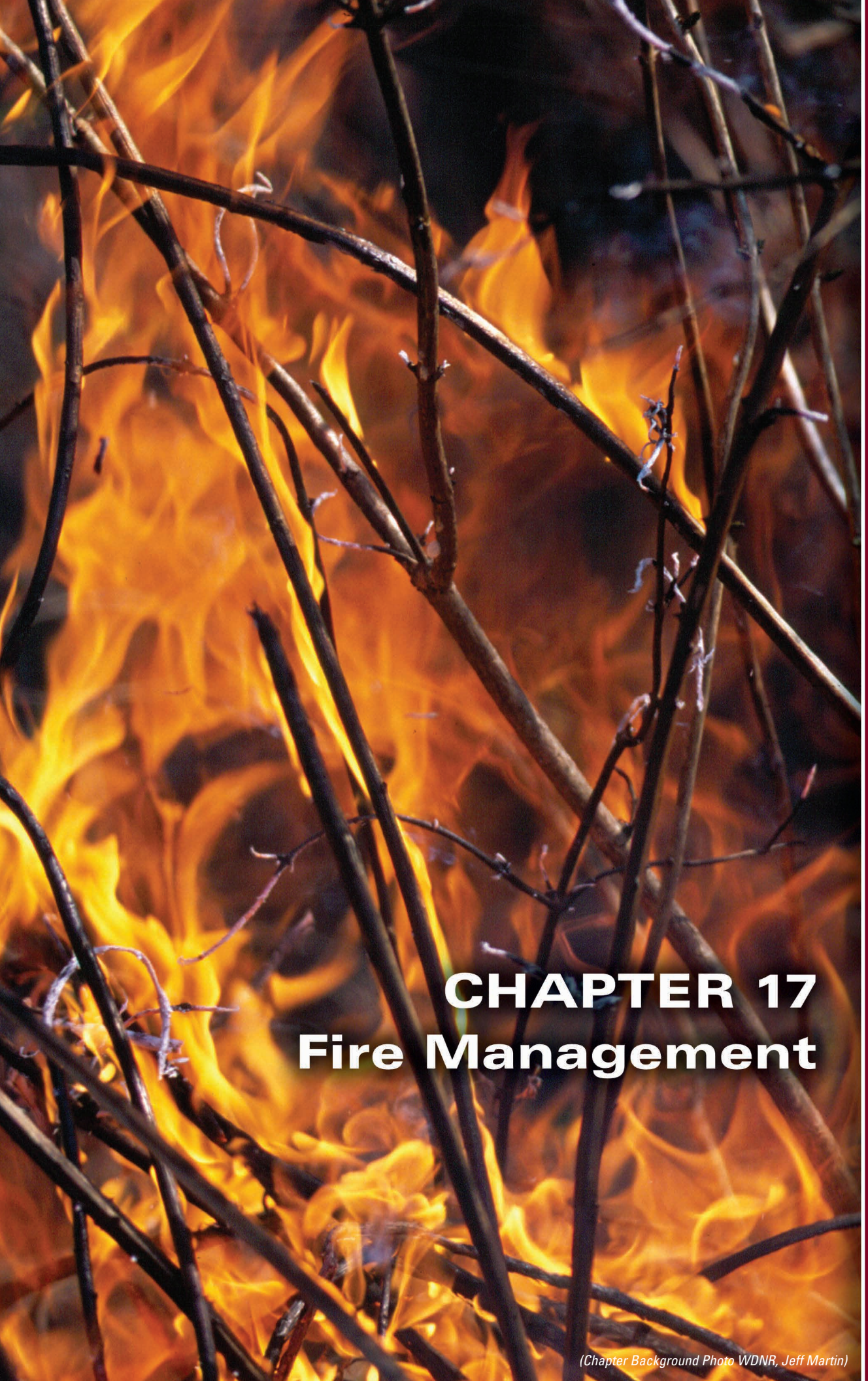

17

CHAPTER 17
Fire Management

(Chapter Background Photo WDNR, Jeff Martin)

CHAPTER 17
FIRE MANAGEMENT

Part I: Wildfire Management

Part II: Prescribed Fire Management

Part I: Wildfire Management

Figure 17-1: A Wisconsin DNR tractor and fire plow construct a control line to protect a home from a wildfire in Marquette County. Careless people cause over three-fourths of such wildfires, debris burning being the number one cause. Many of these fires can be prevented and losses minimized with diligent precautions and fuel management.

Wildfire management involves the control, containment and suppression of a wild or uncontrolled fire. A **wildfire** is defined in Wisconsin state statues as an uncontrolled, wild or running fire burning in forest, marsh, field, cutover, or other lands.

Every year, more than 2,500 wildfires occur in Wisconsin, causing thousands of dollars of damage to property, and destroying natural resources. Wildfire managers prioritize the protection of lives, property and resources – in that order. The challenge of every manager is to minimize the damage done by wildfire, while at the same time ensuring the safety of everyone involved.

Protection of Resources from Wildfire

The protection of forest resources is vital to maintain the economics and aesthetics of Wisconsin forests. Landowners can implement a number of simple strategies to protect our valuable forest resources.

- **Maintain access trails and roads.** The spread of wildfire can be slowed by these barriers, thus limiting potential fire damage. Well-maintained roads also allow fire suppression crews to more easily access the wildfire area, speeding up suppression and mop-up.
- **Construct firebreaks or barriers to fire**, to protect high value forest resources, such as conifer plantations. The construction of firebreaks involves the elimination of flammable natural fuels, such as grass and leaves. Removal of the fuels down to bare mineral soil, will slow/stop the spread of wildfire into protected areas.
- **Remove the lower limbs of conifers and small trees near larger conifers** to help minimize the potential of catastrophic crown fires. The elimination of these "ladder fuels" will not allow a fire burning in surface fuels to climb into the crowns or tops of the existing trees. **Crown fires**, or fire in the tops of conifers, destroy the economic value and kill the trees. Crown fires also have the greatest potential for damage to lives, property and natural resources, and are extremely difficult and dangerous to control once they are started.

Protection of Property from Wildfire

Protecting property such as buildings, homes and garages is a high priority. Property owners in wildland areas can take some simple precautions to assist in protecting their property from the ravages of wildfire. The objective is to create an environment where buildings can survive a wildfire without the intervention of firefighters.

