EXTENSION

Using Prescribed Fire in Oklahoma

EXTENSION

E-927

Division of Agricultural Sciences and Natural Resources
Oklahoma State University

in cooperation with the Oklahoma Department of Wildlife Conservation

Notes:

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Revised February 2021

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Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Director of Oklahoma Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is printed and issued by Oklahoma State University as authorized by the Vice President for Agricultural Programs and has been prepared and distributed at a cost of $2.00 per copy. Revised 02/2021 GH.

on the national map (which then takes you to a local NWS website), then click on the location of interest on the map that appears. Finally, click on "Hourly Weather Forecast" or "Tabular Forecast" at the bottom of the page. In the upper menu, check the variables of interest, such as Ventilation Rate. Note, however, Category Day is not an option and you will have to convert their VR units (x 1,000 mph-feet) to square meters per second in order to use Table 1.

With respect to nationwide fire weather and fire danger products, the following sites may be of interest:

weather.gov/fire (NWS National Fire Weather)

wfas.net (USFS Wildland Fire Assessment System)

gacc.nifc.gov (Geographic Area Coordination Centers)

nifc.gov (National Interagency Fire Center)

Prescribed Burning Plan

For more information about prescribed burn plans see OSU Extension fact sheet NREM-2893, *Burn Plan for Prescribed Burning*. A fillable pdf of a prescribed burn plan is available at extension.okstate.edu/fact-sheets/images/burn-plan-for-prescribed-burning/producer_burn_plan.pdf. Assistance with prescribed burn plans can be found at the local OSU Extension office, Natural Resources Conservation Service (NRCS) office or Oklahoma Department of Wildlife Conservation.

Warning

Reading this or any other material in and of itself does not prepare you for burning. You must gain experience. There are many experienced private and governmental fire managers throughout the state. Gain experience by burning with experienced crews and attending prescribed fire training workshops.

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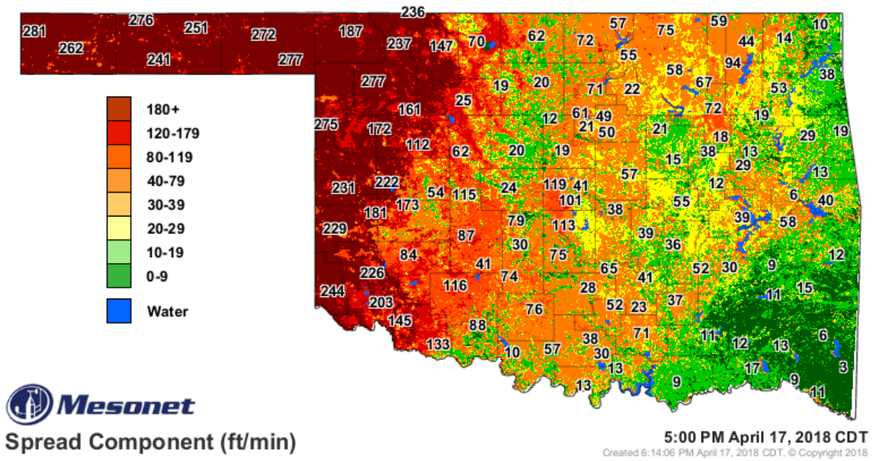

Figure 14. Spread component map during the Rhea megafire, April 2018.

equals the flame length in feet. The Spread Component relates to the speed of movement of the headfire in feet per minute. The Energy Release Component relates to the amount of heat released per area in the flaming zone. Finally, the Ignition Component is the probability (as a percentage) that a reportable fire will result from a firebrand. Figure 14 shows the SC map from the Oklahoma Fire Danger Model at 5 p.m. CDT April 17, 2019, during the multi-week Rhea megafire (which ended up burning 287,000 acres). Extreme rates of spread approaching 300 feet per minute are shown to the west of a dryline in western Oklahoma.

In addition to the NFDRS variables, other output from the Oklahoma Fire Danger Model includes dead fuel moisture (1-, 10-, 100-, and 1,000-hour fuels), live fuel moisture (herbaceous and woody) and the Keetch-Byram Drought Index. Products are available in map, chart and table formats. With a variety of products available to monitor current and view future fire danger across the state, the Oklahoma Fire Danger Model is a valuable tool for wildland fire management.

Other Web Pages Relevant to Fire Management

In addition to the many useful products available on the OK-FIRE website, here are a few other websites that fire managers may find valuable.

Specific fire weather forecasts for Oklahoma from local NWS offices can be found at the following sites:

weather.gov/ama/fireweather (Amarillo NWS)

weather.gov/oun/fireweather (Norman NWS)

weather.gov/tsa/fireWeatherForecast (Tulsa NWS)

weather.gov/shv/fireweather (Shreveport NWS)

These websites feature products that forecast site-specific Ventilation Rate and Category Day. Depending on the local NWS website chosen, Category Day is forecast at intervals ranging from only one to two times per day (daytime only or day/night) to as frequent as every three hours (Tulsa NWS). Ventilation Rate (VR), from which Category Day (Table 1) can be calculated, is forecast at similar intervals at each NWS website (Amarillo NWS also forecasts VR every three hours in x1,000 knot-feet, but one would have to convert these units to square meters per second in order to use Table 1). One can get hourly VR at each local NWS website, but not on the fire weather pages. To do this, go to weather.gov, click on the geographical area of interest

Fire Weather Watches and Red Flag Warnings

During periods when weather and wildland fuel conditions are expected to support extreme fire behavior the National Weather Service will issue Fire Weather Watches and Red Flag Warnings. A "Fire Weather Watch" is issued when upcoming weather conditions, combined with existing fuel conditions, could result in extreme fire behavior. A watch means critical fire weather conditions are possible but not yet occurring. A "Red Flag Warning" means critical fire weather is expected to occur shortly or is already ongoing. Fire Weather Watches are typically issued 18 hours to 96 hours in advance of the expected onset of criteria, while Red Flag Warnings are typically issued less than 48 hours in advance. Both types of these fire weather advisories can be found in the "Fire Advisories and Outlooks" section of OK-FIRE.

When high winds (greater than 20 miles per hour), low relative humidity (less than 30%) and dry herbaceous or woody fuels (less than 6% for 1/2-inch diameter dead roundwood) occur together, the number of wildfires, the intensity of wildfires and the acres of land burned increases dramatically.

Almost all of the wildland fires experienced during these periods result from arsonists or people's activities such as burning trash and brush piles, playing with matches and fireworks or discarding cigarettes.

Fire danger is obvious in emergency situations, but there are other times when fire danger is not so easily recognized. A Red Flag Warning means the conditions that can support wildfires are imminent or already occurring. The Red Flag Warning will provide this warning, urging citizens to exercise extreme care. However, during a Red Flag Warning, conditions exist that are within some fire prescriptions for certain management objectives and can be conducted safely. In summary, a Red Flag Warning:

1. Alerts all fire protection agencies to the increased risk, so a quick response to reported wildfires may be made.
2. Reminds people who use fire to take extra care to contain their fire and be sure it is out before leaving it, or consider postponing burning until conditions are safer.
3. Cautions the public to be extra careful with outdoor fires, smoking materials and matches.
4. Cautions residents whose homes are in or next to wildland fuels to take measures to protect their dwellings if a fire should break out.
5. Alerts law enforcement personnel and community residents to report any activity that indicates an arsonist is setting fire.
6. Alerts landowners to keep a close watch on their land and carry out protection measures.

