidity for prescribed burning ranges from 30 to 55 percent. When relative humidity drops below 30 percent, prescribed burning can become dangerous. Fires are more intense under low humidity ranges and sparks from burning fuels may be transported outside the burn area and ignite surrounding vegetation, causing unwanted spot fires. When relative humidity exceeds 55 percent, a fire may leave unburned islands or may not burn hot enough to achieve the desired results. For most situations where a landowner is conducting a prescribed burn without professional assistance on-site, **preferred relative humidity should range from 40 to 55 percent.**

Temperature - Temperature can also strongly influence the moisture content of fuels being burned. High temperatures help dry fuels quickly. In addition, when fuels are exposed to direct solar radiation (sunlight), they become much warmer than the surrounding air. Moisture will move from the warmer fuels into the air even though the relative humidity of the air is high. Air temperature can also directly impact the heat intensity of the fire. Cool fires are typically not hot enough to kill woody vegetation. Under most prescribed burning objectives, the **air temperature for a late winter to early spring burn should range from 20⁰ to 60⁰ Fahrenheit**. When the objective of the burn is to control woody vegetation, air temperatures above 60⁰F may be necessary to raise woody stem tissue to lethal temperature levels.

Rainfall and Soil Moisture - Because rainfall affects both fuel and soil moisture, it's important to have a good idea of how much rain has recently fallen on the area to be burned. The importance of adequate soil moisture can't be overemphasized. Damp soil protects the root zone of grasses, forbs and trees from being killed during a fire. It also protects soil microorganisms. Even when burning to expose a mineral soil seedbed it is desirable to leave a thin layer of organic material to protect the site from erosion. Prescribed burning should cease during periods of drought and resume only after a good soaking rain of at least 1 inch. On clay soils, much of the rainfall is lost through surface runoff, therefore, duration of the rainfall is more important than the amount that falls. For most prescribed burning objectives, **the soil should be damp to moderately wet**.

Fuel Moisture - Fuel moisture, especially the moisture content of fine fuels such as grassy and weedy material, is strongly influenced by relative humidity, temperature, and rainfall.

Fine-fuel moisture (FFM) should range from 10 to 20 percent for optimum burning conditions. A rough estimate can be obtained by taking the relative humidity (RH) and dividing it by 2: ($RH \div 2 = FFM$). When fine-fuel moisture is below 6 or 7 percent, burning can result in damage to plant roots, microorganisms and even the soil. When fine-fuel moisture nears 30 percent, fires tend to burn slowly and irregularly, often resulting in incomplete burns that do not meet the desired objectives. Fine-fuel moisture is usually at its lowest value when the maximum temperature has been reached for the day (usually in the late afternoon). As the sun sets, the temperature drops and the relative humidity increases. Fine-fuel moisture can also vary considerably depending on the height of the vegetation. Typically, moisture content will increase from the upper portion of the vegetation down to the litter layer. However, a light rain or morning dew following a dry spell can give the false impression that the litter layer and underlying soils are also moist. The bottom of the litter layer should always be checked prior to burning to make sure it feels damp. This is especially important when conducting prescribed burning on organic soils. If the fire dries the surface layer of peat, the organic soils will ignite. These fires are very dangerous and can burn under ground for many weeks in spite of the best control efforts and cause extensive smoke problems. People that have not had extensive training in prescribed fire management should not attempt burning on peat or muck soils.

Airmass Stability - Atmospheric stability is the resistance of the atmosphere to vertical movement and has an important influence on smoke management. A prescribed fire generates vertical air movement as the air is heated. If the atmosphere is unstable, the hot combustion products and smoke will rise rapidly and disperse into the upper atmosphere. Unstable atmospheric conditions promote rapid smoke dispersion. Indicators of unstable conditions include wind gusts, clouds with vertical growth, clear skies, and sometimes dust devils. Under stable atmospheric conditions smoke will be held close to the ground and can cause severe smoke problems and reduced visibility. Indicators of stable conditions include poor visibility due to haze, layered clouds, no wind, or very steady (not gusty) low wind.

Topography - Topography, or the lay of the land, also influences fire behavior and is the most constant of the environmental elements. It is much easier to predict the influences which topography will have on a fire than the influences of fuel characteristics and weather. Aspect, slope and terrain are the three characteristics of topography that can influence fire behavior. Aspect refers to the direction a slope faces. This determines the amount of heating the fuel gets from solar radiation, as well as the condition and types of fuels present. South and southwest slopes are normally more directly exposed to sunlight, and generally have sparser fuel loads, higher temperatures, lower humidity, and lower fuel moisture. North and northeast slopes generally receive less direct sunlight, and typically have heavier fuel loads, lower temperatures, higher humidity, and higher fuel moisture. Slope is the degree of incline of a hillside. Fires burn more rapidly uphill than downhill. The steeper the slope, the faster and hotter the fire burns. This is because the fuels above the fire are brought into closer contact with the upward moving flames. Heat from the flames reduces fuel moisture and allows the fuels to catch on fire quickly. Conversely, a fire started at the top of a slope will move down slope slower and cooler. Terrain refers to the shape, or lay of the land, and can influence the direction and rate of fire spread. Fire in steep narrow ravines can easily spread to fuels on the opposite slope by radiant heat and wind blown sparks. Likewise, fires started at the bottom of ravines may react similar to a fire in a chimney. Air drawn from the bottom of the ravine will create very strong upslope drafts. These upslope drafts will spread the fire rapidly and result in extreme fire behavior that can be very dangerous. In addition, fires immediately adjacent to woodland edges may be affected by wind eddies that may move the fire in the opposite direction of normal wind flow.

