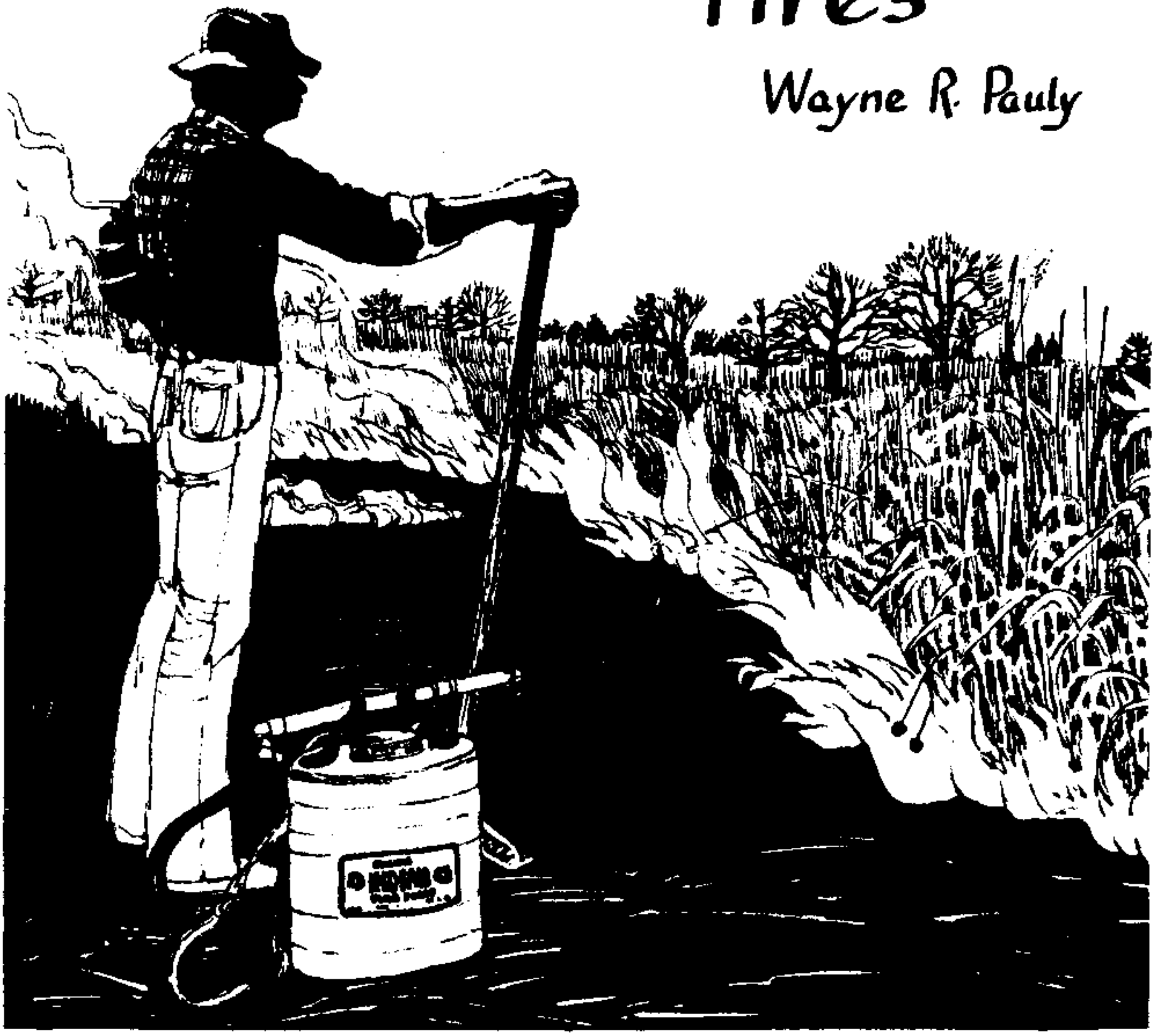
How To Manage Small Prairie Fires

Wayne R. Pauly



Price $4.00

HOW TO MANAGE SMALL PRAIRIE FIRES

by

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April 1982
Revised 1985
Reprinted 1988

Preface

Sponsored by the Dane County Environmental Council and by the Dane County Highway and Transportation Department, the author describes one style of conducting small prairie fires (1 to 100 acres) using hand held equipment and a minimum number of inexperienced people. It is aimed at the novice who has seen controlled burns and wants to know how to conduct one. To many, a well run burn looks tame, and this can lead to overconfidence, which can lead to a fire out of control. This paper describes the planning that an experienced burner goes through before lighting the first match and explains how to conduct a safe burn.

The paper is divided into six topics. The first is a theoretical explanation of what, when, and how often to burn. The second section lists hand tools for conducting a burn, explains how to use and maintain them, and identifies proper clothing to wear when burning. The third discusses how wind, rain, temperature, and humidity affect a burn, and how to arrange for permits, contacting neighbors, and having a plan in case the fire gets out of control.

The fourth and fifth sections explain how to make firebreaks, how to conduct a simple burn, and what to do if the fire gets out of control. The sixth describes hazards that complicate a simple prairie fire. The appendix has a summary of how fire stimulates prairie plants and how it controls some weeds.

C O N T E N T S

CONTENTS, continued

INTRODUCTION

Fire, a tool for managing prairies and keeping them vigorous, is a dangerous tool. In general, a prairie fire burns in a long, narrow line of flames moving quickly through the grass. It is possible to walk several feet behind the flames without discomfort from heat or smoke because flames quickly consume dry grass and move forward for more fuel. Usually a line of fire carried with the wind (head fire) is 5 to 15 feet deep with flames that leap 8 feet or more, while fire burning into the wind (backfire or backing fire) is only a foot deep with flames a foot high. But the description of a prairie fire varies considerably depending on the kind and amount of fuel, height and moisture content of grasses, topography, slope, wind speed, humidity, etc.

This paper presents guidelines for conducting a simple burn. Really the "typical" prairie fire doesn't exist, because there are too many variables. The same prairie will not burn the same way twice, and the way it burns will change from morning to afternoon. Under proper conditions, a grass fire looks tame, but it reacts swiftly to change in wind direction, wind speed, and humidity. A change in wind direction will transform a creeping backfire into a blazing head fire, a doubling of wind speed will quadruple the rate of spread of the fire, and a reduction in relative humidity as the day warms up will make a fire burn hotter and faster.

Never take fire for granted; the worst danger is overconfidence. Under proper conditions of moisture and wind, fire can be controlled, but it is always dangerous. During a few seconds of inattention a fire can change from a safely controlled burn to a racing wall of flames. Therefore, there is no substitute for experience when working with fire. If you have never worked on a prairie fire, then get experienced people to work with you. Contact local conservation organizations for permission to watch a controlled burn, or volunteer to help. Above all, start small; your first burn should be no more than a fraction of an acre, and planned with as much attention to detail as possible. Even small fires can get out of control and cause great damage.

WHAT, WHEN, AND HOW OFTEN TO BURN

WHAT KIND OF AREA SHOULD BE BURNED

Almost any area that has prairie plants will benefit from a burn, because fire discourages Eurasian "weeds" and stimulates growth of prairie plants. Don't bother burning an area that was a plowed field and has no evidence of prairie plants.

Burn a planted prairie as soon as enough plant material has accumulated to carry a fire, which may take two or three years. Burn areas where prairie seeds have been scattered, because seeds scattered in an old field may grow and flower if encouraged with fire; but it takes a long time and lots of seeds.