NOTE: The Red Flag Warning is not a burn ban and is not intended for that purpose. It is intended to warn people of potential problems if fire should escape. Existing burn bans can be found in the "Oklahoma Burn Bans" section of OK-FIRE. The Red Flag Warning is issued only when current and imminent forecast weather and fuel conditions exist to warrant the alert. The Red Flag Warning is rescinded when burning conditions improve.

Oklahoma Fire Danger Model

An excellent tool to assess fire danger across Oklahoma is the Oklahoma Fire Danger Model, originally developed as a joint project of the U.S. Forest Service (USFS) and the Oklahoma Mesonet in the mid 1990s. This model is an adaptation of the National Fire Danger Rating System (NFDRS) to Oklahoma, but to 500-meter resolution and using 15-minute weather data from the Oklahoma Mesonet in conjunction with daily satellite imagery to assess levels of surface greenness. Forecast fire danger conditions are also calculated using the 84-hour NAM forecasts. Output from this model is available in map, chart and table formats and can be found throughout the OK-FIRE website (on the home page as well as in the first five sections listed in the left menu area).

Model output includes color-coded maps of the following NFDRS components: Burning Index (BI), Spread Component (SC), Energy Release Component (ERC) and Ignition Component (IC). Burning Index is related to the intensity of the headfire and is scaled such that BI/10

Introduction

In pre-European settlement times, early explorers such as Washington Irving and Thomas Nuttall found Native Americans using fire in the area now known as Oklahoma. Native Americans used fire to manage wildlife, a primary food source, and to maintain prairie openings in forested regions. Early settlers followed this example for a while, but gradually stopped burning. As land use changed, particularly to farming annual crops, the land was broken up into small ownerships, thus eliminating most fires. In the mid-1900s, media attention focused on wildfires and Smokey the Bear. This information included misleading information about fire and its benefits to humans and the environment.

Fire is an ecosystem driver that facilitates ecosystem processes such as nutrient and water cycling. However, fire seldom affects ecosystems alone. It works in concert with herbivory and climate, thus constituting an integral part of ecosystem restoration. Fire is mandatory for the health of prairies, shrublands and forests throughout Oklahoma and most of the world. Fire is a necessary tool for managing wildlife, livestock and timber. Research has shown that although there are many land management tools, **there is no substitute for fire**. It has taken almost 100 years for our contemporary culture to learn what Native American's have known about fire for thousands of years.

Contemporary Use and Value of Prescribed Fire

About 2.5 million acres, or 6% of the total land area, of native prairie, shrubland and forest are burned by prescribed fire in Oklahoma each year. Prescribed fire use is increasing statewide. However, the number of acres burned is not keeping up with the need to control invading woody species and restore native habitats.

Before the mid-1980s, relatively small amounts of land were intentionally burned except in the tallgrass prairie region of northeastern Oklahoma and the forests of southeastern Oklahoma. The increase in the use of prescribed fire can be attributed to public and landowner education from a number of sources. Internationally, scientists and land managers have acquired a better understanding of the historical role of fire in the development of ecosystems. Today, scientists and laymen recognize the role of fire in maintaining rangelands (i.e. prairies, shrublands and savannahs) and forests. Most of Oklahoma's native plant communities evolved with fire in conjunction with herbivory and climate as major influences on their development. As a result, most indigenous plants and animals are adapted to periodic fire. In fact, some plants require fire to complete their life cycle. A number of native animals and plants are dependent on periodic fire to create or maintain suitable habitat.

Unfortunately, most of Oklahoma's native lands have been degraded as a result of the exclusion of fire. The most obvious example is the invasion of eastern redcedar and ashe juniper into prairies, shrublands and forests across Oklahoma. Redcedar invasion is one readily visible ecological indicator of ecosystem dysfunction.

Prescribed fire is an inexpensive and natural process that can be used to restore ecosystems and landscapes to their historical biological diversity and productivity. Prescribed fire is essential in maintaining the habitat for some endangered or threatened species such as the lesser and greater prairie chicken, black-capped vireo, red-cockaded woodpecker, the eastern and western prairie fringed orchid and many song birds. Prescribed fire also can be used as a tool to manipulate habitat for more common wildlife species such as bobwhite quail, white-tailed deer and turkey.

Prescribed fire can be used to improve forage production, quality, composition and palatability for livestock or wildlife. It also can be used to control non-native or undesirable plant species, plant diseases and internal and external animal parasites, such as ticks, by modifying their habitat. Fire can be used in forest management to reduce logging debris and leaf litter, manage competing vegetation, manage regenerating stands and prepare logged areas for planting or seeding. Prescribed fire can be used to enhance the appearance of both forests and rangelands. Fire creates open park-like conditions in forested areas, opens up savannah areas and controls woody invasion on prairies. Fire can be an economically and ecologically sound alternative to herbicide use to reclaim native prairies, shrublands, savannahs or forests and to reduce the probability of wildfires in the wildland-urban interface and intermix.

Wildfires and a few poorly planned and executed intentional fires have received public attention in the media and have been blamed for destroying land. However, research and practical experience clearly demonstrate fire does not destroy, but may cause a shift in plant species composition. The only real damage done by most of these wildfires is either to human-built structures, such as homes, or to the future values of standing timber, when the trees are a commercial species and are consumed or damaged in the wildfire. Depending on the land manager's objectives, changes resulting from any fire may be either desirable or undesirable. For example, if a small area in a native grass is burned, wild or domestic grazing animals will concentrate their grazing on the burned area. This is called patch burning, patch grazing or rotational grazing without fences, which does not reduce livestock production while it benefits many wildlife species. The growing season after the fire and grazing event may cause the area to be transformed from native tall grasses to native annual forbs that may be labeled as weeds by some. However, this is a short-term phenomenon and the burned/grazed area will revert back to preburned status under prescription grazing.

The key to the successful application of prescribed fire is to use it as part of an overall resource management plan that considers all of the operation's resources and is directed toward specific management objectives. Only then can fire be used successfully.

Fire Prescriptions

Detailed fire prescriptions can be found in OSU Extension fact sheet NREM-2878, *Fire Prescriptions for Maintenance and Restoration of Native Plant Communities*. Unlike controlled burns or wildfire, prescribed fire has clear goals and objectives. However, the outcome to land resources from wildfire or prescribed fires often is similar. A prescribed fire is conducted with an appropriately trained crew and adequate equipment under a prescribed set of conditions for both safety and vegetation management objective.

Conducting the Burn

Once it is determined that prescribed burning is appropriate, several critical steps must be followed to plan and execute a safe and effective burn. The importance of planning cannot be overemphasized. Planning should begin ahead of time because the overriding consideration in planning is SAFETY. No one should attempt a prescribed burn without experience.

Planning includes developing a clear statement of objectives for the burn and how they will be accomplished. Considerations in planning include distance to roads, towns, neighbor's houses, gas and oil production sites and utilities. Other considerations include weather, vegetation type, desired vegetation response, topography and pre- and post-management grazing strategies for domestic livestock and wildlife. The secret to prescribed burning is to let the weather, topography and fuels work for you, not against you.

Effective application of prescribed fire requires an understanding of the technology plus experience. Prescribed burning requires the knowledge of how to manage people, weather, fire behavior, fuels and plant and animal ecology. Good judgment and experience are required to appropriately integrate all of these aspects when making decisions before, during, and after the fire. Once safety and prescription guidelines are formalized, firebreak preparation can begin.