Planning a Prescribed Burn

There are four primary components to planning a prescribed burn. These components include: 1) regulation review; 2) an evaluation of the prospective burn site; 3) preparation of a burn plan for the site; and 4) pre-burn site and equipment preparation.

1) Regulation Review - The first step in the planning process should be to review the applicability and requirements of any state, county, and local ordinances that might regulate prescribed burning in your locality. State regulations pertaining to prescribed burning may be obtained by contacting the Indiana Department of Environmental Management, Air Quality Section or by visiting the following website addresses:

<http://www.in.gov/legislative/iac/title326.html> and

<http://www.ai.org/legislative/ic/code/title13/ar17/ch9.html>.

A good place to obtain local information is from your county sheriff or local fire department. You might also contact your county's health department.

2) Prospective Burn Site Evaluation - The second step to planning a successful prescribed burn is to evaluate the proposed site. Preferably, this should be done 6 months to a year prior to the intended burning period. This will provide ample time to address any problem areas, establish needed fire breaks, make contacts with neighbors and plan for equipment needs. The pre-burn evaluation should be used to determine what type of fire prescription is needed. In other words, what is the intended objective of the burn and what conditions are needed to meet the objective. Setting a burn objective will help determine the time frame within which the burn should be conducted and the type of firing method or methods that should be used. Table 1 provides information on the timing of prescribed burning in relation to the site objective.

The pre-burn evaluation should also be used to collect specific information about the site that will be needed for burn plan preparation. Information about the amount and type of fuels to be burned, the amount and type of fuels outside the intended burn area, as well as information on topography and the location of property boundaries should be noted. Take an aerial photo or

map with you and walk the entire site. Mark the location of roads, trails, water bodies, natural fire breaks, smoke sensitive areas, utility lines, utility poles, fences, buildings, homes, fuel tanks, trash piles, poison ivy patches, and other important features.

Table 1. Burn Objective and Relationship to Burning Time Frame		
Burn Objective	Time of Burn	Comments
• Prepare tall fescue or other cool season grasses for fall herbicide application	September/October	Time burn to allow fescue to re-grow 6" prior to herbicide appl.
• Prepare tall fescue or other cool season grasses for spring tillage.	September/October February/March	Time burn to reduce the amount of residual regrowth prior to tillage
• Thin a stand of cool season grasses and remove litter layer buildup.	March/April	Burn when cool season grasses begin to green-up
• Thin a stand of native grasses and remove excessive litter layer buildup.	January through April	Burning in March/April will reduce wild flower component
• Control cool season grass invasion in established native grasses.	March/April	Burn when cool season grasses begin to green-up
• Increase forb component in established native grasses.	September/October	Low humidity is needed. Thick thatch needed to obtain a complete burn.
• Revitalize a wildflower planting.	January/February	Burn prior to green-up
• Control woody invasion in cool season grass stand.	March through May	Hot fire required. May need lower relative humidity and higher temperatures to achieve good results.
• Control woody invasion in native grass stand.	March through May	Hot fire required. May need lower relative humidity and higher temperatures to achieve good results.

3) Burn Plan Preparation - The third step is to prepare a burn plan. A burn plan should always be developed for every proposed prescribed burn. A burn plan is an all-inclusive document that includes a description of the site to be burned, the objectives of the burn, preparation needs, areas of special concern or potential hazard, a list of pre-determined parameters within which the burn will be conducted (fire prescription), information on precisely how the burn is going to be accomplished (firing sequence), and detailed maps of the area. A burn plan not only helps the landowner carefully and thoughtfully prepare for a prescribed burn, but the plan also provides detailed information to others that might be involved in implementing the burn or affected by implementation of the burn, such as members of your fire crew, the local fire department, sheriff's department, and neighbors. In addition, there are usually only a few days during most burning seasons when weather conditions meet burn prescription parameters. By developing a burn plan and addressing site and equipment needs prior to the burning season, the landowner can quickly take advantage of burning opportunities when they arise.

The following information should be included in every burn plan:

Maps: Each map should show the boundaries of the planned burn area, adjacent landowners, topography, control lines (both natural fire breaks and those that are to be

constructed), smoke sensitive areas, roads, homes, utility lines, fuel and storage tanks, and other potentially hazardous or combustible materials. One map should be prepared for each acceptable wind direction under which the prescribed burn may be safely conducted. Each of these maps should then show the location and appropriate sequence of fires to be set based on each map's assigned wind direction.

Burn Objective: State as precisely as possible the objective(s) for the burn. This will help you set the parameters (fire prescription) under which the burn should be conducted.

Burn Unit Description: Describe the types of fuels that are proposed to be burned within the burn area as well as the site's topography. Note if there are significant differences between vegetation types and heights within the burn area. Also note if there are areas that typically remain wet or exceedingly dry. All of these factors will influence fire behavior and determine other planning needs and parameters.

Adjacent Land Description: Describe the types of fuels and topography that are adjacent to the proposed burn unit. Specifically note any areas adjacent to or in close proximity to the proposed burn area that might easily catch fire as a result of wind blown sparks.