HOW OFTEN SHOULD AN AREA BE BURNED

There are many plant species, kinds of prairies, and environmental factors that influence a prairie's response to fire, and therefore there is no precise answer to the question of how often a site should be burned--only suggestions. The greater the litter cover, the more positive the response to fire, and since mesic prairies accumulate litter faster than dry prairies, mesic prairies respond better to frequent burning. On average, mesic prairies need between one and three years to accumulate "pre-burn" levels of leaf litter (i.e. where leaf litter production equals decomposition). Dry prairies may need four to six years to reach pre-burn levels. These intervals are adequate for burning healthy prairies with no serious weed problems.

More frequent burns are needed on weedy prairies. Fire discourages the Eurasian "weeds", especially cool season grasses, like quack grass, bluegrass, and brome grass. Annual burns will control these weeds, and does it quicker on a dry site than a mesic one because of water stress and possibly other factors that inhibit these weeds. Three or more years of successive fires are recommended to begin controlling alien cool season grasses and woody vegetation. Successive burns have also been recommended on new plantings, although there are differences of opinion on this.

If cool season grasses are not a problem, then burn every three or four years at irregular intervals. Annual burns can increase the dominance of prairie grasses to the detriment of forbs, and burning at regular intervals can favor certain weeds (see Sweet Clover in Appendix).

WHEN SHOULD A BURN BE CONDUCTED

Most prairie burns are conducted in late March, April, or early May. Dry prairies are usually burned on the earlier dates. Weedy prairies are burned on the later dates, because later fires do more to discourage Eurasian weeds. Dry prairies are burned earlier because they start blooming several weeks earlier than moist prairies, and a later fire could damage early wildflowers.

Fires are rarely conducted in the fall, because a fire could escape into the crops adjacent to many prairie remnants. In addition, fall fires destroy winter food and shelter for wildlife, and may induce erosion on steep hill prairies. Spring fires are easier to control because the vegetation has been packed down by snow; fire moves slower, and flame height is reduced. Fall fires are also difficult to plan because cool temperatures keep vegetation too moist to burn well much of the time.

EQUIPMENT

FIRE RAKE

This is an iron garden rake that spreads the fire. Check that the metal rake head is nailed or bolted on, lest it fall off when heated by the fire. Specially designed fire or asphalt rakes have a 12 inch metal extension between the wooden handle and rake head, which keeps the worker a foot farther away from the fire and keeps the wooden handle out of the flames.

To start the fire, rake up a small bundle of dry grass, light it, and drag it along the ground exerting a slight downward pressure. It will bounce along, dropping small bits of burning grass, and picking up more dry grass for fuel.

When dragging the fire rake, there is a tendency to go slower than necessary. Experiment with dragging the rake at different speeds. Notice, several seconds after passing over an area, fires start from pieces of burning grass that fall off the rake--as though dropping a hundred matches. If moved too slowly, the handle could burn and the rake head fall off. When necessary, an experienced person can set a line of fire while dragging the rake at a fast run.

The person dragging the fire rake must stop often to give the fire control crew a chance to catch up. Shake all burning grass from the rake and allow it to cool. If burning embers cling to the rake when you set it aside, flames will spring up where least expected; people who lean on the rake will find flames underfoot.

Rakes are not used to put out fires, but they are used to remove excess fuel from firebreaks and around wooden posts--so take along extra rakes.

FIRE SWATTER/FLAPPER

A flapper is a 12" by 18" piece of reinforced rubber attached to a 5 foot handle. It is used to smother small grass fires, and in tall grass it can extinguish the backfire (fire burning into the wind; also called a backing fire). Flappers alone are useless against a head fire (strong fire carried with the wind). Flappers are most effective when teamed up with a back pack pump; the pump operator knocks down the hot fire, and flappers follow behind mopping up.

To use the flapper, raise it one or two feet and strike at the base of the flames. Do not strike with excessive force, or flaming debris will scatter, starting new fires. When striking the ground, pause momentarily to smother the fire. If the fire is stubborn, like a clump of burning bunch grass, then place the flapper over the fire and step on it to suffocate the flames. In areas of light fuel, you can wiggle the flapper rapidly along the ground to extinguish flames.

Pause occasionally to let the flapper cool since rubber can burn, or else ask someone to spray it with water.

FIRE BROOM

It looks like a straw broom except the bristles are made of split rattan. Soaking it in water for a few hours improves its resistance to burning. It can be used like a flapper, but is most effective when used like a broom with a sweeping motion parallel to the line of flames.

Fire brooms are only effective on cool backing fires, since the individual must work directly over the flames. The fire broom literally sweeps away all combustible material and can extinguish flames three times faster than a flapper on cooler fires. The broom is particularly effective on backing fires in matted old field grasses (see Thick Matted Grass in the Hazards section).

WATER BACK PACK/FIRE PUMP

It is a tank with a 5 gallon capacity and a slide action pump that can shoot a stream of water 20 feet. It is the most valuable piece of fire control equipment.

How is it used? Since the empty tank weighs about 12 pounds and water weighs about 8.5 pounds per gallon, a full tank weighs over 50 pounds. But, tanks are not filled to the top because the gallon in the top three inches splashes out and down your back when bending over!

Fire pumps usually have two nozzles: a single-hole and a two-hole nozzle. The two-hole nozzle produces a spray for working close to the fire, and to wet down areas before they catch fire. This spray nozzle is particularly useful in putting out backfires which are less than a foot deep. The closer the spray is to the fire the better, so when extinguishing a backing fire, work with the nozzle two or three feet above the base of the flames--if the heat allows.

Experienced people work exclusively with the single-hole nozzle and use the index finger to produce a spray when needed. But there is a trick to this. Keep the knuckle straight and hold the finger tip about 1/2" in front of the nozzle so water strikes the finger tip and breaks into large droplets. Commonly, beginners place a finger directly over the nozzle as is done with a garden hose, and get more water on themselves than the fire.

Head fires are 5 to 15 feet deep and hot enough to keep you 10 to 15 feet away. For hot fires use the single-hole nozzle aimed at the base of the flames. Fan the pump side to side so the stream of water covers a wider area. Sometimes in putting out a line of flames, especially backfires, you can stand at one end of a line and lay a stream directly on 20 feet of flames.

Use water efficiently. Very little water is needed to cool a large volume of fuel below the kindling point, especially if a spray is used. With a hot fire, you must use the straight stream, but you can still create a spray. Use a powerful stroke, and bounce water off the ground just in front of the base of the flames. The narrow stream will break into a fan of droplets and cool a larger volume of fuel.

Usually two or more tanks are involved with controlling a fire. Keep track of how much water you've got left, and work with a buddy--one person watches the fire while the other refills his tank. If there's only one tank, then extinguish the fire before refilling it. Take along a bucket and strainer if you'll be near a lake, drainage ditch, or river.

Conserve water. Use flappers to put out smaller fires. If your tank goes dry, drop the strap off the left shoulder; this tips the tank so remaining water pools over the intake hole of the pump hose. You'll get a few extra squirts this way. A few drops of detergent added to each tank breaks water surface tension and makes it spread more on the vegetation.

Finally, practice ahead of time so you can hit what you aim at. Experiment with the best way to hold the pump to deliver a powerful stream. Remember, the hose must always point down so the ball valve in the base of the pump will work properly.