Firebreaks

Firebreaks are used to contain the fire within the boundary of the burn unit and to assist with reducing fuel along the boundary. Firebreaks can be used for access by equipment to the burn unit. Firebreaks must extend to bare ground or mineral soil, with no continuous fuel, so fire cannot creep across the line and outside the burn unit. Firebreaks can create erosion problems so care should be exercised on slopes.

It also may be necessary to mow or shred inside the burn unit along the downwind firebreaks to assist with the backfiring operation. Some fuels (examples: sand sagebrush, annual broomweed and sand shinnery oak) are not totally consumed or burned in the backfiring operation or there is not enough continuous fine grass fuel for a backfire to carry, making backfiring unsafe because of unburned fuel that can carry a headfire into the backfire area and across the firebreak.

Fire Effects

Prescribed fire or wildfires often have the same effects on soils, vegetation, livestock grazing, and wildlife habitat. For a thorough discussion of the research related to fire effects, see OSU Extension fact sheet NREM-2877, *Fire Effects in Native Plant Communities*.

Fighting Wildland Fires

Training courses and manuals are available on fighting wildfires. The following checklist gives a brief overview of potentially dangerous situations. Each year in Oklahoma, firefighters and citizens alike are injured trying to fight wildfires. Too often, landowners and firefighters without proper training get excited and make poor decisions. This can result in people being trapped by the fire, vehicles wrecked and other unnecessary accidents. **If you do not have the training and are not in good physical condition, stay away from the fire.** Never try to fight a wildfire except from the blackened area (the area that has already burned). Never fight the fire from within an area of unburned fuel or ahead (downwind) of the fire.

Watch-Out Situations (Survival Checklist for Fighting Wildfires)

1. Fire not scouted and sized up.
2. In terrain not previously 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 with crew members/supervisor.
8. Constructing a firebreak without a safe anchor point.
9. Building a firebreak 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 is getting hotter and drier.
15. Wind increases and/or changes direction.
16. Getting frequent spot fires across firebreak.
17. Terrain and fuels make escape to safety zones difficult.
18. Taking a nap near a firebreak.

Standard Fire Fighting Orders

1. Keep informed on fire weather conditions and forecasts.
2. Know what the fire is doing at all times.
3. Base all actions on current and expected behavior of the fire.
4. Identify escape routes and safety zones and make them known.
5. Post lookouts when there is possible danger.
6. Be alert. Keep calm. Think clearly. Act decisively.
7. Maintain prompt communications with your crew, your boss and adjoining crews.
8. Give clear instructions and be sure they are understood.
9. Maintain control of your crews at all times.
10. Fight fire aggressively, having provided for safety first.

select fire resistant building materials. For more information about protecting your property from wildfire see OSU Extension circular E-1048, *Wildfire: Preparing the Ranch and Farm*.

The best defense against liability claims from an escaped fire is to exercise good judgment with all decisions and ensure all prudent actions are taken. These actions include following all existing standards, rules and regulations for prescribed burning. Claiming ignorance of prescribed burning methods or governmental regulations is not an acceptable defense. In most cases, ranch/farms insurance policies cover claims related to prescribed fire. However, after reviewing situations and legal cases for the past 30 years in Oklahoma, there are no examples of settlement of claims or successful lawsuits where a well-designed prescribed fire plan was followed.

Oklahoma's Law on Prescribed Fire - Highlights

In Oklahoma the term "prescribed burning" has a legal definition and a burn that is not conducted in accordance with this definition and the state statute (O.S. Title 2 - Section 16-28.2) that describes the prescribed burning process, is considered a "controlled" or even an "uncontrolled" burn.

1. It is lawful to burn. (Section 16-24.1A).
2. It is considered a property right if conducted properly. (Section 16-28.2.F(1)).
3. You are liable if the fire escapes. (Section(s) 16-24.1B, 16-28.D(a)).
4. Civilly liable for the amount of actual damages only. (Section 16-28 and 16-28.2.G(2)).
5. Criminal liability if found to have committed gross negligence, i.e. not fulfilling parts of Section 16-28.2, to include not filling out the Prescribed Fire Notification Plan, notifying adjoining landowners, adequate fire breaks, etc. (Section16-28.G(2)).

How do I Burn to Comply with Current Oklahoma Law?

- Take reasonable precaution against the fire spreading to other lands: Provide adequate firebreaks, manpower and fire fighting equipment. Watch over the fire until extinguished. (Section(s) 16-28.A(1,2,&3)).
- Notify local Forestry Division representative at least four hours in advance in protection areas. (Section 16-28.A(1)).
- Within 60 days of conducting the fire, notify orally or in writing all adjoining landowners. Include proposed date, location and contact number. (Section 16-28.2.B).
- Complete the prescribed burning notification plan (page 18) and submit to local fire department or Forestry Division representative. Keep a copy for your records. (Section 16-28.2.C).
- Within 48 hours of conducting the burn, notify local fire department and/or local Forestry Division representative. (Section 16-28.2.E(1&2)).

This section is not intended to be used as a substitute for the law. Read and know the law before conducting any prescribed fire.

Prescribed Burn Associations

A Prescribed Burn Association (PBA) is made up of landowners and others interested in conducting prescribed fires. The purpose of a PBA is to share knowledge, experience and equipment among members to facilitate and increase the use of prescribed burning. There are more than 20 PBAs functioning very successfully in Oklahoma and others are forming. Cooperators include landowners, state and Federal agencies, and rural and municipal fire departments. See the OSU Extension fact sheet NREM-2880, *Prescribed Burn Associations*, or visit the Oklahoma Prescribed Burn Association website ok-pba.org.

One of the main problems along firebreaks occurs when dead trees and brush are present. If dozing is required, trees and brush piles should be pushed well inside of the burn unit (greater than 100 feet). It is best to scatter the trees instead of piling. If neither of these suggestions is possible, then the brush should be piled next to the line and a dozed line made around them. This will allow the pile to be burned prior to burning the unit or to keep the pile from igniting during the burn. Burn brush piles in June when fuels are green. Burning during or after rain or snow with surrounding dead fuels often results in an escaped fire. Firebreaks may include any of the following:

Mowed firebreaks are best used in conjunction with a strip of bare ground. Do not leave mowed grass in clumps or piles. Raking and/or baling is an option.

Disked firebreaks are best made after mowing first, then disking twice, in opposite directions. Make sure residual grass does not form continuous fuel.

Plowed firebreaks are used with mowing if grass fuels are tall and/or heavy.

Dozed firebreaks should be scraped and not excavated. Do not leave piles of soil containing fine fuels such as grass. Push soil piles outside of the burn area. Push brush inside the burn area and scatter. Do not make brush piles along a firebreak. Brush piles cause major problems during the fire and for several days after.

Two-track or pasture roads work well as firebreaks, but it may be necessary to mow down the center and along the edge of the road to reduce tall fuels.

County roads work well as firebreaks, but watch for traffic and tall fuels in the ditches.

Paved roads work very well, but traffic must be managed. Also, watch for burning embers sliding across the road surface because of the wind.

Natural firebreaks include rivers, creeks, ponds, lakes, canyons (may or may not work well - watch out!) and cultivated fields.

Since most prescribed fires are conducted during the winter or spring, the firebreak should be prepared the preceding fall or at least six months before the burning date. Disking, dozing or blading are methods used most often. The best method will be determined by the characteristics specific to the land area to be burned. Often, a combination of methods is most appropriate because of variability in vegetation type, topography and soil. Mowing as the only firebreak preparation should be discouraged because of safety concerns.