Areas of Special Concern: Describe all areas in and outside the burn area that might pose safety, health or smoke hazards and list the appropriate measures that will need to be taken to mitigate the concerns. Once again, making note of these areas will assist you and others reading the burn plan to be aware of problem areas and how those concerns will be addressed.

Pre-Burn Site Preparation: Describe exactly what site preparation will need to be completed before the burn can be safely conducted. Do control lines (fire breaks) need to be constructed? If so, are they to be planted to a green crop such as winter wheat, clover, annual rye grass, or spring oats; or are they to be plowed, disked or mown? Do control lines need to be placed around utility poles? Are there tree branches or brush extending over any firebreaks that might catch fire and cause the fire to spread to unintended areas?

Equipment Needs: List all the equipment that should be on-site at the time of the burn. Include things such as cellular phones, 2-way radios, hoses, backpack sprayers, truck-mounted water tanks, vehicles, quad runners, leaf rakes, flappers, drip torches and/or fusees. Never skimp on equipment needs.

Personnel Needs: List all the personnel that will be needed to safely and efficiently carry out the prescribed burn. Never skimp on personnel needs. In general, there should be 3 to 4 people for each control line: one to lay fire, one or two to control the line, and one to assist wherever needed. Additional people may be needed to assist with traffic control if smoke will blow across public roadways.

Persons To Be Contacted: List all neighbor, local law enforcement, and local fire department names and telephone numbers. Each of these entities should be contacted as part of burn plan preparation phase. It is important to contact local law enforcement and fire department personnel during the planning stage to ensure the burn will be in

compliance with local ordinances. It also affords these agencies the opportunity to develop their own advanced planning, coordination, and scheduling. It is also important to contact each neighbor to help assess smoke sensitive areas and address other concerns that they might have. In addition, it affords neighbors the opportunity to potentially coordinate, schedule, and assist each other in conducting prescribed burns in the local area.

Each of the entities on the contact list should also be called the day before the burn is anticipated to occur, and then immediately prior to actually conducting the burn. Again, this notification helps keep local authorities advised and prepared to respond in case of an emergency. It also is a courtesy to neighbors so that they can anticipate seeing and reacting appropriately to any potential smoke that might come their way.

Acceptable Burning Parameters: List in this section the range of conditions that must be met at the time the prescribed burn is to take place. The following parameters should be included in this section:

Time of Year - Generally the best time to conduct a prescribed burn in Indiana is from February 1 to April 15. This is when weather conditions and fuel moisture are most often conducive for conducting prescribed burns. The exact time frame within which the burn should occur will depend on the objective of the burn.

Time of Day - Time prescribed burning so that the entire job, including all follow-up work, can be completed before sunset. Remember, as the sun sets, temperature drops and relative humidity increases. Both of these conditions will increase the likelihood of having smoke management problems. When conditions are favorable, try to start burning between 10 a.m. and noon.

Relative Humidity Range - As stated earlier, relative humidity should range between 40 and 55 percent under most situations where the landowner is conducting a prescribed burn without professional assistance. Burning when relative humidity drops below 30 percent can become dangerous even for experienced prescribed fire crews.

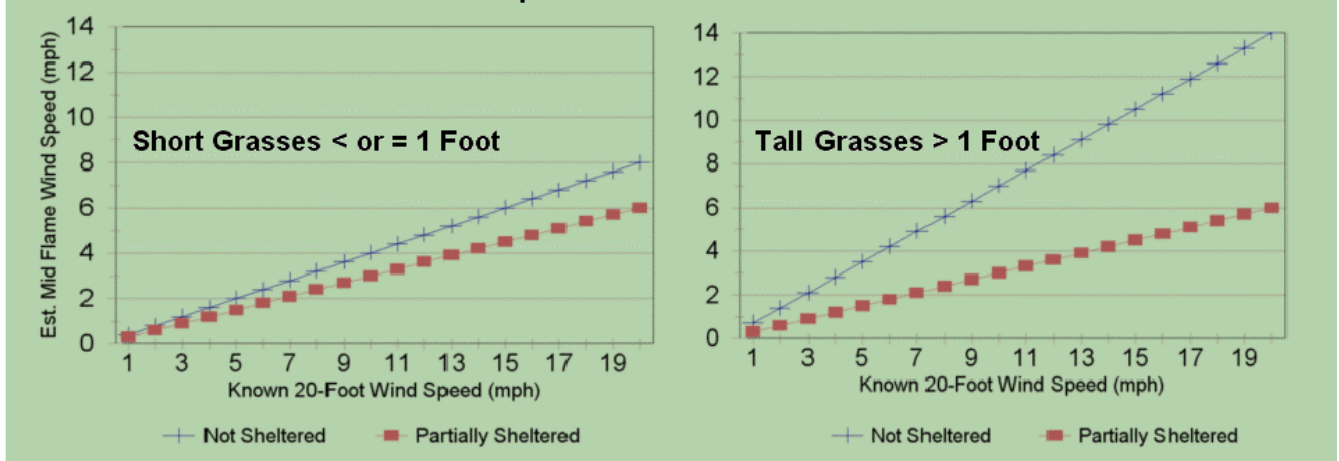
Wind Speed Range - In most situations, the preferred 20-foot wind speed should range between 6 and 18 mph for good smoke dispersion, however, the mid-flame wind speed should generally fall between 1 and 3 mph. See Chart 1 for estimating mid-flame wind speed for sheltered and unsheltered short and tall grasses.