Maintenance: Take the pump apart and learn how it works so you can fix it during a fire. Most pumps can be taken apart with the fingers. Keep the pump slide well oiled; remove the gland nut and squirt oil into the pump housing cylinder. This prevents water from leaking past the gland nut and soaking your hands and clothing. If water continues to leak after oiling, then replace the rubber gasket in the gland nut. Occasionally a tarnish or residue builds up on the sliding brass cylinder causing the pump to stick, polish it up with a very fine steel wool and it will work like new.

Do not allow water to freeze in the tank. Empty the tank, and pump all water out of the hose--pumps are destroyed when water left in the mechanism freezes and expands. Galvanized tanks will rust, and flakes of rust will clog the nozzle; so thoroughly dry out the tank before storing it for the season, or store it upside down.

Extra water containers: If there is no source of water near the burn site, then you must haul it, and each 5 gallons of water is an extra 45 pounds to carry. So conserve water and use flappers whenever possible. Be sure to place extra back pack pumps in a safe area which won't burn, because the nylon straps are quickly destroyed by fire. One safe area is a burned out section of the firebreak.

LAWN MOWER

Mowers are used to cut down tall vegetation and make the fire easier to control. Periodic mowing of a 6 to 10 foot wide strip throughout the summer makes an excellent firebreak, especially on prairies larger than 15 acres. On smaller prairies, a narrow, mowed walking path can be widened prior to a burn.

CLOTHING

Shoes: Leather shoes are preferred, because cloth shoes do not provide adequate support for rough terrain and can catch fire.

Pants: Wear work pants, avoiding flammable synthetics and loosely woven fabrics. Avoid frayed or holey pants, since frayed edges catch fire easily. If cuffs are frayed, stuff them in your socks, or roll them up so frayed edges are not exposed to flames.

Coats: Don't wear nylon or down coats because they are highly flammable. An old wool or tightly woven cotton coat works well. It keeps you warm and insulates against the heat of the fire.

Hats: Hair will burn, so wear a hat and keep your beard away from the flames. The brim of a cap can be pulled down to protect your face from intense heat and sudden flare-ups.

Layered clothing: On a cold day wear layers of clothing. You'll get warm working around the fire, and you'll get cold checking for smoldering sparks after the fire is out. A long sleeve shirt and gloves protect your arms from radiant heat which can cause first degree burns.

BUYING/BORROWING EQUIPMENT

Sometimes you can borrow equipment from the fire department or from the state conservation department fire control office. Also, check with local conservation organizations for leads on where to borrow, rent, and buy equipment. Equipment can be purchased from a local fire equipment supply company, or ordered from places like:

Indian Fire Pumps	Forestry Suppliers, Inc.	Ben Meadows Company
D. B. Smith & Company	205 West Rankin Street	3589 Broad Street
Utica, New York 13503	Box 8397	P.O. Box 80549
(315) 735-5223	Jackson, Miss. 39204	Atlanta, Georgia 30366
	(601) 354-3565	(800) 241-3136

For small "backyard fires" (with existing firebreaks) it is possible to substitute tools you have around the house. A flat snow shovel will work like a crude flapper, and a two gallon compressed air weed sprayer is a small, substitute fire pump.

WEATHER CONDITIONS AND CONTROLLED FIRES

Selecting a day to burn can be discouraging. Spring weather is variable, and there may be only a few days in April when weather is not too windy, too wet, too dry, too calm, or too humid for burning. Therefore plan to burn as early as possible, unless you require a late burn for weed control. Select several possible days for the burn.

HUMIDITY

Relative humidity is the most important factor influencing the behavior of a grass fire. Relative humidity is defined as the quantity of water vapor actually in the air compared to the maximum quantity of water vapor air can hold at a given temperature, and it is expressed as a percentage. For example, a 60% relative humidity at 50° F means that the air contains only 60% of the total water vapor it can hold at that temperature. As temperature increases during the day, the quantity of moisture the air can hold also increases, and therefore the quantity of moisture creating 60% r.h. at 50° F will yield only 30% r.h. at 70° F.

As air cools, its ability to hold water vapor is reduced, and at night the temperature can fall to a point where relative humidity reaches 100%, air becomes saturated, and excess water is deposited as dew--having the same effect as a light rain.

Relative humidity determines how hot a grass fire will burn. Dry air (low relative humidity) absorbs dampness from dead grass, whereas damp air (high relative humidity) returns moisture to the grass, and dead grass can adjust within minutes to a change in relative humidity. High relative humidity and moist fuel slow a fire because heat is wasted drying the grass before it will burn. In fact, at dusk the falling temperature and rising relative humidity can extinguish a grass fire.

A relative humidity between 25% and 60% is appropriate for a controlled fire, but below 20% is hazardous, and above 70% grass burns poorly if at all. Above 50% there is little chance of spot fires starting from embers carried in the wind, but a fairly brisk wind (10 mph) is needed to drive the fire. The effect of wind is to deflect the angle of the flames and to drive drying heat into the vegetation ahead.

A useful rule of thumb to predict changes in relative humidity during the day is: **relative humidity will drop to one half of its previous value as temperature increases 20° F, and will double as temperature decreases 20° F.** For example, the early morning temperature is 40° F, with an 84% relative humidity, and the expected high for the day is 80° F. As the temperature increases to 60° F the relative humidity will drop to 42%, and at 80° F the r.h. will be about 21%. In another example, the mid-afternoon temperature is 70° F with a 33% r.h.; as the temperature drops to 50° F the r.h. will double to 66%.

The lowest relative humidity of the day is usually between 3:00 p.m. and 5:00 p.m. Therefore early evening can be a good time to burn firebreaks because falling temperatures cause increased relative humidity. Grass absorbs moisture, burns cooler, and makes fire easier to control. But burning firebreaks in the morning can be tricky, because rising temperatures, decreasing humidity, and increasing winds make fire increasingly difficult to control as the day progresses. Remember, weather conditions affecting a fire can change dramatically in a few hours. You must stay aware of those changes and adapt fire control techniques accordingly.

TEMPERATURE

The major effect of temperature is related to relative humidity. As explained above, when air temperature increases, relative humidity decreases, and therefore fuel moisture decreases. Generally it is too hazardous to conduct a prescribed fire above 80° F, and from 70° F to 80° F the rate of spread of fire increases exponentially. Below 32° F light fuels do not burn, although a heavy mat of grass can burn well.

Prolonged high temperatures coupled with a lack of rain will dry out heavier fuels like brush and dead wood. This increases the chance that these larger fuels will flare-up. Bright sun multiplies the effect of temperature; a south facing slope will warm up and dry out much quicker than a level area.

In evening there can be a temperature inversion which will hold smoke near the ground. Inversions occur on calm evenings as the sun disappears below the horizon. Air near the ground cools rapidly, but the upper air continues to be warmed by the setting sun. The interface between cold air below and warm air above traps smoke near the ground.

WIND

A steady breeze of 3 to 15 miles per hour is ideal for burning, because it carries fire in a definite direction, while gusts or steady winds over 15 mph make fire difficult to control. Do not burn on a calm day when breezes can come from unexpected directions and take fire out of control. It is interesting to note that although wind speed has a marked effect on a head fire, it has little effect on the speed of a backing fire.

Fires create their own thermal winds when the quick rise of hot air causes the inrush of cooler air to take its place. A steady breeze moderates the thermal updraft's tendency to take fire in erratic directions and also inhibits the formation of small fire whirlwinds. Whirlwinds form while burning grassland on rolling terrain and behave like dust devils you may have seen on dusty ball fields. Whirlwinds can pick up a piece of burning debris, carry it several dozen feet, and start new fires across the firebreaks.