Often, natural barriers such as streams or rock outcrops can be used as firebreaks. Linking man-made features such as ponds, roads and plowed fields together with constructed firebreaks can save time and money. For disked or dozed firebreaks, caution should be used when disturbing highly erodible sites. For mowed firebreaks, heavy accumulations of downed fuel by mowing may need to be raked and removed. Fire spreads along mowed firebreaks and can be especially difficult to contain, so mowed fire breaks should be used only by experienced crews in situations in which bare-soil fire breaks are not feasible. Brush piles or dead eastern redcedar trees, which can cause spot fires several hundred feet downwind from the firebreak, are very hazardous when close to a firebreak. Snags or hollow trees should be cut within 100 feet of firebreaks because they can cause a chimney effect when burning and embers can spread many feet downwind. Better yet, protect hollow trees from fire by clearing a patch of bare ground around them. Hollow trees and snags are valuable habitat for many wildlife species. Brush piles should only be burned under special conditions (e.g. snow cover for several days, or in May and June with all green vegetation) and surrounded with very light fuel loads. However, it is recommended that brush piles not be created at all and downed trees spread throughout the area to be burned.

Caution should be used when burning volatile fuels such as eastern redcedar or sagebrush. These species contain phenolics or other chemicals that flash when exposed to fire. Leaf litter should be raked or blown from firebreaks in forested areas. Pine needles are of special concern because fire can creep across firebreaks with only small amounts of pine leaf litter present. Caution should be used when burning stands of timber that have been recently logged or thinned. Logging or thinning debris increases fuel loads dramatically and can cause spot fire problems.

The firebreak should be an appropriate type and width for the amount and type of fuel present as well as size of burn unit. To reduce flame length and fire intensity next to the firebreak, use more than one type of firebreak (i.e. mowed and disked). The mowed area should be on the inside of the disked area. Firebreaks need to be wider on the downwind side of the area to be burned and should be burned-in or blackened inside the bladed line (bare ground). The minimum burn-in is typically 100 feet for grass fuels and 500 feet for windrowed brush or volatile fuels.

The burned-in firebreaks are prepared by using a less intense fire prescription (i.e. higher relative humidity, lower air temperatures and lower wind speeds). For example, for a fire with a southwest wind, the burned-in firebreak would be on the north and east boundary of the area to be burned. If volatile fuels are a problem, firebreaks should be burned-in with a backfire and strip-headfire during the morning preceding the initiation of headfire. Otherwise, the burned-in firebreak is established as part of the firing procedure. Firebreaks in forested areas without prairie openings can be as little as 8 feet wide if prescriptions for ground fires are used.

If the firebreak is planted with a cool-season annual grass, then maintenance costs will be reduced, although there will be the initial cost of seeding and mowing until the stand is established. Avoid cool-season perennial grass planting on firebreaks because they contain dead material and support fire crossing the firebreak. Existing barriers, such as roads, sometimes can be used in the plan to reduce costs. A secondary, indirect cost may be needed to defer grazing or to implement a grazing system, such as intensive early stocking (IES), rotational grazing with fencing or rotational grazing without fencing, known as patch burning, to allow for the build-up of an adequate fuel load to support a fire.

For more information about firebreaks see OSU Extension fact sheet NREM-2890, *Firebreaks for Prescribed Burning.*

Fire Crew

Only one person who is highly experienced with firing techniques and fire behavior serves as the fire boss. The fire boss is responsible for coordinating the fire crew, checking out all equipment, checking weather conditions, notifying the proper authorities and directing implementation of the fire. If the landowner or the fire boss is not satisfied with the firebreak preparation, fire prescription, personnel, weather conditions or other aspects of safety, then the fire boss should postpone the burn. If the fire has already been started, but is not going well, then the fire should be put out. Teamwork and communication between the fire boss, the fire crew, the landowner and the relevant authorities is essential for successful prescribed burning.

A crew of people with experience in conducting a prescribed burn is absolutely necessary. Several neighbors often will work together so everyone gains additional experience in prescribed burning and they can pool their equipment resources. Experience is always valuable.

Cost of Burning

The costs of conducting a prescribed fire vary with the amount of preparation before the fire, equipment and personnel used during and after the fire and pre-burn and post-burn management. In general, costs vary from $0.50 to $25 per acre. Usually, the greatest direct cost of prescribed burning is preparing a firebreak around the perimeter of the area to be burned. Often, firebreak preparation such as dozing is a one-time cost and can be maintained indefinitely with mowing, disking or herbicide. The cost of doing nothing or not burning is the most expensive because it could put you out of business, regardless of the objectives.

Firing Techniques

Headfires, backfires, strip-headfires, area ignition and center and ring ignition are useful methods for setting fires under various conditions. Each fire type behaves differently and should be thoroughly understood before being used. In Figures 1 through 4 and 6, the black solid circle/arrow symbols represent the position of fire crew members and the direction in which they are moving in lighting the fire.

The tools described above can assist prescribed burn managers with information about potential smoke impacts prior to conducting the burn.

For additional assistance with determining potential smoke management problems and forecasted smoke dispersion conditions on the day of the burn, managers can utilize the Oklahoma Dispersion Model. The Oklahoma Dispersion Model (ODM) is a tool developed in conjunction with the Oklahoma Mesonet to assess surface dispersion conditions up to several miles downwind and, in conjunction with forecast information, is used to predict dispersion conditions during the next 84 hours. Output from this model can be found throughout the OK-FIRE website (on the home page as well as in the first five sections in the left menu area).

Atmospheric dispersion conditions in the ODM are broken into six categories, ranging from very poor (red) to excellent (dark green). With respect to smoke dispersal near the surface, it is best to burn during the green conditions (moderately good through excellent). Current dispersion conditions and wind directions are updated every five minutes using the latest Mesonet data; the trajectory of a smoke plume can be determined by looking at the wind directions on this map. Forecast maps of both dispersion and weather conditions (for plume trajectories) are available for the next 84 hours, as well as chart and table forecasts at specific Mesonet sites. An example of a forecast dispersion and wind direction map is shown in Figure 12. Very poor to poor dispersion conditions are forecast for the northwest portion of the state, while moderately good conditions are predicted in the southeast portion, due to the stronger winds and cloud cover.

OK-FIRE also has a Fire Prescription Planner (Figure 13). Prescribed burn managers can enter prescriptions, run it for any Mesonet site and get an hourly forecast table for the next 84 hours. The table will indicate time periods, based on the NAM forecast, when all prescription criteria entered will be met (“Criteria Met?” column), indicating possible windows to conduct the burn.

Liability

Liability for any damages caused by the fire rests with the person who sets the fire or who causes the fire to be set. Prudent action by the landowner and fire crew in carrying out a prescribed fire will demonstrate a “good neighbor policy” and will help to prevent frivolous claims and lawsuits. Prudent action is defined as using good judgment and executing a well-designed fire plan.

What is negligence? It is the failure to exercise the degree of care the situation requires. It is a subjective measure that, in some extreme cases, is measured by a judge and jury. The burden of proof rests with the plaintiff. However, the person who sets the fire or causes it to be set can be held liable even if not negligent. Even though the Oklahoma Prescribed Burning Law does not address negligence, it is very important in determining damages during a jury trial.

Oklahoma is one of only four states that impose strict liability on prescribed burners. Under strict liability, defendants are liable for the damage caused by an escaped prescribed fire even if there is no evidence of negligence on their part and regardless of the precautions taken to contain the fire. An escaped fire is prima fascia evidence of negligence, so determining the value of the damages is the only question in the case of a damage claim or civil suit.