Temperature Range - Under most prescribed burning objectives, air temperature for a late winter to early spring burn should range from 20^o to 60^o Fahrenheit.

Soil Moisture - The importance of adequate soil moisture can't be overemphasized. Damp soil protects the root zone of grasses, forbs and trees from being killed during a fire. It also protects soil microorganisms. For most prescribed burning objectives, the soil should be damp to moderately wet.

Allowable Wind Directions - Allowable wind directions will ultimately depend on several factors including: the location of smoke sensitive areas, control lines, and structures; the type of fuels inside and outside the burn area; and topography. Only those wind directions that will achieve the burn objective in a safe manner should be listed.

Chart 1. Estimated Mid Flame Wind Speed For Sheltered and Unsheltered Short and Tall Grasses



Firing Methods - Prescribed burns can be conducted using several different firing techniques (alone or in combinations) to achieve specific results. Only those firing methods that will achieve the burn objective in a safe manner should be listed. Specific firing techniques are discussed later in this publication.

Fire Escape Contingency Plan - Write down a step-by-step contingency plan as to who will do what in case fire escapes the burn site. At the minimum, the plan should include (1) the telephone numbers for the local fire department, sheriff's department, and each of the adjacent neighbors; and (2) a section that identifies escape routes and safety zones for your fire crew. All crewmembers should review this section of the plan before the prescribed burn is initiated.

4) Pre-Burn Preparation - Finally, the fourth step to planning a successful prescribed burn involves finalizing all the legwork and groundwork necessary to legally, safely and efficiently carry out the burn. Pre-burn preparation includes: fulfilling any requirements mandated by local ordinances; rounding up the proper equipment and making sure it works properly; completing any work that needs to be performed on control lines; enlisting personnel to assist with the burn; and communicating with neighbors, local fire and sheriff's departments.

Establishing Control Lines

Control lines, frequently called firebreaks, are features of the landscape used to stop, slow, or control the spread of a prescribed fire. To be effective, firebreaks should be at least 15 to 20 feet wide and border the entire burn area. Four types of firebreaks are most commonly used. **Natural firebreaks** are existing physical features that inherently do not contain combustible fuels, such as rivers, streams, lakes, ponds, and roads. Caution should be used when using certain wetlands as control lines. Wetlands containing dense stands of emergent vegetation, such as cattails, can carry fire across the top of the water surface. **Constructed firebreaks** are areas where the vegetation has either been completely removed by tillage practices, sprayed with water or a fire retardant, or frequently mown so as to remove any buildup of fine dead fuels within the control line from previous growing seasons and, thereby, consists only of standing "green" vegetation. **Green-crop firebreaks** are control lines that utilize a fire resistant crop, such as winter wheat, barley, annual rye grass, or clovers that are typically "green" during the burning period. As the name implies, green-crop firebreaks consist of bare soil control lines that have been planted recently to an actively growing "green" crop. Existing, crop (corn or soybean) stubble should not be used as a firebreak. Although standing crop stubble may be interspersed with copious quantities of bare soil, the fact still remains that the stubble is dead and fire can be transported from one standing stalk to another. Even crop stubble that appears to be wet from a

morning dew can quickly dry out as daytime temperature increases and humidity falls. Convective heat from the advancing fire can also assist in drying and curing the stubble.

If crop fields are going to be used as firebreaks, the edges should either be planted to a green crop or conventionally tilled so as to completely remove or bury all crop residues. Caution should be taken not to just turn the crop stubble over into furrows. Stubble, turned over and concentrated in this fashion, can ignite and burn the entire length of the furrow, even when lightly covered with soil. All stubble should be well incorporated into the soil. The best time of the year to prepare crop field edges for a late winter or spring burn is during the fall prior to the intended burn as part of the crop harvest and tillage operations. This allows an extended period during which crop residue can breakdown and become further incorporated into the soil.

Firebreaks may also be created by establishing **black lines**. Black lines are typically created by setting fire to the leeward portion of a fuel bed, allowing the fire to slowly advance in a controlled fashion against the wind. Once the fuel has been burned off to a specified width the fire is extinguished.