In general, wind is calmer in morning, picks up during the day, and falls off at dusk. You may choose to burn firebreaks during the morning and evening hours--avoiding the winds of midday.

On the day of the burn, it is important to spend time walking over the site observing wind shifts and gusts. As you walk, throw dry grass into the air to see how far it blows and in what direction. Do this several times in different locations. It is a simple observation but much can be learned from it.

RAIN

If it rains during the night, it is still possible to burn the next day, since a sunny day with a light breeze will dry grasses within hours. The morning dampness is an advantage for burning firebreaks, because fire in moist grass is easier to control. By late morning when firebreaks are completed, the grass has dried in the sun, and the prairie is prepared for a hot fire.

Rain may indicate that good burning weather will follow. Sudden lightning storms are associated with cold fronts, and weather following a cold front is often characterized by sunny days and steady winds from the northwest.

PREPARING FOR AND CHOOSING A DAY TO BURN

Several weeks before the planned fire, phone the local fire department and find out if burning permits are required. Permits may be required by the town fire warden, the fire department, the state conservation department, or other governmental agencies.

You cannot predict good burning weather more than a few hours ahead of time, so check weather reports the night before, and again on the morning of the fire. There is no substitute for experience in deciding what combination of weather conditions is appropriate for safe burning, so consult with someone who has had experience.

For the inexperienced crew, it may be best to start when conditions favor control--45% to 60% relative humidity, wind less than 6 mph, and air temperature 40° F to 60° F. Burn in late afternoon or early evening when you know relative humidity is on the rise. Experiment with a few small burns and learn about the fire's behavior and combustibility of various fuels

Contact the fire department on the day of the fire and explain your plans. Also explain your plans to the neighbors, since a fire department may be required to respond to a call from a concerned neighbor, despite prior assurance that it is a properly supervised fire. Finally, in case of a runaway fire, have the phone number of the nearest fire department, and locate the nearest telephone.

FIREBREAKS

A firebreak is anything that will stop a fire and contain it in a controlled area. It could be a plowed field, a road, a mowed path, or a burned strip of land. This section describes how to make firebreaks by burning.

A tractor mower can cut down the tall grass in spring just before burning a firebreak, making fire easier to control. Grass mowed once in July grows enough to carry a fire next spring, but the amount of fuel is reduced, thereby making fire easier to control. On the other hand grass mowed once in fall at the end of the growing season mats down and is difficult to burn in spring. With just a push mower it would be best to maintain a mowed firebreak around the prairie throughout the growing season.

A minimum of three to four people is necessary to burn firebreaks. Equipment should include at least one fire back pack, a rake, and a few flappers. Often the person in charge of a crew handles the rake and is responsible for dragging the fire no faster than the fire control crew can handle. One person is assigned to walk back along the burned firebreak extinguishing smoldering areas that could flare up, while the other crew members work with the individual handling the rake at the leading edge of the fire.

BURNING AT RIGHT ANGLES TO THE WIND

With the wind from the north, this is a method for burning firebreaks on the south and north borders of the prairie. To make the first firebreak in an east-west direction at the south end of the prairie, light a fire at the southwest corner, and drag it 5 to 10 feet eastward.

Extinguish flames carried with the wind on the south side of the line of fire, but allow flames to slowly back into the wind on the north side (Figure 1). You must quickly put out flames carried with the wind on the south side, lest an unexpected gust of wind fan it into a racing head fire. Drag the rake slow enough so the crew can keep up.

Allow the backfire to burn until the firebreak is 3 to 20 feet wide, then extinguish it, and drag fire another 10 to 40 feet east. Again, quickly extinguish the south side of the flames carried with the wind, and allow the backing fire to burn north against the wind. Repeat this process until you have a firebreak the length of the area to be burned.

Never allow the backfire to be more than 40 feet long, lest a wind shift turns a slow backfire into a blazing head fire. If you're impatient with a slow backfire burning a 20 foot wide break, then set a second line of fire 5 to 10 feet upwind (north) and parallel to the first line of fire. The wind will drive this second line of fire into the backfire of the first line. This is a quick way to widen a firebreak.

Use flappers whenever possible to conserve water. Water is needed to put out head fires, so don't waste it on backfires or you won't have enough for emergencies.

Some people prefer to rake a scratch line before they burn out the firebreak. They rake away as much litter as possible in a narrow line (wide as the rake) along the down wind side of the proposed firebreak. Then they light a backing fire along this scratch line. A good scratch line will significantly reduce the amount of water and work required to control a fire.

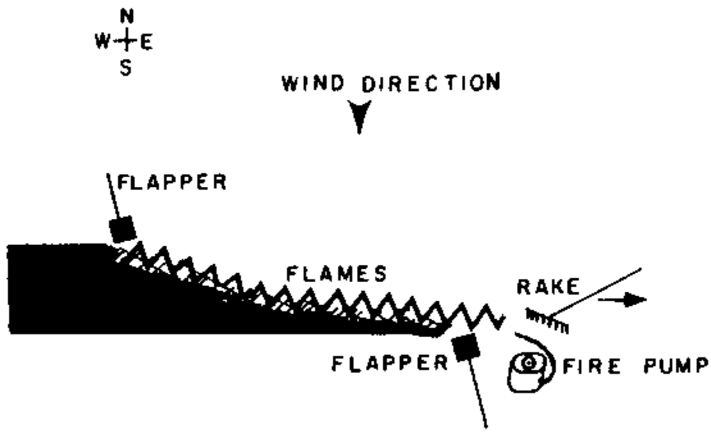


Figure 1. Drag fire to the east and allow it to burn into the wind from the north. Quickly extinguish flames on all other sides.

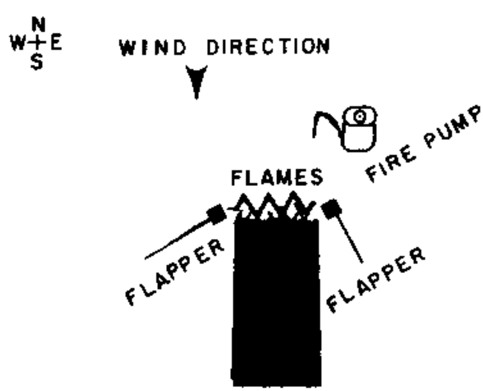


Figure 2. Fire is allowed to back into the wind in a line about 10 feet wide. Crew members control the width of the firebreak by extinguishing flames along the edges of the firebreak.

BURNING DIRECTLY INTO THE WIND

With wind from the north, this is a technique to make firebreaks along the east and west borders. For this firebreak along the east border, start at the south end (downwind), and drag a 5 to 20 foot line of fire at right angles (east-west) to the wind. Put out the flames on the downwind (south) side, and allow the fire to back into the north wind, making a firebreak 5 to 20 feet wide (Figure 2). Control the fire by putting out the edges of the line of fire, and allow it to burn into the wind forming a firebreak along the east (or west) border of the prairie.

BURNING AT AN OBLIQUE ANGLE TO THE WIND

With gusty winds, it may be easier to burn a firebreak at an oblique angle to the wind, rather than at right angles to the wind. For example, you could enclose a prairie in a 'U' shaped firebreak (open end towards the wind) using the methods described above, or you could enclose the prairie in a 'V' shaped firebreak using firebreaks at an oblique angle to the wind.