An important consequence of the lack of a reasonable negligence rule in Oklahoma’s prescribed burning statute is that the burner is assuming all the liability risk even when a neighbor could have reduced potential damage by managing fuels and other actions (such as using fire-resistant building materials on houses). Therefore, homeowners and other landowners living in the context of wildland fuels are free to practice negligence in the face of potential wildfire either from an escaped prescribed fire or a wildfire with no liability consequence. This is a classic example of contributory negligence on behalf of the homeowner.

However, negligence rules are changing across the country partly in response to the realization that fire in the urban-wildland interface or intermix requires prudence on the part of all property owners. Property owners should act responsibly and manage their fuels and

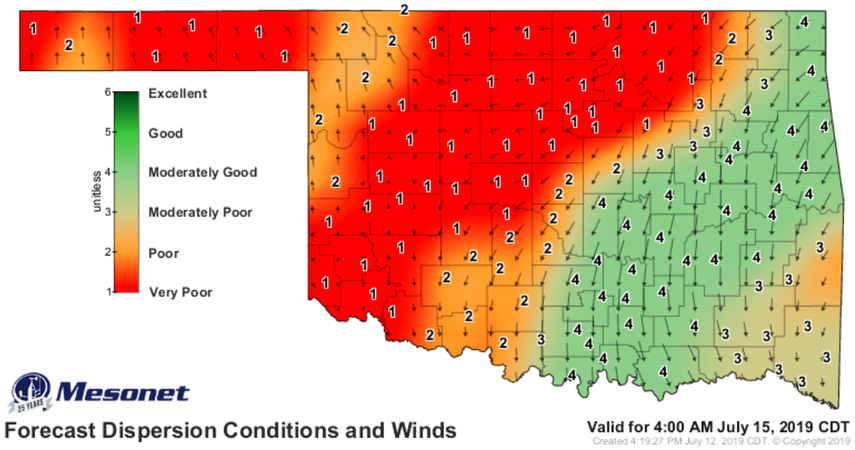

Figure 12. Forecast dispersion and wind map for 4 a.m. CDT July 15, 2019.

OK-FIRE Fire Prescription Planner

Latest forecast based on 1 pm CDT 07/23/18 NAM; NEXT 6-hr update expected 11 pm CDT 07/23/18

Fire Prescription Table for Vinita — Print Table

Disclaimer: *This forecast table, as with other OK-FIRE products, is based solely on output from the latest 84-h NAM forecast. As no weather forecast model is perfect, users are encouraged to check the official forecasts of the National Weather Service for consistency or discrepancies in the weather variable portion of this forecast.*

Change Prescription or Site

DATE / TIME	Criteria Met?	TAIR	RELH	WDIR	WSPD	1hr PRECIP	DISPERSION	1hr DFM	10hr DFM
Mon 7/23/18 10 pm CDT	No	74°F	81%	NNE	6 mph	0.00 in.	1 (VP)	11%	9%
Mon 7/23/18 11 pm CDT	No	72°F	84%	NNE	6 mph	0.00 in.	1 (VP)	13%	11%
Tue 7/24/18 12 am CDT	No	71°F	87%	NNE	5 mph	0.00 in.	1 (VP)	15%	12%
Tue 7/24/18 1 am CDT	No	70°F	90%	NNE	5 mph	0.00 in.	1 (VP)	16%	14%
Tue 7/24/18 2 am CDT	No	69°F	89%	N	4 mph	0.00 in.	1 (VP)	18%	14%
Tue 7/24/18 3 am CDT	No	69°F	89%	N	4 mph	0.00 in.	1 (VP)	19%	15%
Tue 7/24/18 4 am CDT	No	69°F	89%	NNW	4 mph	0.00 in.	1 (VP)	19%	15%
Tue 7/24/18 5 am CDT	No	69°F	89%	NNW	4 mph	0.00 in.	1 (VP)	19%	15%
Tue 7/24/18 6 am CDT	No	69°F	89%	NNW	4 mph	0.00 in.	1 (VP)	19%	16%
Tue 7/24/18 7 am CDT	No	69°F	90%	NNW	4 mph	0.00 in.	2 (P)	19%	16%
Tue 7/24/18 8 am CDT	Yes	74°F	79%	NNW	5 mph	0.00 in.	4 (MG)	16%	16%
Tue 7/24/18 9 am CDT	Yes	79°F	69%	NNW	6 mph	0.00 in.	4 (MG)	14%	16%
Tue 7/24/18 10 am CDT	Yes	84°F	59%	N	7 mph	0.00 in.	5 (G)	11%	15%
Tue 7/24/18 11 am CDT	Yes	87°F	55%	N	8 mph	0.00 in.	6 (EX)	9%	14%
Tue 7/24/18 12 pm CDT	Yes	89°F	50%	N	9 mph	0.00 in.	6 (EX)	8%	13%
Tue 7/24/18 1 pm CDT	Yes	91°F	46%	N	10 mph	0.00 in.	6 (EX)	7%	11%
Tue 7/24/18 2 pm CDT	No	91°F	44%	N	10 mph	0.00 in.	6 (EX)	6%	10%
Tue 7/24/18 3 pm CDT	No	92°F	43%	N	10 mph	0.00 in.	6 (EX)	6%	9%
Tue 7/24/18 4 pm CDT	No	92°F	42%	N	10 mph	0.00 in.	6 (EX)	6%	9%

Figure 13. Example of a resulting forecast table for Vinita in the Fire Prescription Planner on OK-FIRE. Using the entered prescription, the table indicates in the "Criteria Met?" column a burn window from 8:00 a.m. to 1:00 p.m. the next day (green shaded cells) in which all prescription criteria are met.

Headfires (Figure 1) move with the wind, are most intense, have the highest rates-of-spread (approximately 10 to 15 times faster than backfires), have long flame lengths and have high maximum temperatures. Headfires are effective in killing trees and shrubs or burning downed and dead trees on prairies and shrublands. They also are effective in burning low quantities of fine fuel where heavy grazing, spot grazing or soil inclusions cause discontinuous herbaceous fuels. In oak/pine forests, headfires can be used to control competing hardwoods. In general, headfires increase grasses and decrease woody plants. Headfires should not be used where quality hardwood production is a management objective unless herbaceous fuels are reduced.

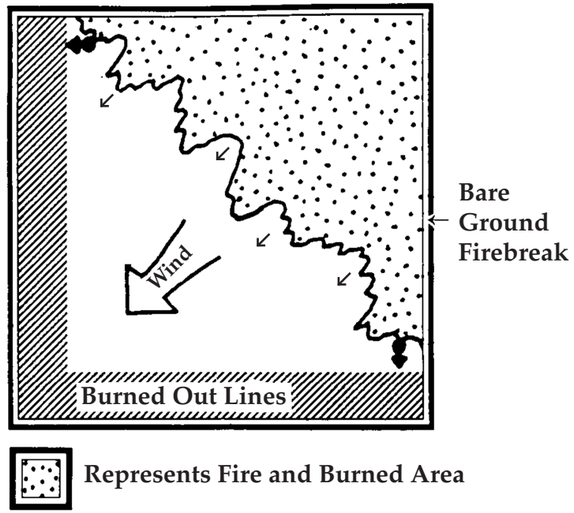

Figure 1. Headfire.