Firing Techniques

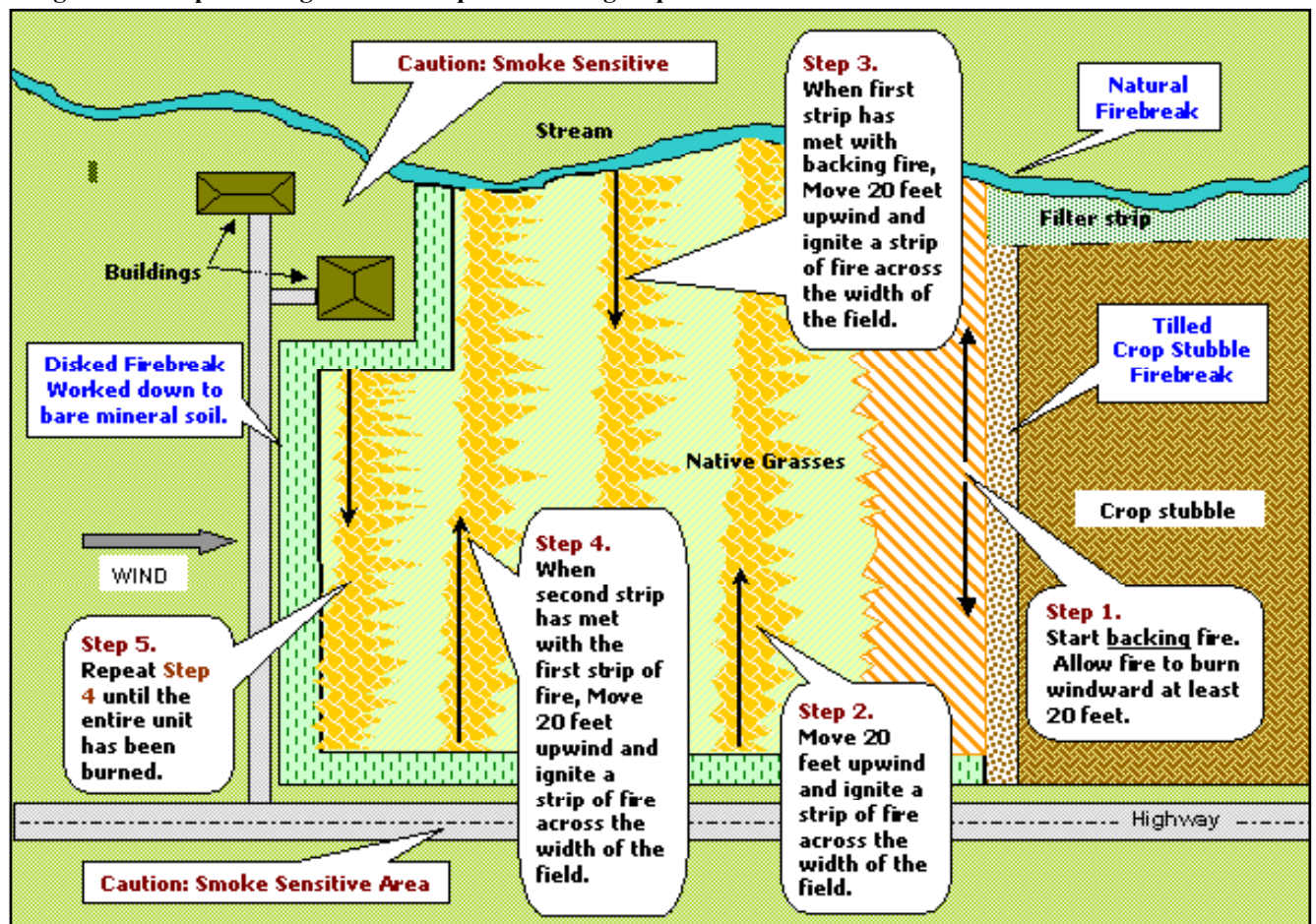
There are many different techniques that can be used to complete a controlled burn. When and where fires are started in relation to the area to be burned and the direction of the wind, can determine how hot the fire becomes and how fast the fires moves. Firing techniques allow the person conducting the fire to control the fire to some extent. The four firing techniques most commonly used are: 1) the backing fire, 2) the strip-heading fire, 3) the flanking fire, and 4) the ring fire.

1) Backing Fire – This firing technique is the easiest and safest method for completing a prescribed burn, provided wind speed and wind direction remain steady. It is generally used by novices of prescribed burning because the rate of spread is relatively slow compared to other firing techniques and more easily controlled. The backing fire is also the most common firing technique use, and should always be the first line of fire set in any prescribed burning sequence. A backing fire is always started along a firebreak or other barrier at the most leeward (downwind) edge of the burn area and allowed to back into the wind. This method can be used successfully provided that a wind is consistently blowing in one direction, relative humidity is low, and there is a continuous source of fine dead fuels throughout the area to carry the burn. Because a backing fire burns slowly against the wind, completing the prescribed burn using only a backing fire may take several hours.

When used with other firing techniques, the backing fire is set first and allowed to burn an area at least equal in width to the expected average flame length, prior to setting any other fires. This helps ensure that any fire moving in a windward direction as a result of additional fires ignited upwind will be contained within the blackened area created behind the backing fire. In general, backing fires should be allowed to burn windward a distance of at least 20 feet from the leeward control line before employing other firing techniques to complete the prescribed burn.

2) Strip-Heading Fire – This technique employs the use of a backing fire, followed by a series of strip fires set in sequential order along lines upwind from the control line and perpendicular to the wind. The timing of ignition and distance between the firing lines are adjusted so that no strip of fire becomes too robust before it meets a downwind firebreak or another line of fire and dissipates. Strip fires are typically set 20 to 50 feet apart. The distance between strip fires is used to control the average flame length, which is dependent on topography, wind speed, fuel height, and fuel load. When using this method, the first step is to set a backing fire along the downwind control line and allow it to burn a strip wide enough to control and contain any upwind strip fires. Strip-heading fires can be used to reduce the amount of time needed to perform a complete burn or help carry fire through areas having low fuel loads or high relative humidity and high fuel moisture.