If wind is from the north, start the firebreak in the center of the south end of the prairie, and drag it northwest. Extinguish flames on the southwest side and allow the fire to burn as a backfire on the northeast side. A gust of wind from the north does not blow directly at a line of fire set by the rake, but instead fans the flames at an oblique angle. Therefore the fire control crew has an easier time extinguishing the flames on the downwind (southwest) side of the firebreak. The backfire will burn northeast into the north wind, and it is unlikely that the wind will shift enough to get behind the backfire to fan it into a blaze. This method can be safer than burning a firebreak at right angles to gusty wind, where a sharp gust works directly on the line of fire dragged by the rake.

BURNING ON STEEP SLOPES

Burn the first firebreak along the crest of the hill. Then, if fire escapes while burning the other firebreaks, it will burn uphill and stop at the top firebreak.

To burn firebreaks down the side of a hill, use a modified version of the technique for burning firebreaks into the wind. Start a 5 to 20 foot line of fire at the top of the hill and parallel to the crest. Extinguish fire on the uphill side and allow it to creep downhill.

Control the width of the firebreak by extinguishing the sides of the fire. Generally this is the technique used on the sides of steep hills because fire burns slowly downhill and quickly uphill, regardless of wind direction

BURNING AT NIGHT

The person assigned to put out smoldering fires along the firebreak should stay away from the main fire to preserve night vision. Good night vision is needed to see sparks that could ignite a serious fire.

It is difficult to burn a firebreak in a straight line when blinded by the light of the fire. Set up a lantern ahead as a target to aim for, or focus on a star. Keep track of equipment, as it is easy to burn it up in the dark.

CONDUCT A SIMPLE BURN

To plan this imaginary burn, we will use one acre of well drained prairie surrounded by old fields of quack and brome grass. Wind is out of the north, shifting northeast and back north.

PLANNING

Plan the burn on paper: 1) make several plans for wind from different directions, 2) plan where and in what order to burn the firebreaks, 3) plan what to do if wind shifts occur, or if fire gets out of control, 4) how much equipment and how many people will you need, and 5) how much time will it take to finish the burn.

Pace off the perimeter of the prairie to get the length of each firebreak needed to control the fire. An experienced crew of three to five people can burn 300 to 600 feet of firebreak in an hour. It may take several days for a small or inexperienced crew to complete firebreaks around a large prairie. Your purpose in burning firebreaks is to either encircle the prairie on four sides or prepare a 'U' or 'V' shaped firebreak with the open end towards the wind.

MAKING FIREBREAKS

Plan the sequence of burning firebreaks so that each completed firebreak reduces the risk of an escaped wild fire when the next firebreak is burned. Therefore, if wind is out of the north, burn the first firebreak on the south side at a right angle to the wind. If fire escapes while burning the other firebreaks, the north wind will drive the fire into the south firebreak.

Burn the second firebreak on the west border starting in the southwest corner, and head north. Burn this firebreak using one of two methods. Either use a ten foot wide line of backfire burning at right angles (east-west) to the north wind; or use a north-south line of fire burning to the east, while extinguishing flames burning on the west side of the proposed firebreak. A fire burning in a line parallel to wind direction is a flank fire, and since wind is shifting to the northeast, the flank fire burns as a backfire into the shifting northeast wind.

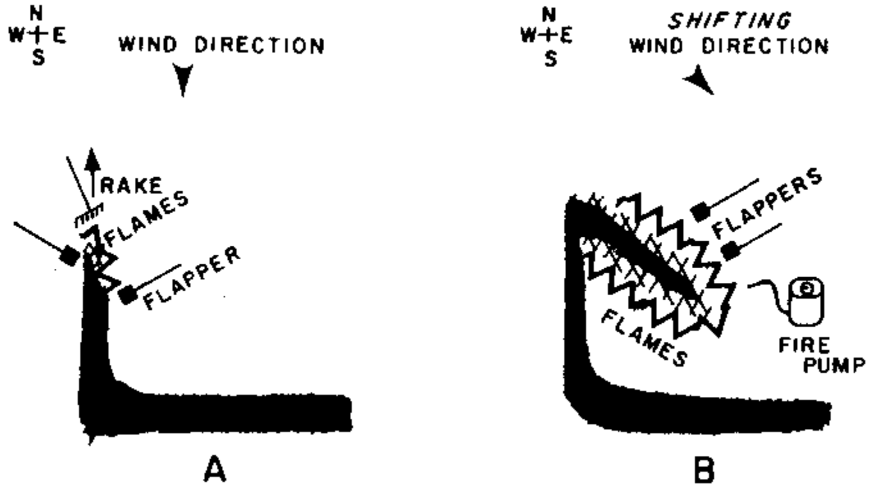
Remember, have no more than 40 feet of backfire burning at one time, lest an unexpected northwest wind transforms the flank fire into a racing head fire. If a sudden northwest wind did occur, the racing head fire would burn out at the south firebreak, while crew members put out the backfire burning to the north and east (Figure 3).

A flank fire is tricky to manage because a slight wind shift can transform it into a head fire. Keep the fire line straight, because wind fanning a bulge in the line will create a head fire. Watch for patches of heavy fuel where fire can surge ahead, forming a bulge.

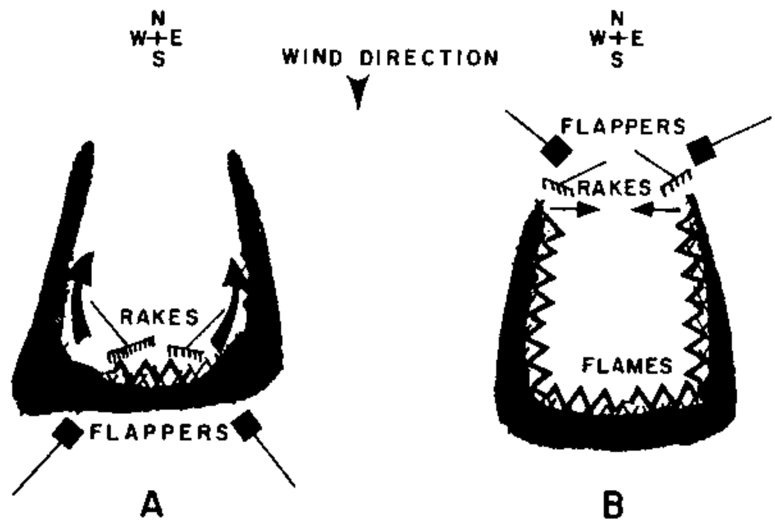
Make the third firebreak along the eastern border. Again, either burn the break with a 10 foot wide line of fire northward into the wind, or with a flank fire burning to the west. If fire escapes, it will burn out against the firebreaks on the south and west sides. If winds are variable, you may choose to burn a fourth break on the north end and encircle the site.

BURNING THE PRAIRIE

Now we're ready to burn the prairie. Walk around the firebreaks and check for spots that didn't burn well. If grass is thickly matted, rake off ashes and look for unburned grass where fire can creep across firebreaks. Unburned fuel can be burned when the backfires are lighted.



<u>Figure 3.</u> These two illustrations represent a changing situation where the wind shifts from the north (A) to the northwest (B) and gets behind a flank fire to fan it out of control. The fire heads toward the firebreak on the south border, while the fire control crew puts out flames on the north side.



<u>Figure 4.</u> In the first illustration (A), backfire and flank fires are set along the inside of the south, east, and west firebreaks. In the second illustration (B), a head fire is set along the north border, while the fire control crew extinguishes flames backing into the north wind.

Gather the crew together and explain how the fire will be set and where each crew member should be positioned. Review the fall-back plan in case of an escaped fire. Station several crew members downwind to watch for spot fires started by glowing embers. Remind people to spread out and to look behind for spot fires, because people tend to stare at the main fire, instead of downwind where spot fires can get started.