PLANNING PRECAUTIONS

- Plant fire resistant landscaping vegetation around homes. Deciduous plants hold more moisture and are less flammable than conifer plants. Carefully space plants and prune them regularly. Remove dead leaves and other litter from around the plantings.
- Construct buildings using fire resistant materials when at all possible. Such materials include cement, stucco, plaster, steel, masonry, and fireproof sidings. Roofing materials should also be fire resistant. Available materials include Class A shingles, metal sheeting or ceramic tile. Embers and sparks igniting nonfire resistant roofs have played a major role in the destruction of buildings on large forest fires.
- Plan a defensible space extending 30 feet around the building as free of combustible fuel as possible.

EXISTING STRUCTURES

- Maintain building driveways to a standard of 12 feet wide and 15 feet of vertical clearance. This allows fire trucks access, and forms a firebreak to slow or stop wildfire. The driveway should also include a turnaround near the buildings to allow fire suppression equipment to easily escape to safety.
- Clear the roof and gutters of needles, leaves and other debris.
- Screen outside openings to the basement, attic and roof vents.
- Mow the lawn and keep all vegetation healthy and well-watered.
- Clean up leaf and needle litter, especially against buildings and under porches and decks.
- Store woodpiles and other flammable materials at least 30 feet away from structures.
- Maintain a defensible space extending 30 feet around the buildings. The objective is to create an environment where the buildings can survive a wildfire without direct intervention from fire suppression crews. This 30-foot zone of protection should be as free of combustible fuel as possible to limit any ignitions from the wildfire. Trees should be pruned up six to 10 feet, and all tree limbs within 15 feet of the building removed. Any dead vegetation such as leaves, needles, twigs, and branches should be removed. The grass should be mowed and adequately watered.

Part II: Prescribed Fire Management

Prescribed fire is the intentional application of fire to wildland natural fuels, under specific environmental conditions, to accomplish planned land management objectives. Historically, Native Americans used fire liberally to accomplish improved travel conditions, improve berry production, clear land, confound enemies, and for hunting. Today, prescribed fire can be used as a part of forest management to satisfy many different land management objectives. Though it is not generally considered a timber stand improvement practice, it can in some circumstances be used to accomplish many of the same goals as weeding or cleaning. While commonly prescribed, it is one of the most complicated and complex operations to implement.

Integrated Resource Management Considerations

- Prescribed burns can impact wetland areas and water quality if not carefully planned and conducted.
- Prescribed burns should be planned to avoid nesting seasons and other critical wildlife use periods.
- Prescribed burning can reduce the number of snags, den trees, and amount of course woody debris on a site.
- While prescribed fire can be used to treat nonnative invasive plants, it does not in and of itself eradicate them. Some temporary control is likely, but difficulties sustaining long-term control are confounded by the:
  - patchiness of understory and mixed-severity fuels and fires
  - persistent seed banks of nonnative invasive plants
  - ability of many species to rapidly increase after fire (fire equipment can transport seed to new locations and burned areas can be ideal seed beds)

  Prescribed fire, while not effective on its own, can be part of an integrated management strategy.
- Smoke and blackened vegetation can affect visual quality in sensitive areas.
- Burning in standing timber may affect merchantability, since pulp and paper industries cannot accept charred wood.
- Prescribed burning, particularly firebreak construction, can adversely impact cultural areas.
- Repeated intense burns may affect soil productivity. When conducting prescribed burns, use low- or moderate-burning intensity so that the minimum amount of forest floor is consumed consistent with meeting the objectives of the burn, especially for dry, sandy soils or shallow soils over bedrock.

TO BURN OR NOT TO BURN?

Prescribed fire is a versatile tool in land management. In managing forests in Wisconsin, however, sometimes it is not the best choice. If any of these situations exist, the use of prescribed fire is not a viable option:

- Federal or state regulations prohibit burning.
- Local ordinances or zoning rules prohibit burning.
- Safety factors cannot be mitigated to ensure personnel safety.
- Containment risk factors exceed suitable limits.
- Endangered resources or natural communities are subject to harm, or their status is in doubt.
- The natural community or timber type being managed is not adapted to fire. In Wisconsin, oak is most closely associated with prescribed fire. Most other timber types are incompatible with fire (i.e., northern hardwoods, central hardwoods, etc.).
- Fire behavior or fire effects will not meet the objectives for the burn area (e.g., if the goal is to top kill buckthorn three to four inches in diameter, it is unlikely that a fire with one to two foot flame length would be able to safely generate enough intensity to accomplish the goal).
- Local residences would be in jeopardy.
- Smoke sensitivity issues cannot be mitigated satisfactorily.

PLANNING AND DESIGN

Figure 17-2: A pre-burn briefing conducted prior to every prescribed fire addresses a number of critical items.

Prescribed burn plans generally involve a written document that addresses a number of factors. The plan should clearly describe the existing vegetation on the burn area, and the desired future condition. The plan should also spell out the specific weather conditions and ignition patterns required to achieve the desired fire behavior. Any issues relating to adjacent lands, communities, structures, roads, smoke management, and traffic control needs should also be addressed. Finally, the plan should identify the people and equipment needed to safely complete the burn, and include a detailed contingency plan for reacting to any emergency.

Burn Plan Management

- Consult with local Wisconsin DNR personnel trained and experienced in prescribed burning for pertinent assistance in planning and conducting burns.
- Check local fire regulations and obtain a burning permit from the Wisconsin DNR or your local municipal or township authorities, as needed.
- Consider protection of the largest coarse woody debris from fire, if practical.
- Include cultural resource information in both wildfire suppression and prescribed burn plans. Important information includes:
  - Locations of known cultural resources.
  - Locations of high probability areas for the occurrence of cultural resources.
- Identify occurrences of nonnative invasive species, and evaluate the effects fire is likely to have on them. Identify any need to treat infestations prior to burning, or any integrated pest management (IPM) treatments to be used in conjunction with burning to prevent new infestations (see 8.1, 8.3 and 8.4).

Land Management Objectives

Achieving land management objectives are the primary consideration for conducting prescribed burns. These objectives are varied and diverse. Some examples are:

- **Fuel reduction to reduce the risk of catastrophic wildland fire.** This objective is especially important in forests in proximity to urban areas. Reducing fuel loads is one of the most effective elements of any fire prevention and protection program.
- **Site preparation for natural seeding or mechanical replanting forests.** Prescribed burning is one of the least expensive and most environmentally sound ways to accomplish this practice. Nutrients are released into the soil during burning to further enhance the re-establishment of a new forest.
- **Restoration of fire dependent ecosystems.** Fire is a natural and necessary component of some ecosystems, such as native prairies and oak savannah. Periodic fire is required for regeneration and growth of fire adapted species within these systems. Prescribed burning assists in restoring and maintaining these rare plant and animal communities.
- **Improvement of wildlife habitat.** Fire and wildlife have a long and intimate association both in and out of the forest environment. Prescribed fire is rarely lethal to wildlife and helps habitats by increasing browse – creating edge and increasing productivity.
- **Controlling vegetative competition.** Examples would include burning to decrease woody vegetation in grass duck nesting fields, or to control maple sprouts while favoring more desirable oak seedlings.
- **Controlling forest insects and diseases through the use of fire.** Certain pathogens and insects can be controlled through the timely use of prescribed fire.
- **Improved pasture conditions for livestock is possible through prescribed burning.** Research has shown forage for livestock can be improved in quality and quantity with timely burning.
- **Control of nonnative invasive plants and other competing vegetation** can be accomplished, in some cases, by exploiting sensitivities to fire.
- **Enhance desired aesthetic qualities** by favoring specific plant species, or enhancing herbaceous components.