Backfires (Figure 2) move against the wind and, when compared to headfires, are effective for burning fine fuels while reducing damage to woody plants and forbs if fuels are discontinuous. Backfires are safer for burning in less-than-optimum conditions, burning volatile fuels, preparing burned-in firebreaks or in heavy fuel loads where extra control is necessary. Backfires can be used in young stands of timber when the temperature is less than 45 F. Backfires take much longer to execute than other methods. Backfires produce less smoke per unit of time because of their slow rate of spread.

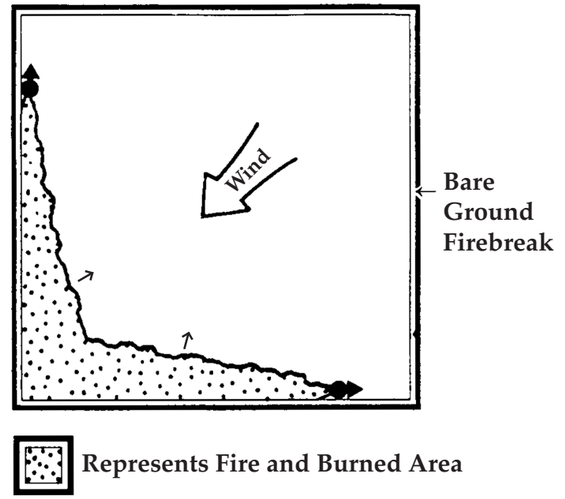

Figure 2. Backfire.

Strip-headfires (Figure 3) and flank fires (Figure 4) are variations in types of ignition techniques to control fire intensity. They are used when backfires move too slowly, but a headfire would be undesirable or too dangerous. This technique is useful when large areas are to be burned. It is useful for burning mature timber and even younger stands when fuels have been previously reduced. Strip-head firing is accomplished by initiating a backfire, then doubling the distance of the burned-in firebreak and setting a headfire. The process is repeated until the blackened area meets the prescription guidelines for the firebreak. Strip-head firing allows the fire crew to build a burned-in firebreak much faster than using a backfire alone. Strip-head firing also is used when fuels are discontinuous because of topography, natural or man-made barriers or soil inclusions.

Flank fires (Figure 4) are lit into the wind and the fire spreads at right angles to the wind. Flank fire behavior is intermediate between that of headfires and backfires in terms of spread rate and flame lengths. Flank fires are a fundamental part of the overall firing process as fire crews move from a backfiring position to a head firing position. This firing method can be used in addition to backfires to increase the area ignited in a shorter period of time. This ignition technique should rarely be used by itself because slight wind shifts can turn a flank fire into a headfire without adequate means of control.

Area (spot) ignition (Figure 5) is used to set numerous spots within an entire area on fire. Spots may be ignited at approximately the same time in a grid pattern (e.g., through use of a helicopter) or in strips of spot fires similar to strip-head firing techniques. Safety for the fire crew is especially important with this technique. This technique is different from the other techniques in that spots of fire rather than a continuous fire front is set. Fires set with area ignition often create their own wind from the numerous fires burning together. This type of fire often is used on rangelands to control hardwoods or eastern redcedar because it can become very intense and give good tree crown scorch. On forestland, area ignition is used with different objectives. Here, crown scorch should be minimized. It can be used where strip headfires

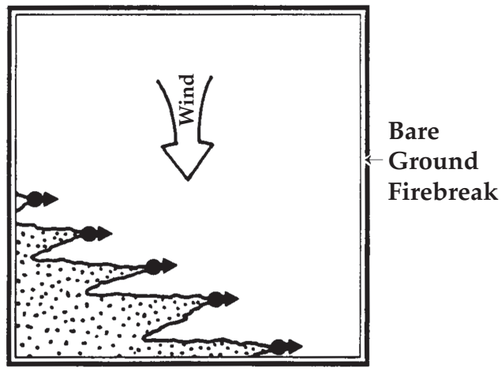

Figure 3. Strip-Headfire.

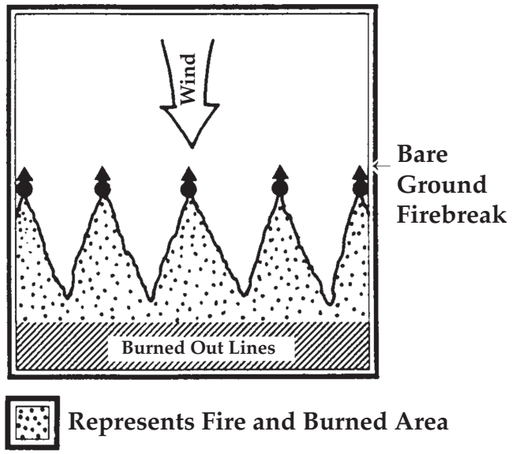

Figure 4. Flank Fire.

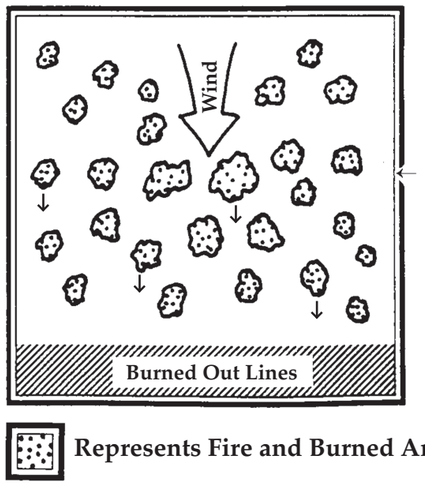

Figure 5. Area (spot) Ignition.

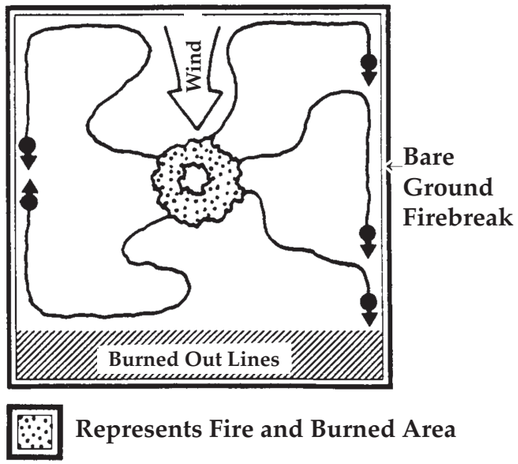

Figure 6. Center and Ring Ignition.

may become too intense. By increasing or decreasing the distance between ignited spot fires, intensity can be lessened or increased respectively. Remember, the greater the number of spot fires burning together the greater the fire intensity of the overall fire and the likelihood of the fire creating its own wind.

Center and Ring ignition (Figure 6) is similar to area ignition, except that one or more spots in the center are ignited after the downwind firebreak is established, either through a previously established burned-out line (rangeland) or with a backfire (forestland). The outer firebreak is then ignited in a ring around the fire in the center of the area. The updraft caused by the central fire causes fire along the outer ring to move toward the middle. Intensity of the fire increases more slowly over time than with area ignition. However, this firing technique causes hot fires. Center ignition may give results similar to area ignition. This fire type may increase firebrands in the air and cause spot fire problems for some distance downwind. This technique is useful on rangeland for controlling redcedar and on forestland to reduce logging debris after

allow for horizontal dispersion of the smoke, as well as local shifts in wind direction, draw two other lines from the fire at an angle of 30 degrees from the centerline.