There are three basic patterns of ignition: a ring fire, a backing fire, and strip head fires. With a ring fire, the prairie is encircled with fire which sweeps across the area. But first, firebreaks are widened with backfires. Two people with rakes drag fire along the inside edge of the south firebreak in opposite directions from the center (Figure 4). They continue dragging fire along the inside perimeter of the east and west firebreaks, and halt at the northern end of the firebreaks. If wind is shifting north to northeast, the person dragging fire up the east border should stay several dozen feet behind the equivalent position of the person on the west border, so as to prevent smoke and fire from engulfing crew members on the west border.

Now the crew leader must determine if backing fires have widened firebreaks sufficiently to contain a head fire set along the northern border. Finally, rakes set the head fire across the north end, and crew members put out the backing fire burning northward. Be sure that everyone is ready for the head fire because it can burn with incredible speed and heat which will keep everyone dozens of feet away. Station people around the perimeter to watch for fires creeping across partially unburned portions of the firebreak, and for spot fires ignited by embers.

The advantages of the ring fire are: it gets the job done quickly, it creates strong hot updrafts which disperse smoke, and it burns areas of sparse fuels where fire must jump from clump to clump. The disadvantages are related to the intensity of the fire. Once the head fire gets a good start, it is a power unto itself, and only wide firebreaks will stop it. Also, there is a high potential for embers spotting fires outside firebreaks.

One might choose to burn the entire area with a backing fire. It's a relatively easy fire for an inexperienced crew to control, but you must watch out for a 180° wind shift which would fan the creeping backfire into a running head fire. A disadvantage of backfiring is its slow progress. In ten minutes, a backing fire might cover 30 feet, while a head fire could travel 200 feet, and the time needed to burn a large area with a backing fire increases the chance for a wind shift during the fire. An advantage is a reduction in the density of smoke released at any one time, although a disadvantage is that smoke tends to stay near the ground because there isn't a strong thermal updraft to disperse it.

Where litter is moist, a backing fire may consume more fuel than a head fire, and may cause more damage to woody invaders. A head fire will skim over dry upper layers and leave unburned the moist litter beneath. But a slow moving backfire will radiate heat back over the burned areas, and may dry out the litter enough so it will burn. Woody species are damaged and sometimes killed by the prolonged heat of a creeping backfire.

Strip head fires are probably the most versatile method of prescribed burning (Figure 5). The downwind firebreak is backfired to widen it so the first strip head fire won't jump it. Then each strip head fire is lighted upwind, and at a distance chosen to keep flame length and fire intensity at a comfortable level. The strips can be 20 to 150 feet wide. If conditions change or different fuel complexes are encountered, then strip width can be adjusted to control fire intensity. Small areas of heavy fuels can be backfired.

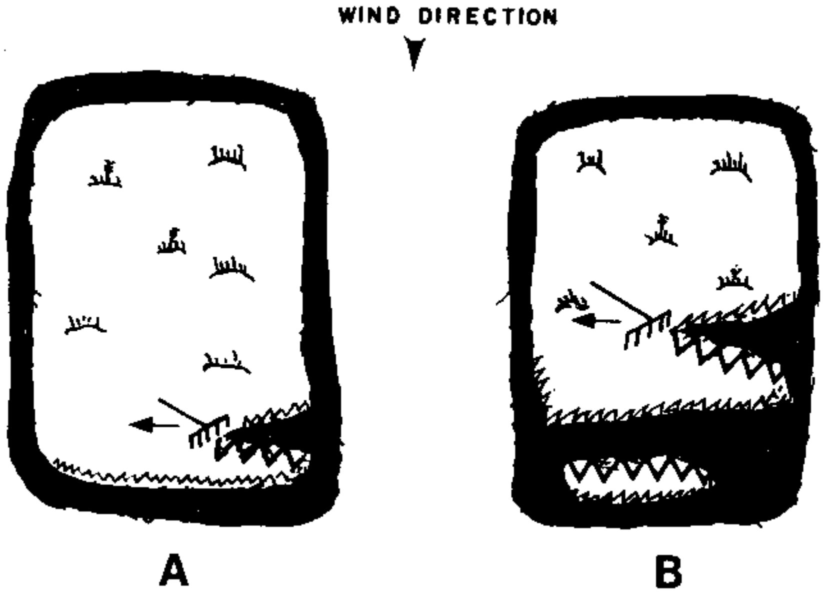


Figure 5. In the first illustration (A), the strip head fire is dragged across the width of the prairie and burns toward a backing fire along the downwind firebreak. In the second illustration (B), the first strip head fire is almost burned out while a second one is ignited and burns toward the backing fire of the first strip.

The hottest portion of a burn is where head fire of one strip meets backfire from the previous strip. At this point the two fires interact to produce the largest flames, highest intensity, and greatest thermal updrafts. A situation to avoid is three or more strips burning at one time, because interaction among strips can create unexpectedly intense fires. Fire interaction is most prevalent when fuels are heavy, winds are light, and strips closely spaced. In addition, fire lines should be kept relatively straight and normal to the wind. Deep curves in the line can cause fire on each side to interact and produce intense local fires.

ESCAPED FIRES

Better than having to deal with an escaped fire, is not to let it happen in the first place! Thorough planning is essential. But unfortunately, despite careful preparation fire does occasionally escape.

In advance: Learn the phone number of the nearest fire department, and locate the nearest available telephone. Designate one person to call if the fire escapes. Locate natural firebreaks like roads, rivers, plowed fields, etc. that might stop a racing fire, and plan how to set backfires to widen them if necessary.

Day of the burn: Determine where the wind would take an escaped fire, and locate the nearest natural firebreak in that direction. If fire escapes and the natural firebreak is wide enough to stop it, then divide into two groups and work on opposite flanks of the escaped fire. Extinguish the edges, work towards the middle, and narrow the advancing line of fire; while the leading edge of the head fire burns toward the natural fire break. Be alert for burning debris blown across the firebreak, starting new fires.

Do not get directly in front of a head fire. This area is very hot and full of smoke. A gust of wind can carry burning debris dozens of feet beyond the main fire, or cause flames to suddenly leap ahead--engulfing you in heat, smoke, and flames.

Backfire: Use a backfire as a last resort to limit an "out of control" fire. A backfire set along the edge of a natural firebreak like a small stream, ditch, or trail widens it. Drag a line of fire along the upwind edge (the side closer to the escaped fire) and let it burn into the wind. This may be enough to stop the racing head fire from jumping a small, natural firebreak.

Problems with backfires: If a fire gets out of control, you must race to the area selected for the backfire, work directly in the path of the racing wild fire, and then get out of the way. And because you're working fast, there are more chances for mistakes. Flames from the backfire could creep across a small, natural firebreak, creating two fires out of control. A partial solution is for two people to stay at the natural firebreak, and set the backfire if needed.

Often, the only thing to do when a fire gets out of control is to stand back and wait until it burns itself out. Be sure to know if any buildings, vehicles or other private property are in the path of the fire and act according to your emergency plan. It should go without saying that your vehicles are parked in a safe place, not in the potential path of an escaped fire.

Avoid driving or parking vehicles with catalytic converters over dry grass, because a converter is hot enough to ignite dry grass.

FINISHING UP

Extinguish any smoldering hot spots. Look for smoldering clumps of bunch grass because these plants may die if fire in the center is not put out. Turn over logs to check the undersides, because wind can fan a smoldering piece of wood into flames. Check for fire at the base of wooden fence posts, trees, railroad ties, and poles. It may not be necessary to extinguish all the little smoldering fires, but it is good public relations to be thorough.