Factors Influencing Fire Behavior

A prescribed fire is designed around a carefully developed burning prescription designed to generate the specific fire behavior needed to accomplish the intended land management objective. The following are key components that must be considered.

FUEL

Fuel is defined simply as any combustible material. Wildland fuels consist of live and dead plant materials. Some factors of wildland fuel affect the prescribed burn planning.

- **Fuel types** are classified by the primary carrier of the fire. Light fuels are grasses, leaves and small twigs, which burn rapidly and completely. Heavy fuels – made up of branches, limbs and trees – burn hotter, longer and more slowly.
- **Fuel moisture** is the amount of water in a fuel. The higher the moisture the slower a fuel will burn. Both live and dead fuel moisture has to be considered before burning. Light fuels take on and lose moisture much faster than heavy fuels.
- **Fuel loading** (see Figure 17-3) is a very important consideration in planning a prescribed burn. The fuel load is the quantity of fuel available for combustion. The higher the fuel load, the more intense a given fire.
- The horizontal continuity of fuels is important to predict the spread of a prescribed fire. **Uniform fuels** are continuously distributed over a given area. **Patchy fuels** would indicate uneven distribution of fuels.
- The vertical arrangement of fuels is also important. **Ground fuels** are fuels able to burn under the surface of the ground (i.e., deep duff, tree roots, peat soils). **Surface fuels** are combustible materials on the surface (i.e., grass, leaves, shrubs, stumps). **Aerial fuels** are the fuels located above the surface in the canopy including leaves, needles, branches, snags, and tree crowns.

Figure 17-3: Light fuels tend to burn rapidly and completely. They also dry out much faster than heavier fuels when the relative humidity decreases.

WEATHER CONDITIONS

Weather conditions are another important consideration. Weather conditions must be closely monitored before and during prescribed burning. Both predicted and actual weather will influence the decision to burn. Some basic weather parameters that must be evaluated in the development of a burning prescription include:

- **Temperature:** A measure of warmth that directly influences fuels. Higher ground and fuel temperatures make the fire burn hotter and faster.
- **Wind:** The primary factor influencing the rate and direction of fire spread. Wind encourages the combustion process and spread of fire by increasing the supply of oxygen, drying out fuels and carrying firebrands ahead of the main fire.
- **Relative Humidity:** The ratio of the amount of moisture in the air to the amount of moisture the air could carry at saturation. Fuels and the air are constantly exchanging moisture. Light fuels, such as grass, gain and lose moisture quickly with changes in relative humidity. A **low relative humidity** means the air will take moisture from light fuels, making it easier to ignite and burn rapidly. Heavy fuels exchange moisture with the air much slower, and respond to changes in the relative humidity much slower.

TOPOGRAPHY

Topography is the configuration of the earth's surface, including its relief and position of its natural land features. Topographical influences on the behavior of a fire can be predicted. Several topographic terms are important to understand in relationship to fire behavior.

- **Aspect:** The direction a slope faces. A south facing slope will absorb more of the radiant heat of the sun, therefore, the fuels on that slope will have a lower fuel moisture allowing for easier ignition and rapid spread of fire. North facing slopes will have wetter fuels, therefore, less intense fire.
- **Slope:** The steepness of a hillside. Fires burn more rapidly uphill than downhill. The steeper a slope, the faster a fire burns uphill. Slope also causes concern where burning materials can roll downhill and ignite fires below the main fire.
- **Elevation:** The height of terrain above mean sea level. Elevation can play an important role in the types and conditions of fuel. Fuels at lower elevation generally dry out earlier in the year than higher elevation fuels.
- **Shape:** The rugged topographic features of the landscape, such as box canyons, ridges and saddles. These features can affect the rate, direction and intensity of a fire burning near them.

OPERATIONAL CONSIDERATIONS

Once the decision to conduct a prescribed burn has been made, the next step is to evaluate a number of operational considerations that are key to conducting a successful burn.

Fire Spread Patterns

The direction of fire spread, relative to the wind direction, is an important factor in managing the fire behavior relative to the land management objectives of the burn. Fire spread can be categorized into three basic types: backing fire, head fire, and flank fire.

BACKING FIRE

Backing fire is a fire that backs into the prevailing wind or downslope. Fires of this type transfer heat to adjacent fuels through radiation. Backing fires produce short flame lengths, slow rates of spread, and low smoke densities but with poorer smoke dispersal. **Backing fires burn fuels for a longer duration and at higher temperatures, and consume more total fuel than flanking fires.** Overall prescribed burn costs per acre are higher because of the longer time needed to complete a burn. Backing fires work well when wind velocities are low and from a constant direction. Burning downward on slopes has a similar effect as backing fires in flat areas.

HEAD FIRE

A **head fire** is a fire that burns with the wind or upslope. This type of fire spread transfers heat to adjacent fuels by convection. Wind drives convective heat into fuels downwind – lowering fuel moistures, raising fuel temperatures, and lowering ignition temperatures. Head fires burn fastest, hottest and with the longest flame lengths. **Head fires are the most difficult to control because of the greater potential for firebrands to ignite fuel outside the burn area.** Head fires transfer less heat to the surface with greater smoke volumes than backing or flanking fires. Containment is critical with this kind of fire, especially as wind speed and the amount of fuel increases.

FLANK FIRE

Flank fire is a fire spread that burns at oblique angles to the prevailing wind direction or slope direction. Flanking fires transfer heat through both radiation and convection. **Rates of spread, flame lengths, and fire intensity are between the extremes of head fire and backing fire.** Spotting can still occur with flanking fire, but at shorter ranges. Flanking fires are set parallel to control lines on a prescribed fire and spread at right angles to the wind or slope.

Ignition Patterns

Specific ignition patterns are used for each type of fire spread. The ignition pattern and ignition sequence are key to achieving the objectives of the burn, and meeting the containment requirements of the burn area with a minimum of risk.