Diagram 1. Strip-Heading Fire Technique and Firing Sequence

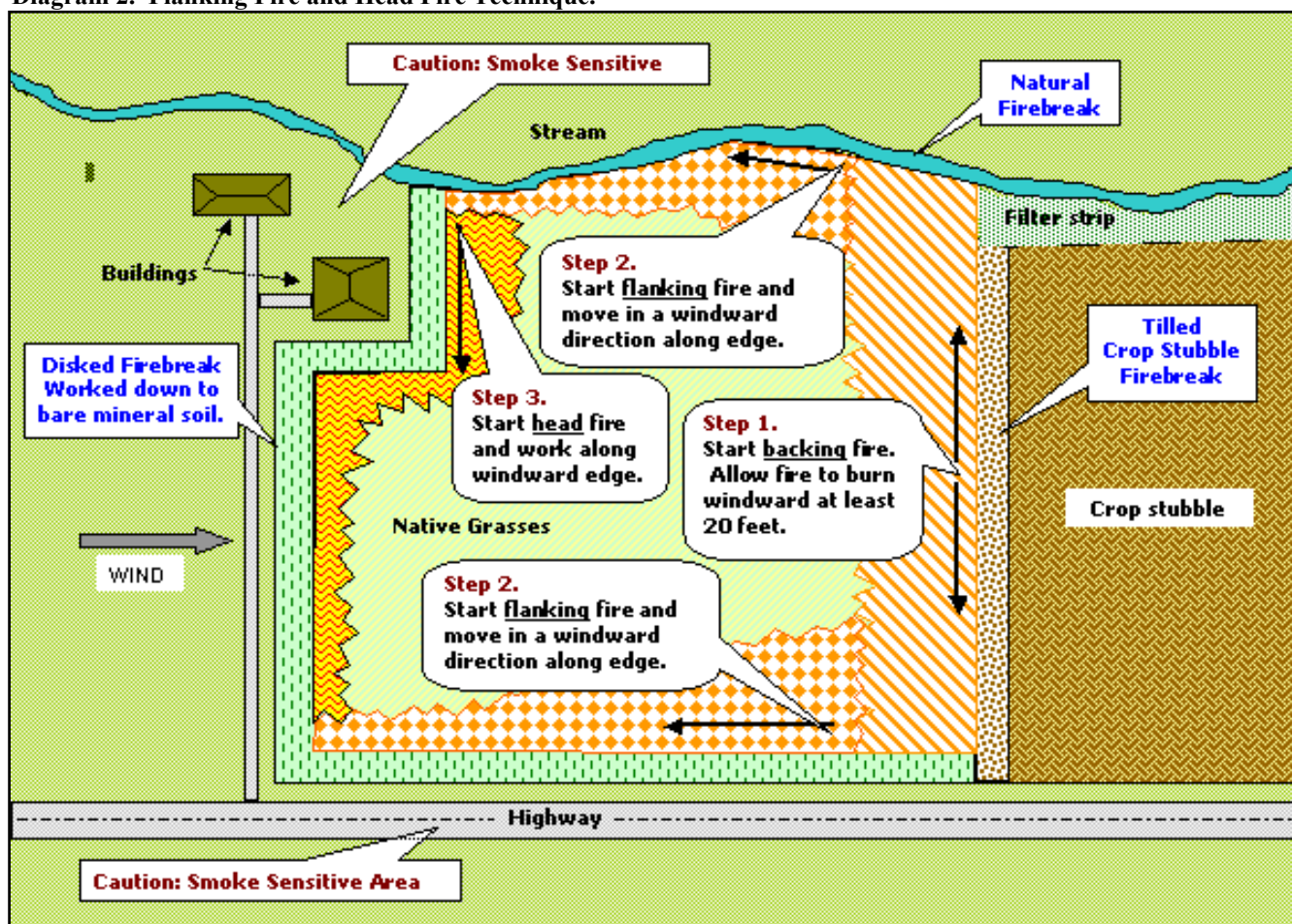


3) Flanking Fire – The flanking fire technique employs the use of fire set in lines parallel (flanking) to the wind. Although flanking fires can be ignited within the central portions of the burn area, extensive knowledge of fire behavior and experience is required, and therefore, it is not recommended for use by most landowners. For the purpose of this fact sheet, discussion is limited to the use of flanking fires along the outer flanks of the area to be burned, along established firebreaks. Flanking fires are typically used along the flanking control lines (firebreaks) to burn vegetation within the burn area away from the control lines, similar to the results obtained by a backing fire. Flanking fires should not be ignited until a backing fire has burned and blackened a strip wide enough along the baseline to control and contain any upwind fire resulting from the ignition of flanking fires. Flanking fires are frequently used in between the ignition of strip-heading fires to reduce flame height along the flanking firebreaks. The use of flanking fires also reduces the amount of time necessary to complete a prescribed burn. To properly employ the flanking fire technique, at least two persons carrying their own ignition source, are needed to simultaneously set the flanking fires.

4) Ring Fire – This firing technique creates the hottest fire and is best used when the burn objective is to control the invasion of woody stems. The ring fire technique is first initiated by using a backing fire to establish a wide, blackened control line at the downwind edge of the burn area. Once the baseline is secured with a wide blackened area, the remainder of the perimeter is ignited, starting at each end of the backing fire and moving in a windward direction. As the perimeter fires merge, flame height and temperature become quite intense and can create a very strong convection column, capable of carrying fire a considerable distance downwind. As a result, ring fires are more apt to start wildfires in neighboring fields. The ring

fire technique should only be used by experienced personnel or where the downwind landscape is composed primarily of bare mineral soils, such as plowed crop fields. To properly employ the ring fire technique, at least two persons carrying their own ignition source, are needed to simultaneously set the fires about the perimeter.