Conserve water--get it directly on the hot spot. Work in pairs, one person rakes away ashes or turns a log, while the other wets it down. Finally, inventory equipment and be sure nothing is left behind.

Good! Now sit down, put your feet up, and have a beer. You've earned it!

RAKE —SQUIRT—

HAZARDS

OVERCONFIDENCE

A controlled burn can turn into a wild fire in less than one minute, and the typical reason for fire getting out of control is inattention and inadequate planning. People take their skill in handling fire for granted if they work with it for several hours, but conditions change during the day. Reduced relative humidity and a sudden gust of wind from an unexpected direction can change the character of the fire, and you must be ready to respond immediately. Everyone on the fire control crew must remember that fire is a dangerous tool. It can be controlled, but not tamed. **Every fire is a potential wild fire.**

PINES

Pines are often planted near dry prairies. Keep fire away from pines, because flames can ignite pitch exuding from wounds in trunks, setting the whole tree afire, and pitch fires are difficult to extinguish.

On the other hand, an individual pine on a prairie can be surprisingly well adapted to fire. Needles may get scorched and killed, but new ones emerge each spring from buds which seem immune to all but the hottest fires. Burning around pines in late spring is more hazardous than early spring because fresh needle growth has a high resin content.

Fire in the ground layer of needles is difficult to put out because it smolders under the surface and flares up several minutes after you're sure it's all out. You may have to rake litter away down to bare ground creating a small firebreak.

BRUSH

Fire is one way to control brush, cutting it down is another, but only the tops are killed and the brush resprouts. Burning through brushy areas causes problems not encountered with grass alone, that is, burning wood embers float up on fire thermals and land outside firebreaks igniting new fires. This is an increasing hazard as relative humidity drops below 50%; above 50%, spot fires rarely occur.

Burning embers may travel 10 to 100 feet or more depending on wind speed and fire intensity, so learn to take this into account when planning ignition pattern and width of fire breaks. Cutting down brush ahead of time will reduce the likelihood of embers rising on hot air currents. In addition, the multiple resprouts of cut brush are more heavily damaged then the single stemmed saplings. The multiple stems trap leaf litter which burns hot in the center of the sprouts.

The renewed vigor shown by some woody invaders after a fire can be discouraging. It often takes three consecutive years of fires to significantly reduce the density and vigor of many woody species. A relative humidity between 25% and 35% is considered ideal to inflict maximum damage; below 25% conditions are hazardous for a prescribed burn.

OAKS AND OAK LEAVES

Oak leaves persist through the winter without decomposing, and a breeze can carry burning leaves across firebreaks. Leaves are also carried up in thermals and small fire storm whirlwinds. The solution to this problem is wide firebreaks and alert crew members around the perimeter.

Black oaks often have an abundance of dry leaves hanging on branches in spring. Tongues of flame from a tall grass fire can reach up and ignite them, making a good deal of excitement. Usually there is no problem. The leaves burn too quickly to damage the oak, although some leaves may blow across the firebreak, igniting new fires.

RED CEDAR (junipers)

Cedars are sensitive to fire. At one time wild fires routinely killed small cedars before they could get established on bluffs and hill-prairies. But now, cedars dominate many dry prairies because wild fires have been stopped. Some cedars are extremely flammable, going up like torches soaked in kerosene, while others do not burn at all. For example, <u>Juniperus communis</u> (juniper) invariably burns hot, while the flammability of <u>J. virginiana</u> (red cedar) varies with the individual. Even resistant junipers will burn with repeated fires, because the low branches killed by previous fires act as tinder to kindle the whole tree. Beware! Burning cedars send embers high into the air, so watch unburned areas for several hundred feet downwind.

ROLLING TERRAIN AND FIRE WHIRLWINDS

Fire whirlwinds are created by the thermal updrafts of a fire burning up and around hills and knolls, and resemble the dust devils often seen on dry, dusty ball diamonds. These fire whirlwinds create problems by carrying burning material aloft and depositing it dozens of feet away, igniting new fires.

The solution is alert crew members posted around the perimeter, and knowledge of when whirlwinds are likely to occur. Fire whirlwinds happen when winds are light (3-8 mph), fuel concentrations are heavy, and head fires meet backfires. Whirlwinds also occur when fire burns up a lee slope and over a ridge into the wind.

DEAD TREES AND CHIMNEY FIRES

A hollow or cracked wooden pole (e.g. telephone pole) or tree (dead or alive) can ignite, creating a chimney fire. Fire in the bottom of the tree creates a draft up the hollow center fanning flames at the base, just like a fireplace and chimney. A hollow, punky log on the ground can act as a horizontal flue and create sparks which will carry several hundred feet. A surprisingly small flame licking punky wood can start it smoldering, often not noticeable for fifteen or twenty minutes, and fire in rotten wood is difficult to extinguish.

If you have a chimney fire, then one of the few ways to stop it is to cut the tree down, otherwise you'll need lots of water and maybe a ladder. Therefore, create firebreaks around problem trees by raking away excess grass, wetting down the trunk, and burning a firebreak around the base.

Some people recommend removing any "problem" trees before conducting a prescribed burn; but these hollow trees are homes for flying squirrels, raccoons, woodpeckers, bluebirds, and many other animals.

WOODEN FENCE POSTS, RAILROAD TIES, AND DEAD WOOD

Some people firmly believe that a grass fire will burn quickly past wooden fence posts without igniting them. This is probably true with new, treated posts, or when relative humidity has been high for a few days, but otherwise old posts ignite easily and smolder perhaps undetected for a long time. Either burn a firebreak around each post or keep them soaked with water. Old railroad ties also burn well, so keep an eye on them.

If possible, remove logs and other dead wood lying on the ground. This will save you the trouble of staying late to put out smoldering logs--long after the grass fire is finished. In addition, a pile of burning wood will kill roots of prairie plants and open an area for weeds.

PROTECTING SPECIMEN TREES

A hot fire around the trunk of a small tree can kill the cambium layer, girdling the tree. In addition, hot drafts from a vigorous fire can kill the lower branches. Keep fire away from specimen trees, or rake away excess fuel and burn around and under them with a backfire prior to setting the main head fire.

TELEPHONE LINES AND POWER LINES

Low telephone lines can be damaged by the heat of a head fire, so burn under lines with a backing fire. Use caution around power lines because the carbon in a thick blanket of smoke billowing through the lines can allow bolts of electricity to arc across.

UNPLOWED FIELDS

Corn stubble will burn and is difficult to extinguish, so don't expect an unplowed field to act as a firebreak. Standing corn burns even better than stubble.

MARSH LAND WITH STANDING WATER

Fire will move through a marsh with standing water. On a warm day the tops of the grass are dry, even though the bottoms are immersed in water. Fire carries right over the surface of the water, burning the dry tops. Therefore, do not expect a wet marsh to act as a firebreak.

PEAT FIRES

In a dry year, organic marsh soil can catch fire, so don't burn in a marshy area if the soil is dry. Peat fires are extremely difficult to put out, and can burn for months. Be aware of sphagnum in certain wet prairie-marshes which could be destroyed by fire in a dry year.

COLD AIR DRAINAGE

After sunset the temperature falls, and as air cools, relative humidity increases; grass absorbs more moisture, fire burns slower, and may eventually go out. Cold air drainage exaggerates this effect, because the heavier cool air accumulates in low areas, and relative humidity jumps dramatically after sunset.