BACKING FIRE IGNITION PATTERN

This firing pattern (see Figure 17-4) involves lighting a fire along the upwind side of an established control line, and letting it back into the wind. It is commonly used in closed canopy forests. **The advantages of this pattern include ease of control, low intensity, low rates of spread, and low scorch of trees and shrubs.** It is also a good method for controlling undesirable species with longer heat retention in the soil and roots. The negatives are slow moving fire, increased costs per acre, and patience.

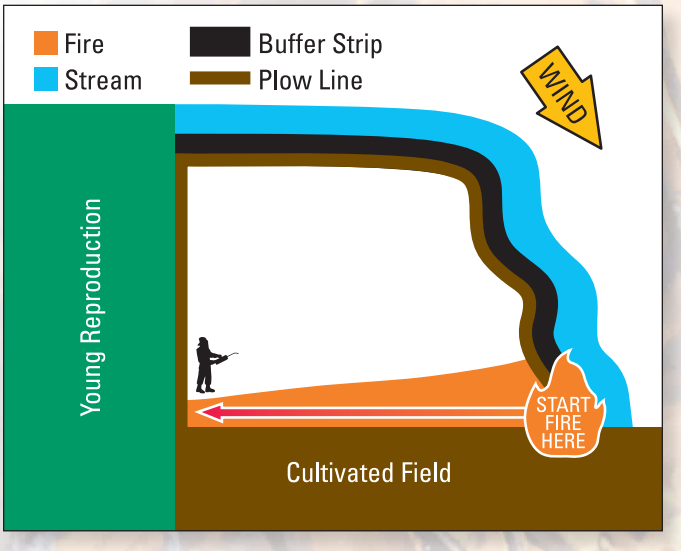

Figure 17-4: Backing Fire Ignition Pattern

STRIP HEAD FIRE IGNITION PATTERN

Strip head fire ignition (see Figure 17-5) involves igniting a series of short duration head fires, by moving perpendicular to the wind from one side of the prescribed burn area to the other. The first strip is initiated at the downwind end of the burn area, and each progressive upwind strip of head fire burns into the area already blackened by a previously burned strip. Adjusting the width of the strip adjusts the intensity of the fire. This pattern is commonly used in grassy areas where greater control is needed. **The advantages of this ignition pattern are that it is fast, inexpensive, can be used on large areas, and helps alleviate some smoke management concerns.** The smoke rises faster and to greater heights. The disadvantages are fast rates of spread, increased spotting potential, and greater burning intensities.

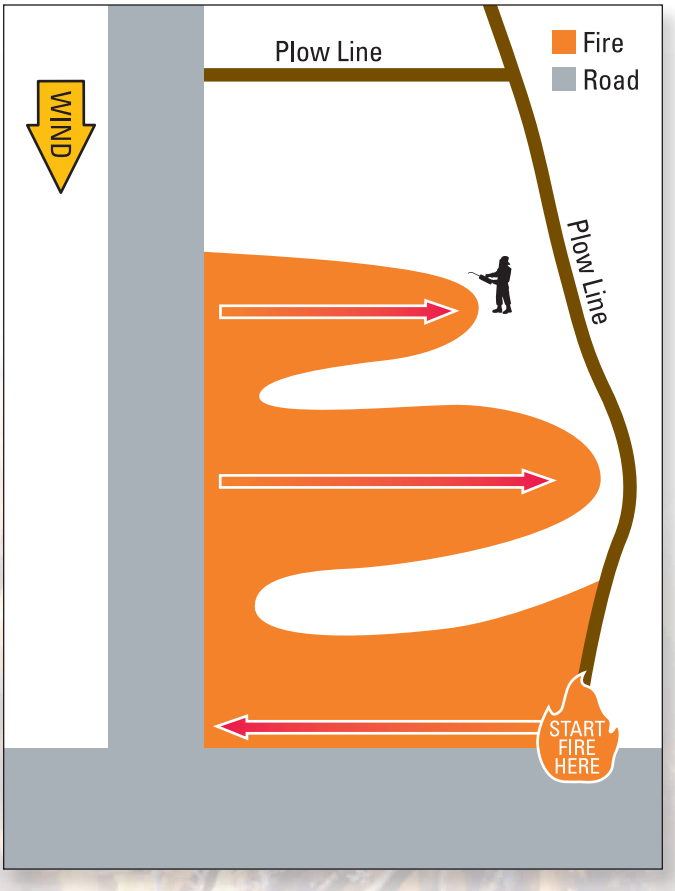

Figure 17-5: Strip Head Fire Ignition Pattern

FLANK FIRE IGNITION PATTERN

Flank firing ignition (see Figure 17-6) involves firing parallel with and into the wind or with slope. It can be used in a variety of situations from large broadcast burns to an underburn in closed canopy forests. Multiple ignition personnel can be used for large area burns. **The advantages of this ignition pattern are safety (no head fire), moderate burn intensities, and relatively low costs.** The disadvantages are a greater need for coordination and timing, and the potential that a wind shift could quickly endanger the safety of the ignition personnel, and threaten the control of the burn.