4. **Identification of smoke-sensitive and other affected areas (Figure 10).** Some areas may be adversely affected by smoke. Using the smoke plume trajectory map:

   (a) Determine the smoke-sensitive areas within the smoke trajectory.
   (b) Recognize the smoke-sensitive areas that already have an air pollution problem.
   (c) Identify any potential areas where emission of sulfur dioxide (SO_2) merges with the smoke plume. Likely sources of sulfur dioxide are smelters, electric power plants and other factories where coal is burned (SO_2 from these sources combined with particulates from fire may be a significant health hazard).
   (d) If other known sources of smoke overlap the trajectory toward a sensitive area, consider increasing the screening distance on the trajectory map to account for the effects of the combination.

5. **Evaluation of the results.** If any areas in Step 4 are identified that could be adversely impacted by smoke production from the prescribed fire, postpone the burn and wait for a higher Category Day—one that will reduce the smoke trajectory enough so those areas will not be impacted.

A simple online smoke screening model is also available for use to plot smoke trajectory at fireweather.fdacs.gov/Simple-Smoke/ (Figure 11).

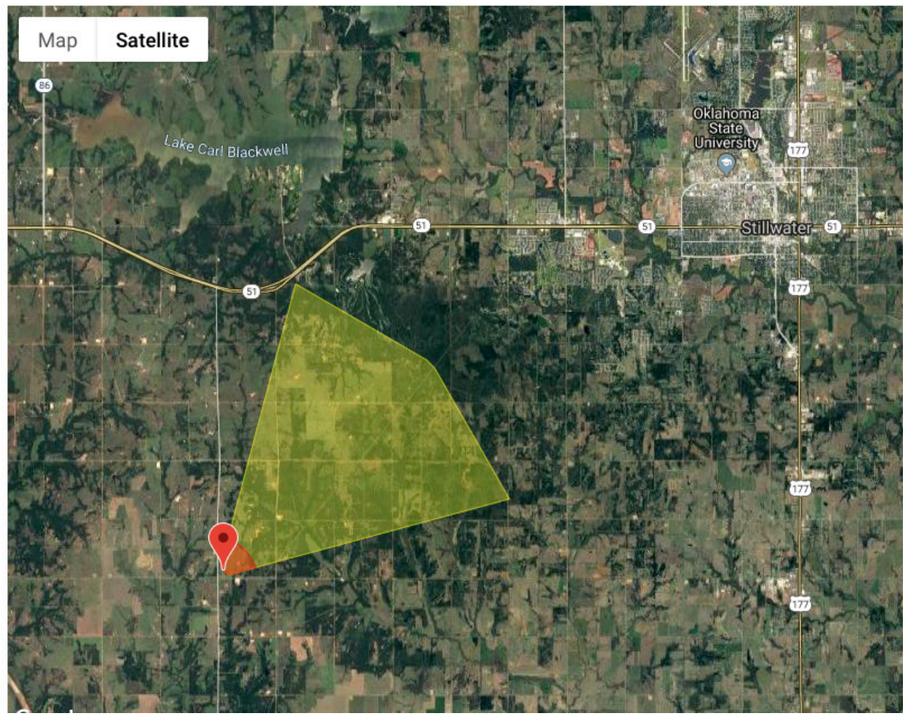

Figure 11. Map of smoke trajectory generated from online smoke screening model.

schools, hospitals and residences. Select one or more of the following four categories (note that other firing techniques not listed should be considered under the headfire category if less than 1,000 acres):

(1) Backfire less than 1,000 acres.

(2) Headfire less than 1,000 acres.

(3) More than 1,000 acres.

(4) Brush piles and/or windrows.

Using Table 2, select the Type of Burn and Category Day. The resulting number in the table for that row (Type of Burn) and column (Category Day) combination is the minimum number of miles downwind to screen for smoke-sensitive areas.

Table 2. Distance (miles) downwind that should be examined for possible smoke sensitivity.

Type of Burn	Category Day				
	I	II	III	IV	V
Backfire less than 1,000 acres	NB*	10	5	2.5	.75
Headfire less than 1,000 acres	NB	20	10	5	.75
Fire larger than 1,000 acres in size	NB	20	10	5	.75
Brush piles/windrows	NB	30	15	8	.75

* No Burn

3. **Trajectory of smoke plume (Figure 10).** Locate the site to be burned on a map and draw a line representing the centerline of the smoke plume. The length of the line should be greater than the screening distance determined in step 2. If the burn will last for a long period of time, draw another line showing the predicted wind direction at the end of the burn. To

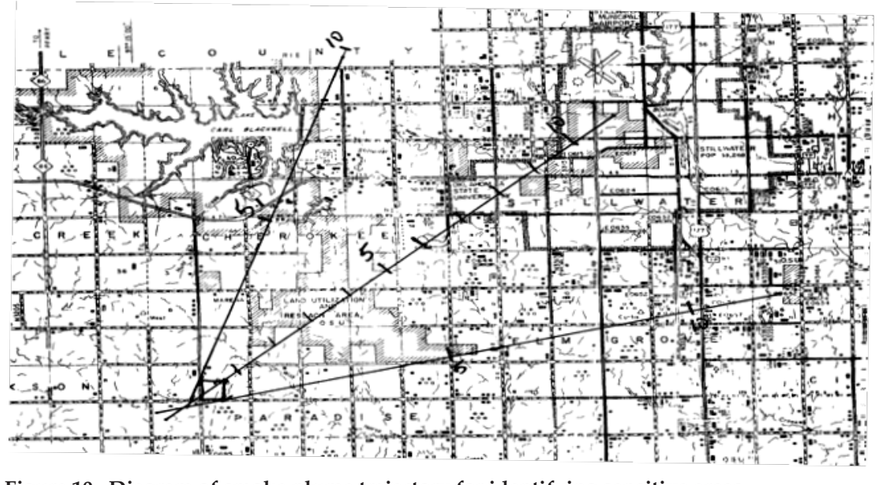

Figure 10. Diagram of smoke plume trajectory for identifying sensitive areas.

harvest. Application of the technique in mature forests is not recommended because severe crown scorch can occur when flame fronts meet. This technique can be modified with strip-fires across the center for successful under-burning of forests. Center and ring ignition should only be used under light wind conditions.

Weather Conditions

Other than the season of burn, weather variables are the main environmental factors considered in developing a fire prescription. Fire behavior in rangeland and forestland is directly related to local weather conditions, and regional forecasts may not be accurate enough for making decisions concerning burning of local sites. Weather conditions must be monitored on site using a digital weather meter or weather kit. Weather variables such as relative humidity, air temperature and wind speed dictate how the fire will behave and how the plant community will respond to the fire. Wind speed and direction can change rapidly. Therefore, a prescribed fire should not be started within 12 hours of a weather front or when winds are variable in direction.

The amount of moisture in dried grass (i.e. 1-hour dead fuel moisture) is directly related to relative humidity and can change within one hour. Changes in relative humidity will change fire behavior and combustibility of fuels. The amount of time since a rain and the amount of tree or shrub cover also will impact fuel moisture and fire behavior. Fire prescriptions have a range of acceptable limits for all of these weather variables and should be followed closely. A rule of thumb to use in the field to predict changes in fire behavior is that when the air temperature increases 20 F, the relative humidity decreases by 50%. For example, if the air temperature increases from 60 F with 40% relative humidity in the morning to 80 F in the afternoon, the relative humidity will drop from 40% to 20%. This relationship also works inversely (e.g. as air temperature decreases, relative humidity increases). A fire conducted safely at 40% relative humidity may pose a safety risk at 20% relative humidity (Figure 7).