THICK MATTED GRASS

Fire can be difficult to extinguish in a thick mat of old field grass, especially a backing fire. Flames smolder under the surface, and when you hit matted grass with a fire swatter, embers fly out spreading the fire (this is a particular problem with reed canary grass). The fire broom is especially effective on a backfire in matted grass, because it sweeps under the edge of the mat and gets directly at the hot spot. A stream of water from a fire pump is deflected by the dense mat, and fire beneath will continue to smolder. Water is most effective if you work from within the burned out area, and squirt it back beneath the mat, directly on the hot spot. However, the burned out area of a backing fire is very smoky.

There's a hazard associated with burning firebreaks in matted grass moistened by dew or rain. Fire burns off the dry upper layer leaving behind patches of moist grass exposed to the drying action of wind and sun. When firebreaks are completed and the prairie set afire, then flames creep across the firebreak by burning these patches of partially dried, matted grass.

ROCKS AND BOULDERS

It is difficult to extinguish flames in an area with rocks and boulders, because flappers do not work well around rocks. You may need extra water available when burning firebreaks in these areas.

POISON IVY

It is hazardous to burn through areas of poison ivy, because smoke particles carry the irritating oil from dead leaves and woody stems. Contact with this smoke causes a rash on sensitive people, and if inhaled causes serious complications in the lungs. This appears to be more of a problem with fall fires and when burning brush piles containing poison ivy debris.

THICK SMOKE FROM GREEN GRASS

In late April and early May, cool season grasses like brome and quack grass will be green and 3 to 8 inches tall. On a dry day, this green material will burn with lots of smoke. Avoid breathing this smoke, because smoke from green plants can make a person sick.

Often you can attack a smoky head fire from inside the burned area, and from this position, wind carries smoke and heat away from you (as seen in the sketch to the right). If you get caught in a cloud of smoke, crouch down where air is cleaner and move to a safe area.

Allowing smoke to cross certain highways may violate the law, so use care when burning near highways, and try to select a day when wind will not carry smoke across the highway.

LOW RELATIVE HUMIDITY

It is hazardous to burn on days with extremely low relative humidity (less than 20%) because abnormally dry grass will erupt into flames. Under these conditions a light gust of wind can take a small fire raging out of control. Moisture contributed by humidity slows a fire because some heat is used up drying out the grass before it will burn. The day's lowest relative humidity is usually between 3:00 and 5:00 p.m.

APPENDIX

THE EFFECTS OF BURNING

The most obvious effects of a burn are easily seen. Fire rejuvenates a prairie; more plants flower, produce seed, grow taller, and are generally more robust than the previous year. Specifically, fire lengthens the growing season for most native prairie plants and shortens it for the Eurasian "weeds." Fire increases available nutrients through indirect stimulation of microbial activity in the soil, and by releasing a small amount of nutrients from the ash. Fire also controls invasion of shrubs and trees.

How does fire accomplish all this?

First, it lengthens the growing season for "warm-season" native plants by burning off accumulated leaf litter in the spring and exposing a darkened soil surface to the warming rays of the sun. Without fire, the light colored leaf litter reflects the sun's rays, insulates the ground like a blanket, and slows the soil warming process. Most prairie plants grow best in warm soil, and the sooner the soil warms up, the sooner plants start growing. This may extend the growing season by as much as four weeks. Prairie plants are not damaged by a spring fire because most have buds which lie just beneath the ground where they are protected.

Second, fire shortens the growing season for many Eurasian "weeds" (cool-season plants that originated in the meadows of Europe). Bluegrass, quack grass, and brome grass are examples of cool season plants which are serious weeds in some prairies. These grasses are usually dormant during the heat of summer, and studies have shown that warm soil causes the roots of some cool season grasses to stop growing.

As a result, the same fire that encourages warm-season plants, discourages cool-season invaders by advancing the onset of warm soil temperatures. In addition, fire may induce water stress on drier prairies, and since prairie plants are better adapted to drought, they compete favorably with the cool season meadow plants of Europe. Finally, a prairie burn in late April or early May is liable to burn off 3 to 8 inches of growth on the cool-season plants before prairie plants have even started growing.

These factors combine to shorten the growing season for cool-season weeds and give a competitive edge to prairie plants. Unfortunately, late burns also shorten the growing season for native cool-season grasses such as needle grass (Stipa spartea), june grass (Koeleria cristata), and wild rye (Elymus canadensis). Although fire may reduce the dominance of these cool-season native plants, it will probably not eliminate them.

Third, an indirect result of fire is an increase in microbial activity early in the season due to the warm soil temperatures explained above. This microbial activity releases more nutrients earlier in the season. The nutrients come from the breakdown of organic material in the soil, and from special free-living nitrogen-fixing bacterial which combine free atmospheric nitrogen with other elements, and converts it to a form of "fertilizer" that plants can use.

Fire also stimulates the growth of native prairie legumes which have root nodules with a bacteria that converts atmospheric nitrogen into a form usable by other plants.

Relatively insignificant amounts of nutrients (mostly phosphorus and potash) are released onto the soil by burning leaf litter, and the nitrogen is lost into the atmosphere, making it is unavailable to prairie plants.

Because of abundant rainfall in Wisconsin, trees and shrubs invade open sites. Farther west, the lack of rainfall keeps brush out of prairies, but in the Midwest our prairies need help from an occasional fire. Fire controls woody plants in two ways. First, fire stimulates prairie plants to form a vigorous sod which prevents establishment of woody seedlings. Second, fire kills the above ground parts of invading shrubs and trees. Deciduous trees and shrubs resprout from the roots, but conifers such as red cedar and some pines are killed by fire. Repeated fires are needed to keep resprouting brush under control. Fire weakens brush, but rarely eliminates it completely.

SWEET CLOVER

Sweet clover (Melilotus alba & M. officinalis) can be a serious weed in planted or native prairies. Dense stands of sweet clover can decimate native prairies and destroy new plantings. Sweet clover is a biennial; it produces green herbage the first year, produces flowers and seeds the second year, and then dies.

Fire can control sweet clover, and the best control has come with an early April fire one year followed by a mid-May fire the following year. The early April fire stimulates germination of sweet clover seeds, and the mid-May fire destroys fresh growth on second year plants. To be effective, the mid-May fire must occur after sweet clover has grown sufficiently to completely shade the lower 5 inches of the stem. Shade kills the axillary buds where resprouting occurs, while fire destroys the tops.

This burn regime is most effective when sweet clover is synchronized; that is, one year all plants are seedlings and the next year all plants are flowering. Conversely, out of synchronization means that flowering plants and seedlings are mixed together in the same area in the same year.

On occasion fire appears to be the cause of a sweet clover problem. This phenomenon occurs on native prairies that haven't been burned in several years, and where an occasional sweet clover has dropped seeds. Fire stimulates germination and removes the 6 to 12 inches of duff covering the seeds. Removal of the leaf litter allows seedlings to reach light immediately, and the result is an explosion of sweet clover in a prairie that never had many.

Acknowledgments

The author thanks Elaine Andrews, Richard Henderson, Evelyn Howell, Virginia Kline, and Simon Widstrand for reviewing this paper. Much of the information about when and how frequently to burn, and the effects of burning were Contributed by Richard Henderson. I am indebted to the Dane County Environmental Council and The Dane County Highway and Transportation Department for their support. Finally, I give special thanks to Petra Jones for patient editing, and Gene Moran who introduced me to burning and shared his 25 years of experience.