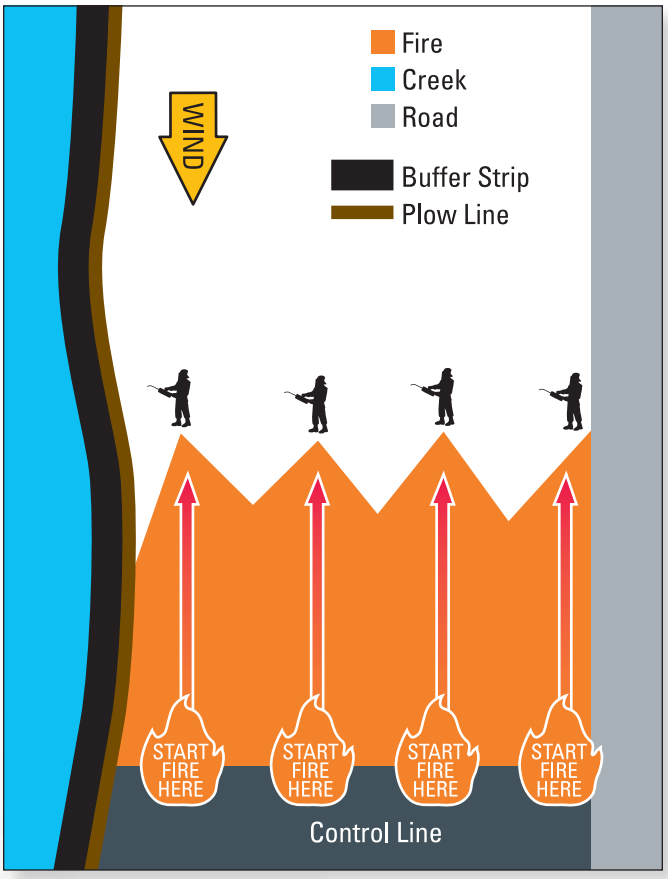

Figure 17-6: Flank Fire Ignition Pattern

CIRCULAR FIRE IGNITION PATTERN

The circular pattern, also called the ring firing pattern or the perimeter firing pattern, (see Figure 17-7) is a common ignition pattern that involves lighting fire around the perimeter of a burn area with the fire converging toward the center. **This pattern is most commonly used because of the ease of coordination, safety and speed.** It can be the most cost-effective burn pattern. A backing fire is first lit along an established firebreak on the downwind side of the burn area. A flanking fire is then initiated up the sides of the burn area along firebreaks. When the backing fire has burned out an area of sufficient width, a head fire is ignited along the upwind edge of the burn area. The separate fires then converge in the middle of the burn unit. **This pattern also allows for maximum smoke lift and dispersion.** The disadvantages of this pattern are high fire intensities in some areas of the burn, and the difficulty and danger involved in stopping the head fire, should the burn have to be aborted.

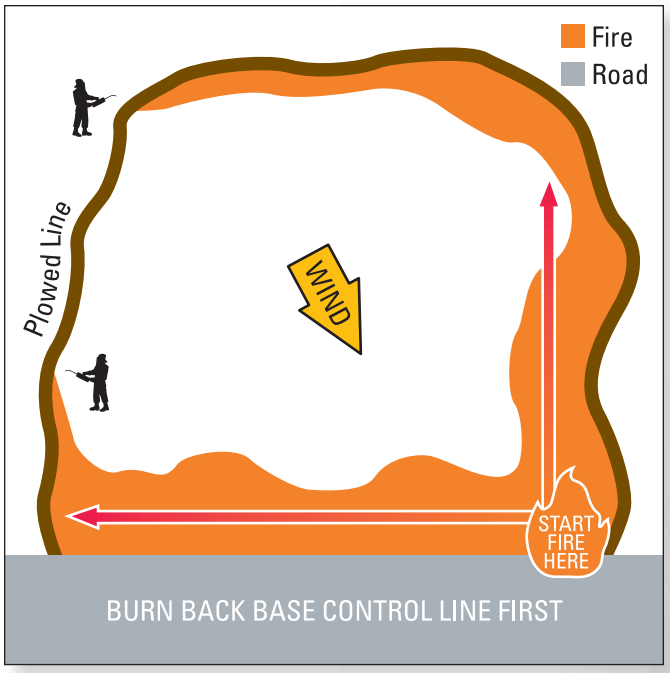

Figure 17-7: Circular Fire Ignition Pattern

SPOT FIRING IGNITION PATTERN

Spot (or dot) firing (see Figure 17-8) involves the setting of many small fires that burn together quickly. **This pattern of ignition controls the intensity of the resulting fire.** This pattern can be effective in either grass or forested areas.

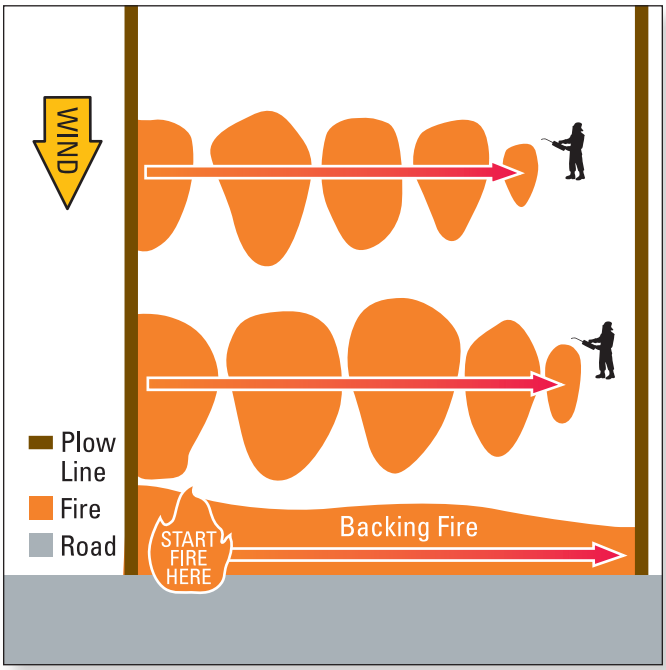

Figure 17-8: Spot Firing Ignition Pattern

Figure 17-9: Igniting a backing fire along a freshly prepared firebreak in a hardwood stand.

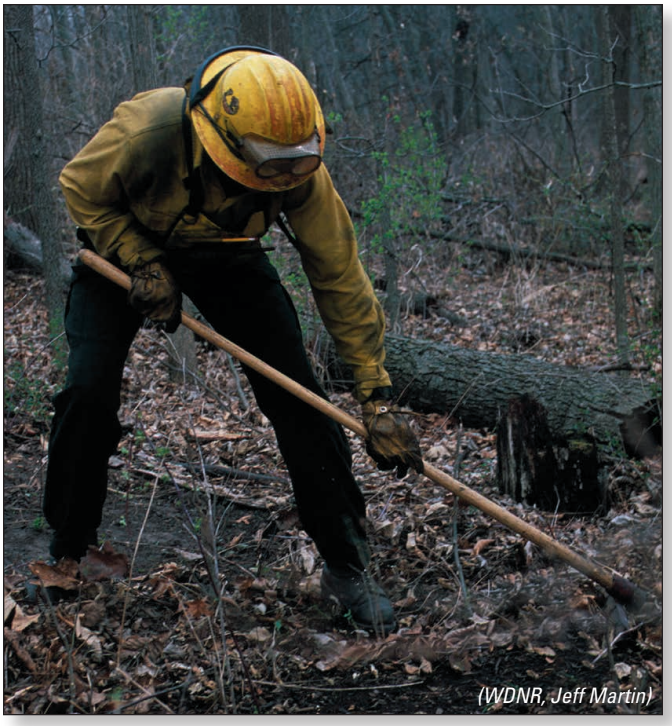

Figure 17-10: Constructing a mineral soil firebreak prior to a prescribed burning in a Wisconsin woodland.

Figure 17-11: Igniting one side of the burn area where a circular (or perimeter) ignition pattern was used.