Diagram 2. Flanking Fire and Head Fire Technique.



Smoke Management

It is the responsibility of those conducting a prescribed burn to minimize any detrimental effects that smoke from the fire might create. In fact, persons conducting prescribed burning can be held liable for damages or accidents that occur as a result of smoke from the burn. Therefore, it is very important to make sure smoke management is addressed in all phases of planning a prescribed burn as well as during the actual burn. The following guidelines should be used to reduce the detrimental effects of smoke.

1. Consider all on-site and off-site impacts that smoke might impact when planning a prescribed burn.
2. Use the most up-to-date weather information prior to the burn to help assess smoke behavior and movement.
3. Conduct prescribed burns on days when conditions will allow the smoke to rise and dissipate quickly. Visual indicators of favorable atmospheric conditions include: clouds growing vertically; gusty winds blowing in a consistent direction; smoke from other sources rises quickly and to great heights; good visibility; and the formation of cumulus clouds. Indicators of poor atmospheric conditions include: clouds forming dense layers; steady or little wind; smoke from other sources drifts apart, hangs, or moves downward; poor visibility or haze; fog; and the formation of stratus clouds.

4. Use extreme caution when smoke-sensitive areas are adjacent to or downwind of the proposed burn area. Burning should not be done when the wind will carry the smoke across roadways, airports, dwellings, populated areas, and areas where domestic animals are confined or sensitive to smoke. As a general rule, do not burn if smoke-sensitive areas are downwind of the burn area and within one-half mile.
5. Check the area to be burned for combustible materials that might produce toxic fumes such as tires, asbestos, PCBs, and solvents. Either remove the items from the burn area or adjust the burn area to prevent the area around them from being burned. Remember that poisonous plants, such as poison ivy, can be rendered more toxic as the heat mobilizes the irritating oils and are transported along with the smoke. If poison ivy is present, make sure all members of the fire crew are advised, so that they may judge their own susceptibility.
6. Prior to conducting the actual burn, a small test fire involving the fuels to be burned should be set to evaluate smoke behavior. The test fire should be conducted in an open area away from woodland edges or structures that might create atypical wind currents.
7. Use backing fires whenever possible. Backing fires consume dead fuels more completely and create less smoke.
8. When possible, burn during the middle of the day. Atmospheric conditions at that time of the day tend to be most favorable for smoke dissipation.
9. Try to complete all burns prior to 5:00 pm. As the sun sets, temperature falls, relative humidity increases, and winds decline or cease altogether. Under these conditions, smoke will tend to hang close to the ground in and around the burn area.
10. If conducting a prescribed burn under less than ideal smoke transport conditions, consider breaking the larger burn unit into smaller units and allowing the smoke to dissipate prior to burning each successive unit.
11. Notify adjacent landowners, homeowners, the local fire department, and local law enforcement agencies several days prior to the burn and again on the day the burn is to be implemented. It is not only common courtesy, but local statutes may require an official notification procedure. Response to the notification may also bring unknown problems associated with the proposed burn plan to the burner's attention, such as a neighbor with respiratory problems or a family gathering planned next door. Local authorities need to be notified so that they know it is not a wildfire. It also gives local authorities advanced opportunity to review the burn plan, be better prepared in case the fire escapes, and perhaps coordinate a planned training opportunity for firefighters and other first responders.
12. As part of the actual burn plan, prepare an emergency plan that addresses changes in smoke management. Be prepared to extinguish the fire if the burn is not going according to the plan. Be prepared to contact local law enforcement officials if wind direction changes and the smoke is expected to blow across public roadways, so that traffic can be safely controlled until the smoke dissipates and is no longer a threat.
13. Never conduct prescribed burns on organic soils. Fires on organic soils are almost impossible to put out and can continue to burn underground and create smoke problems for many days if not weeks. Changing weather conditions during that time can create serious smoke problems for miles around.

Appropriate Burning Apparel

All persons assisting with the burn should wear the following apparel at all times during the prescribed burn:

- Hard hat
- Leather gloves
- Eye protection
- Leather boots (lace-up, 8-inch minimum height)
- Handkerchief (for covering mouth and nose)

- Fire resistant trousers and shirt. Use clothing that is 100% natural fiber, such as cotton or wool. Do not use clothing that is 100% synthetic fiber or synthetic fiber/natural fiber blends. Synthetic materials will melt and can cause serious burns.

Ignition Sources

Although a properly functioning drip torch is the most efficient tool for setting fires during a prescribed burn, most landowners do not have access to this equipment. Instead, most landowners utilize fusees and signal flares to set the fires. Fusees are elongated signal flares that last longer and allow the user to remain more upright when using the flare to ignite the vegetation. Flares and fusees are ignited by striking the friction cap (attached to one end of the device) against the exposed end. The precautions, listed below, should always be followed when using these devices:

- Always read and follow manufacturer warnings, precautions, and safety instructions that come with the device.
- Fusees and flares drip extremely hot, molten materials that can burn through clothing and cause serious burns. Always hold fuses and flares downward and well away from your body.
- Fusees and flares emit caustic smoke. Do not breathe the fumes.
- The flames of these devices are extremely bright. Do not look directly at the flame.
- When igniting, always hold the device downward and away from your body, and strike the friction cap away from your body.
- Once lit, these devices drop fire constantly. Do not ignite a fusee or flare in an area that you do not intend to burn. Do not ignite the device until you are ready to burn.
- Keeping burning flares well away from other objects and people.
- Never store these devices with or close to other flammables or ignition sources.
- Do not leave burning flares or fusees unattended.