Firebreaks

Confining prescribed fire to the areas that are intended to burn is the most critical element to the operational phase of a prescribed fire. A firebreak is a natural or constructed barrier able to stop or check fire spread, and to provide a control line from which to work. An effective firebreak must interrupt the continuity of the fuel bed, and provide containment of the fire under prescribed weather conditions.

- **Natural and artificial firebreaks** are existing features of the landscape. Natural firebreaks include lakes, streams, rivers, wetlands, snow banks, and rockslides. Artificial firebreaks include roads, ditches, trails, and tilled farmland. Utilization of such firebreaks can lower the costs of containment and aid burning operations. When using roads as firebreaks, smoke management must be considered, and traffic control measures may be required.
- **Wet lines or foam lines** can be used as firebreaks where there are environmental or cultural resource concerns. Wet lines and foam lines are inexpensive and easily constructed with common firefighting tools. A wet line is constructed by spraying water on fuels immediately prior to ignition. A foam line is constructed with chemically treated water. Class A foam additives raise the efficiency of water by lowering its surface tension, making it three to five times more effective in wetting fuels. Approved Class A foams are biodegradable and environmentally safe. Foam lines are also more persistent and visible than plain water. The disadvantages to these firebreaks are that they require additional crewmembers, equipment and large amounts of water. Wet lines and foam lines will also evaporate in fine fuels, requiring a more cautious initiation of firing.
- **Mowed firebreaks** are the least desirable of firebreaks because they do not remove all of the fuel. Mowed firebreaks must be very wide (25 to 50 feet) to be effective – even in grass fuel types. The cut vegetation should be removed or blown to the outside of the firebreak prior to fire ignition. These firebreaks can be prepared in advance, but still require increased patrols and surveillance by control crews to prevent fires from escaping. Wet lines and foam lines are usually used in conjunction with mowing to ensure safety and control of the burn.

Figure 17-12: Localized fuel concentrations can result in "hot spots" with increased fire intensity.

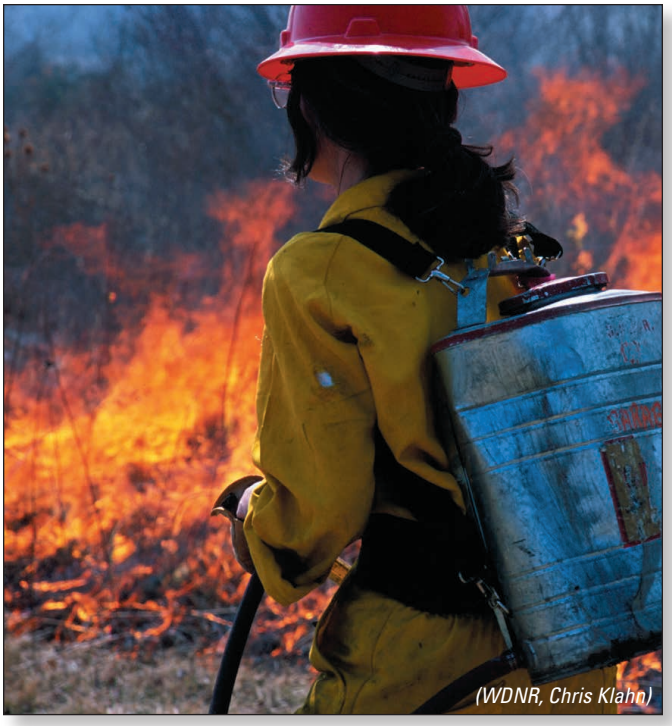

Figure 17-13: With secure firebreaks, stable weather, and well-executed firing patterns, hand tools like backcans, swats and shovels may be all that are needed by foot patrols to contain a burn.

Figure 17-14: Fires that crown-out in conifers can throw sparks great distances, which could cause a prescribed burn to escape control.

Figure 17-15: Although this type of plowed firebreak is more common on wildfires than prescribed burns, a bare mineral soil break provides one of the best anchors for ignition lines.

- **Burned firebreaks or black line firebreaks** involve the use of controlled fire to create a firebreak. Burned firebreaks are constructed prior to burning the whole prescribed fire area. Fire suppression crews must extinguish both sides of a line of fire to construct this type of break. The technique involves a lot of hot, difficult work by lots of firefighters, as well as large quantities of water or foam, since it requires setting and extinguishing fires two different times on the same land area.
- **Bare ground or mineral soil firebreaks** are constructed in areas lacking natural firebreaks. The construction of a mineral soil firebreak involves physically removing all fuels by rotovating, bulldozing, plowing, or disking with machinery to expose bare soil. The constructed firebreak width should be one and one-half times the flame length exposed to the firebreak. A typical constructed firebreak is from six to 15 feet wide. Mowing vegetation from six to 20 feet adjacent to the firebreak can diminish flame lengths along firebreaks and effectively increases the size of the firebreak (see 8.2).

Figure 17-16: Mop-up involves extinguishing all burning materials in the burn unit, such as this old log and stump.

Managing Firebreaks and Accesses

- Construct firebreaks outside of cultural resource areas. Use cultural resource professionals or tribal representatives to help determine firebreak locations.
- Construct firebreaks only deep enough and wide enough to control the spread of the fire.
- Avoid construction of firebreaks for fire management that result in drainage directly into a waterbody.
- Provide adequate filter strips when constructing firebreaks that expose bare soil near wetlands.
- Use firebreak construction methods in wetlands that do not expose bare soil whenever practical. These may include wet lines, existing constructed or natural barriers, foam, or retardants. If techniques result in exposure of bare soil, such areas must be restored if wetland hydrologic functions are impacted.
- Employ suitable water diversion structures on firebreaks, approaches to water crossings, or on roads and trails found within the riparian management zone to divert water off of the right-of-way before it reaches the waterbody (see 8.4 and 8.6).
- Monitor the effectiveness of cultural resource management practices during prescribed burns and wildfire suppression activities.
- Control access to sensitive cultural resources.

BMP: Managing Firebreaks and Accesses

- Where possible, locate bladed firelines on the contour. Construct waterbars as needed to direct surface water off firelines and into undisturbed forest cover. Recommended specifications for building waterbars and their spacing can be found in Chapter 12: Forest Roads, Drainage Structures, pages 12-12 and 12-13.

Protecting Water Quality

- Establish unburned zones that do not contain firebreaks to protect water quality in situations where steep slopes, highly erodible soils, or the likelihood of substantial organic matter removal are present.
  - Follow manufacturer recommendations.
  - Avoid cleaning fire retardant application equipment in lakes, streams and wetlands.

BMPs: Protecting Water Quality

- Carefully select fireline locations and consider weather, fuel, soil, and topographic conditions in and around the burn area to minimize impacts on water quality.
- Avoid burns that remove forest floor litter to prevent exposing soil in riparian management zones and on slopes where eroded soil may wash to surface waters.
- Avoid burning piles of slash in riparian management zones.
- Use natural or existing barriers (e.g., roads, streams, and lakes) where possible, or mowed, raked, and wet lines for firelines where bladed or plowed firelines will erode soil and degrade water quality.
- Avoid plowed and bladed firelines in riparian management zones except where necessary to control wildfire.
- Avoid applying chemical fire retardants over surface water. Prevent chemical fire retardants from flowing into surface water.

Smoke Management Considerations

Smoke can contribute to air quality concerns. A prescribed burn should be conducted in ways that minimize adverse environmental effects, and are in compliance with local and state air quality regulations. The following are some considerations relative to smoke management:

- Moist fuels produce more smoke than dry fuels.
- Head fires produce more smoke than slower backing fires.
- Smoke problems are more pronounced at night than during daylight. Burn during the day to maximize convective lift. However, burning during the day will create more intense fire that is more difficult to control.
- Stable air mass conditions help to restrict smoke convection and dispersion. Burn in slightly unstable air mass conditions.
- Check for possible restricted air space that smoke could impact, especially around airports and/or military bases.
- Check for smoke sensitive areas (nursing homes, schools and residential areas) and avoid sending smoke that would impact them. Notify sensitive receptors of burning plans as a common courtesy.
- Estimate and predict smoke duration and concentration to assess the risks of burning.
- Use test fires to confirm smoke behavior.
- Have an emergency plan to extinguish the fire if smoke conditions change adversely.
- Comply with all local and state air quality regulations.
- Avoid smoke on any public roadway.

Safety Considerations

- Safety should be the foremost consideration on every prescribed fire. The protection of lives, including firefighters, is the primary concern for all fire managers. Safety is promoted through training, removal of hazards, and the use of personal protective equipment. Firefighters have been injured and killed on the most innocent of prescribed fires.
- Everyone involved with prescribed fire should be wearing full personal protective clothing for his or her safety. Clothing and equipment worn should include all of the following:
  - Hard hat or helmet
  - Leather gloves
  - Nomex or other fire resistant shirt and pants
  - Leather boots
  - Goggles

The 10 Standard Fire Orders were developed in 1957 by a task force studying ways to prevent firefighter injuries and fatalities. Shortly after the Standard Fire Orders were incorporated into firefighter training, the 18 Situations That Shout Watch Out were developed. These 18 situations are more specific and cautionary than the Standard Fire Orders and described situations that expand the 10 points of the Fire Orders. If firefighters follow the 10 Standard Fire Orders and are alerted to the 18 Watch Out Situations, much of the risk of firefighting can be reduced.

10 STANDARD FIRE ORDERS

Fire Behavior

1.....Keep informed on fire weather conditions and forecasts.
2.....Know what your fire is doing at all times.
3.....Base all actions on current and expected behavior of the fire.

Fireline Safety

4.....Identify escape routes and make them known.
5.....Post lookouts when there is possible danger.
6.....Be alert. Keep calm. Think clearly. Act decisively.

Organizational Control

7.....Maintain prompt communications with your forces, your supervisor and adjoining forces.
8.....Give clear instructions and ensure that they are understood.
9.....Maintain control of your forces at all times.

If One Through Nine (Above) are Considered, Then...

10.....Fight fire aggressively, having provided for safety first.

The 10 Standard Fire Orders are firm. WE DON'T BREAK THEM; WE DON'T BEND THEM. **All firefighters have a right to a safe assignment.**

18 SITUATIONS THAT SHOUT WATCH OUT

1.....Fire not scouted and sized up.
2.....In country not seen in daylight.
3.....Safety zones and escape routes not identified.
4.....Unfamiliar with weather and local factors influencing fire behavior.
5.....Uninformed on strategy, tactics and hazards.
6.....Instructions and assignments not clear.
7.....No communication link between crewmembers and supervisors.
8.....Constructing line without safe anchor point.
9.....Building line downhill with fire below.
10.....Attempting frontal assault on fire.
11.....Unburned fuel between you and the fire.
12.....Cannot see main fire, not in contact with anyone who can.
13.....On a hillside where rolling material can ignite fuel below.
14.....Weather gets hotter and drier.
15.....Wind increases and/or changes direction.
16.....Getting frequent spot fires across line.
17.....Terrain or fuels make escape to safety zones difficult.
18.....Feel like taking a nap near fireline.

Pre-burn Briefing

A pre-burn briefing is necessary before every burn. All participants must be present before any prescribed fire activities can commence. The briefing should cover the following topics:

- Hand out maps to all participants.
- Review current weather and expected fire behavior.
- Explain the burn plan, and describe the ignition pattern to be used.
- Ensure everyone understands how to communicate. Test all radios.
- Check all equipment to ensure that they are all operating properly.
- Identify a burn boss. Assign personnel and equipment:
  - Assign specific control crew segments of the burn perimeter.
  - Assign an ignition crew and review firing sequence.
  - Observe weather conditions.
- Identify water fill sites to be used.
- Cover contingency plans in case of spot fires/breakouts.
- Check for appropriate personal protective clothing and equipment.
- Review appropriate safety procedures.
- Ask for questions – clarify if necessary.
- Conduct a test fire to confirm fire behavior and smoke dispersal.

Figure 17-17: Wearing full personal protective clothing is necessary for the safety of all crewmembers.

COMMON DENOMINATORS OF FIRE BEHAVIOR ON TRAGEDY FIRES

A **tragedy fire** is a fire that caused serious injuries or death(s):

- Most incidents happen on smaller fires, or on isolated portions of larger fires.
- Most fires are innocent in appearance before unexpected wind shifts in direction and/or speed results in flare-ups or extreme fire behavior. In some cases, tragedies occur in the mop-up stage.
- Flare-ups generally occur in deceptively light fuels, such as grass and light brush.
- Fires run uphill – surprisingly fast in chimneys, gullies and on steep slopes.
- Some suppression tools, such as helicopters or air tankers, can adversely affect fire behavior. The blasts of air from low flying helicopters and air tankers have been known to cause flare-ups.

Figure 17-18: A fire crew reviewing escape routes and safety zones prior to a prescribed fire.