Pre-Burn Check List

Prior to initiating any prescribed fire the burn crew leader should review all aspects of the official burn plan and ask the following series of questions.

- ___ Does the weather forecast meet the “Acceptable Burning Parameters” specified in the burn plan? If a weather front is expected to pass through the area on the day the burn is planned, DO NOT BURN.
- ___ Have all neighbors and appropriate law enforcement and fire department personnel been contacted and properly notified?
- ___ Have all “Pre-Burn Site Preparations” been completed, checked, and are they functional?
- ___ Is all the equipment needed to safely carry out the burn on site and is it functioning properly?
- ___ Do all the personnel know how to safely handle and properly use the ignition sources and other equipment?
- ___ Are all the personnel necessary to carry out the burn on site?
- ___ Are all personnel physically fit to perform potentially strenuous activity?
- ___ Have all personnel been briefed on the prescribed burn plan and know their assignments?
- ___ Are all personnel wearing appropriate burning apparel?
- ___ Is the weather forecast expected to be favorable throughout the entire proposed burn time?
- ___ Do you have a working cellular phone with the telephone number of the local fire department entered?
- ___ In your opinion, can the burn be carried out according to the burn plan in a safe manner?

If the answer to any of the above checklist questions is “NO”, then DO NOT BURN!

If the answer to all of the above checklist questions is “YES”, then the next step is to conduct a small, test burn to better assess smoke management and how the actual burn might respond under the current conditions.

Conducting the Prescribed Burn

If the test fire performs satisfactorily, begin the prescribed burn by starting a backing fire along the most downwind (leeward) portion of the field, according to the burn plan. Allow the backing fire to burn inward from the control line to a distance of at least 20 feet; making sure the downwind edge of the control line has been secured, and fire has not crept across the firebreak. As the backing fire continues to burn against the wind, lengthen the peripheral edges of the backing fire by igniting short segments of the flanking control lines. Allow the flanking fires to burn inward and away from the flanking control lines. Never set fire to more area along the flanking control lines than what the fire crew can control. At least one crewmember should routinely check back along the burned control lines to make sure fire has not escaped across the lines. At this point, the ignition of additional lines of fire varies according to what type of firing technique is specified in the burn plan.

If only a backing fire is being used to burn the entire unit, continue setting fire in short distances along the flanking control lines to keep ahead of the advancing backing fire. When flanking fires have been set all the way to the most windward (upwind) section of the field and the flanking control lines are secure, lay fire along the windward control line to complete the prescribed burn.

If the strip-heading technique is going to be employed, stop and reassess current conditions. If it is still appropriate and safe to perform a strip-heading fire, move upwind approximately 20 feet from the advancing backing fire and begin laying a strip of fire in a line parallel to the backing fire and perpendicular to the wind direction. Prior to laying each successive strip of fire across the field, check to see if wind speed, wind direction, and the rate of spread at which the backing fire is advancing are such that the strip-heading technique is still appropriate and safe to use.

If the ring fire technique is prescribed, stop and reassess the current conditions. If it is still appropriate and safe to perform a ring fire continue laying fire along the flanking control lines and allow the fire to burn inward and away from the flanking control lines to a width equal to at least twice the height of the flames or twenty feet, whichever is greater. Once these conditions have been attained, lay fire to the most windward control line to complete the prescribed burn. Ring fires can be very hot and create strong convection columns and wind speeds, which can carry hot sparks across control lines and into neighboring fields. Crewmembers should be on constant lookout for spot fires that might erupt in nearby fields or breach control lines.

Once the prescribed burn has been completed, crewmembers need to ensure that the fire is completely out. Smoldering embers can quickly reignite or be blown into neighboring areas and start wildfires. Check all fields adjacent to the burn area at least twice to ensure the fire hasn't escaped. Drench all smoldering debris and hot embers with water. Check the area again that night and the next day, especially if conditions have turned windy and dry.

In Case of an Emergency

In case of an emergency or escaped fire:

- Call 911 or the local fire department.
- Move all persons to safety zones, such as:
 - Man-made firebreaks,
 - Paved, gravel, or dirt roads,
 - Permanent bodies of water, or
 - Areas already blackened by the fire.
- Contact all neighbors that may be potentially affected.

After the Prescribed Burn

After the burn has completed, inspect the area to see if the prescribed burn met its objectives. Ask questions like: Were the firebreaks wide enough? Were the firebreaks effective? Did I have all the equipment and manpower that I needed? Did I get the results that I was expecting? Make a list of things you would do differently the next time.

Of course, the desired vegetation response may not be apparent immediately after the burn. The assessment of changes in vegetation diversity and density will have to be delayed until the entire growing season can be evaluated. So, it is important to return to the site several times during the growing season to fully assess the results.

Related *Habitat Management Fact Sheets*:

Warm Season Grass Establishment
Warm Season Grass Management
Strip Disking
Fescue Eradication

Strip Spraying
Prescribed Burning
Wildflowers

Prepared by the Indiana Department of Natural Resources, Division of Fish and Wildlife. For up-to-date information concerning the Indiana Division of Fish and Wildlife, or for information on the location of your District Wildlife Biologist, visit our website at www.wildlife.IN.gov

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