POST-OPERATIONAL CONSIDERATIONS

Post-burn Monitoring

The fire is not over until all of the burn area is completely extinguished, the fuel is cold, and there is no smoke being produced. There are generally three steps to post-burn assessment:

- **Perimeter monitoring** of the burn area must be continuous from the onset of burning until the burn boss declares the fire out. Perimeter monitoring must ensure that the fire is kept within the burn unit boundaries. This activity is most critical as the main fire front passes a given area. At least one person must be kept back to periodically patrol the perimeter of the burn until it is declared out, even if the rest of the burn team moves on to other burn areas.
- **Mop-up** is the action of extinguishing all burning materials in a burn unit. Mop-up is the hard work of prescribed burning. It involves the most time and effort of all of the activities on a prescribed fire. Mop-up is not complete until the burn boss declares the fire out.
- **Abandonment standards should include 100 percent extinguishment** of burning or smoldering materials. Wisconsin state statues prohibit leaving a fire that is not extinguished completely.

Fire Effects Evaluation

The goal of any prescribed fire is to accomplish a land management objective. After the prescribed fire, an effective evaluation should be conducted to measure the success in meeting the stated objective. Post-burn evaluations are the key to improved future prescribed fire prescriptions. Evaluations should include pre-burn, burn and post-burn operations to improve all aspects of the prescribed burning. The following are some, but not all, important items that should be evaluated: 1) success in vegetative manipulation; 2) prescribed versus actual results; 3) post-burn vegetative condition; 4) accidents; 5) fire control problems; 6) smoke management problems; 7) burning pattern effectiveness; 8) cost effectiveness; and 9) corrective actions needed.

- **Assess the condition of cultural resources** that may have been affected by prescribed burning or wildfire suppression activities.
- **Field inspect the burned area** to identify cultural resources that may not have been previously identified, but have been newly exposed by the fire.
- **Remove temporary fire management features** that are inappropriate to the historic character of adjacent cultural resources.
- **Restore water source sites** used for fire management activities as soon as possible following control, or after the completion of mop-up activities.
- **Monitor the burned area for the presence of insects** that commonly infest trees stressed by fire. Salvage may be appropriate if populations of insects such as bark beetles (conifers), ambrosia beetles (hardwoods), or red turpentine beetle (pine) threaten the health residual trees.
- **Monitor the burned area and access routes for nonnative invasive plants**, and take steps to eradicate any that have been introduced by activities related to the burn. Fire equipment may need to be cleaned before it is moved from an infested site into an area that is free of problem invasives (see 8.4 and 8.5).

BMPs: Post-operational Considerations

- Do not clean chemical application equipment in surface water, or in locations that drain directly into surface water.
- Use erosion control measures for firelines that could erode soil into lakes, streams, and wetlands. Erosion control measures include revegetating bare soil and installing waterbars. Placing sod back into plowed furrows at appropriate intervals can act as waterbars (see Chapter 12: Forest Roads, Soil Stabilization, pages 12-16 and 12-17).
- Maintain soil stabilization practices until the site is fully revegetated and stabilized.
- Use mowing or other practices that do not expose soil as alternatives to blading or disking for maintaining firebreaks where erosion may degrade water quality.

BMPs: Invasive Species

- 8.1 Incorporate invasive species awareness, identification, and prevention education into fire training (e.g., fire effects and prescribed fire training).
- 8.2 Avoid placing firebreaks in infestations of invasive species.
- 8.3 Incorporate invasive species considerations into the planning of prescribed burns.
- 8.4 Avoid spreading invasive seeds and other propagules from infested to non-infested areas during prescribed fire activities.
- 8.5 Following a prescribed burn, rehabilitate soil disturbance related to burn activities, especially bladed or plowed firebreaks, where invasive species establishment is likely.

Figure 17-19: A late spring burn can be an effective way to kill young garlic mustard plants. Repeated prescribed fire or other methods may be necessary to control the newly germinated plants the following year.

RESOURCES FOR ADDITIONAL INFORMATION

These resources are specific to the information in this chapter only. Refer to the Resource Directory for additional resources related to this chapter.

DEPARTMENT OF NATURAL RESOURCES, BUREAU OF FOREST PROTECTION

Information on burning permits, wildfire activity, fire weather forecasts, and fire departments.
dnr.wi.gov – keywords "forest fire"

FIRE MANAGEMENT HANDBOOK

This handbook from the Wisconsin DNR contains information on fire suppression tactics and training, and the use of prescribed fire, along with technical information on the Wisconsin Division of Forestry Fire Management Program.

FIREWISE

Information on ways to protect homes located in fire prone areas.
www.firewise.org

NATIONAL FIRE PLAN

Information on the impact of wildfires on communities and the environment.
www.forestsandrangelands.gov/resources/overview/

NATIONAL INTERAGENCY FIRE CENTER

Wildland fire information, fire statistics, and links to other agencies.
www.nifc.gov

NATURE CONSERVANCY

Information on the use of prescribed fire and training.
www.nature.org/ourinitiatives/regions/northamerica/unitedstates/illinois/volunteer/prescribed-fire-training.xml

NORTHERN PRAIRIE WILDLIFE RESEARCH CENTER

Information on the use of fire in wildlife management.
www.npwrc.usgs.gov

U.S. FOREST SERVICE, FIRE AND AVIATION MANAGEMENT

Information about wildfire activity and situation reports, fire management, training, fire use, and fire prevention.
www.fs.fed.us/fire

WILDLAND FIRE INCIDENT MANAGEMENT FIELD GUIDE

This publication from the National Coordinating Group covers all aspects of wildfire management and safety.
www.nwcg.gov/publications

NOTES

WISCONSIN DEPARTMENT OF NATURAL RESOURCES
NOTICE OF FINAL GUIDANCE & CERTIFICATION

Pursuant to ch. 227, Wis. Stats., the Wisconsin Department of Natural Resources has finalized and hereby certifies the following guidance document.

DOCUMENT ID

FA-20-0005

DOCUMENT TITLE

Wisconsin Forest Management Guidelines

PROGRAM/BUREAU

Forest Economics and Ecology, Applied Forestry Bureau

STATUTORY AUTHORITY OR LEGAL CITATION

S. 823.075, Wis. Stats. & NR 1.25, Wis. Admin. Code

DATE SENT TO LEGISLATIVE REFERENCE BUREAU (FOR PUBLIC COMMENTS)

2/10/2020

DATE FINALIZED

4/6/2020

DNR CERTIFICATION

I have reviewed this guidance document or proposed guidance document and I certify that it complies with sections 227.10 and 227.11 of the Wisconsin Statutes. I further certify that the guidance document or proposed guidance document contains no standard, requirement, or threshold that is not explicitly required or explicitly permitted by a statute or a rule that has been lawfully promulgated. I further certify that the guidance document or proposed guidance document contains no standard, requirement, or threshold that is more restrictive than a standard, requirement, or threshold contained in the Wisconsin Statutes.

Carmen Hardin — March 27, 2020

Signature — Date