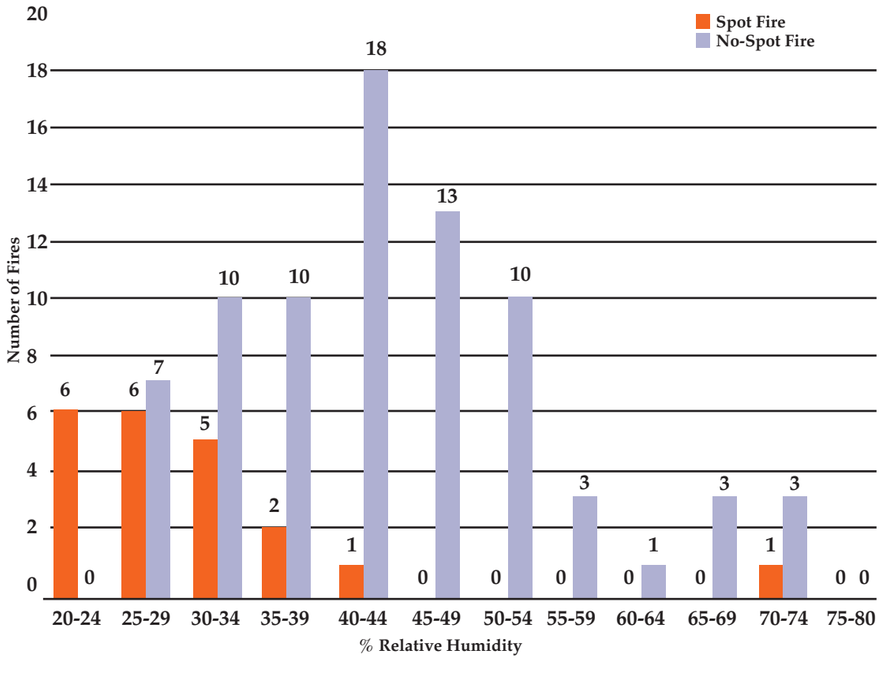

Figure 7. Spotfires can occur at any time, but the majority happen when relative humidity is less than 40%.

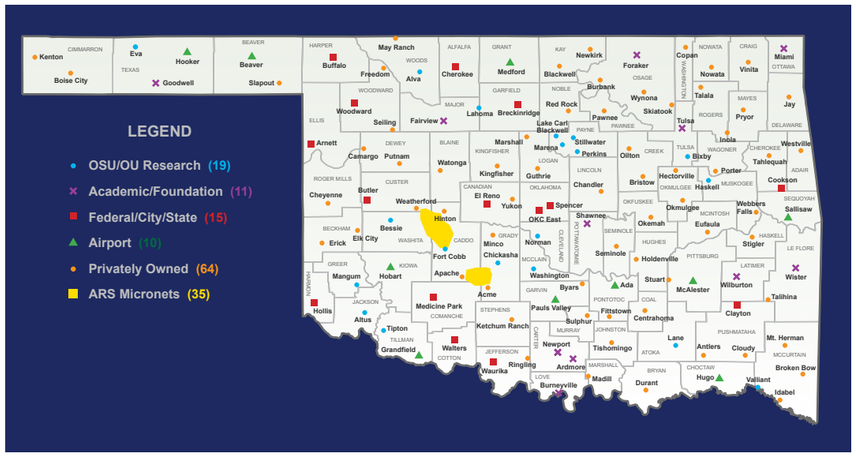

Figure 8. Location of stations within the Oklahoma Mesonet.

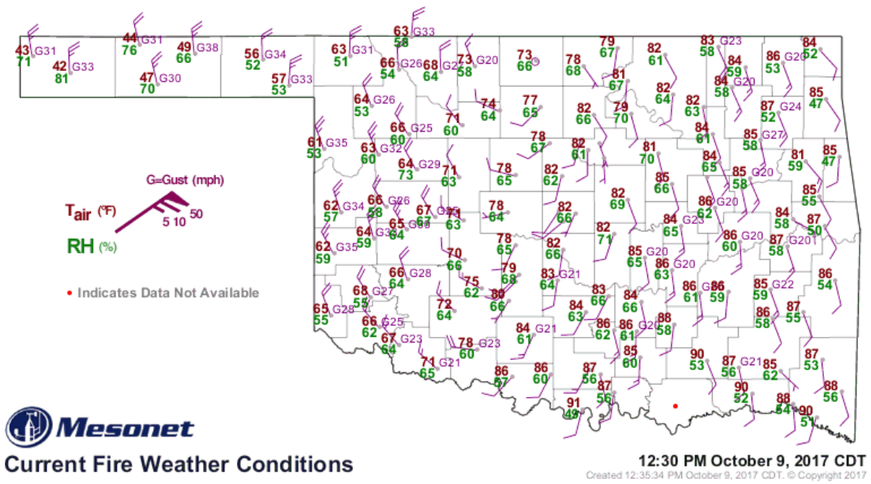

Figure 9. Curent fire weather map from the Oklahoma Mesonet for 12:30 p.m., Oct. 9, 2017.

The Oklahoma Mesonet is a tool that fire managers in Oklahoma can use to assess changing weather conditions as well as fire danger and smoke dispersion conditions. Operational since 1994, the Oklahoma Mesonet is an automated weather-monitoring network of 120 stations that record and transmit weather and soil conditions in near real time (Figure 8). Weather data is recorded and transmitted every five minutes, while soil temperature and soil moisture are recorded and transmitted every 15 and 30 minutes, respectfully.

As an example of the usefulness of Mesonet for prescribed fire, Figure 9 shows the fire weather map for 12:30 p.m. CDT on October 9, 2017. It shows in detail the location of a strong cold front pushing through the state. Ahead of the front (to the east), south to southeast winds predominate with temperatures in the 80s, while behind the front temperatures fall into the 40s in the panhandle with strong winds out of the north and northwest. A fire

occurring ahead of the cold front would be moving toward the north, but after frontal passage would shift directions and start moving to the southeast. Because these maps are updated every five minutes, fire managers can see the location and speed of movement of such weather discontinuities that are so important in fire management. These maps, and many others, can be found on the OK-FIRE website (mesonet.org/index.php/okfire) in the "Current Maps" section. Not only are current fire weather, fire danger and smoke dispersion maps available on the website, but also past and forecast maps. Forecasts are based on an 84-hour numerical weather forecast model called the NAM (North American Mesoscale) model. In addition to maps, prescribed fire managers also can access site-specific information at Mesonet locations in either chart or table formats.

Topography has a dramatic effect on wind speed, wind direction and the spread rate of the fire, especially in mountainous regions or in canyons. The weather conditions depicted on Mesonet maps generally apply to flat terrain, so special precaution for erratic fire behavior and fire crew safety should be taken when burning in areas of non-uniform topography. A backup plan for fire escapes is essential in such areas.

Smoke Management

Occasionally, weather conditions are within prescription guidelines to meet objectives, but the smoke will not dissipate. These conditions often result from a thermal inversion in which warm air aloft traps cooler air close to the earth's surface. In this situation, smoke will stay close to the ground and reduce air quality and visibility. It is possible to "smoke-in" a town for several days. Fires that burn into the night may cause smoke problems. Smoke is usually more of a problem in the hilly and mountainous regions of eastern Oklahoma than in the rest of the state. If smoke crosses a road, a serious safety problem may exist for traffic. Be prepared with personnel to meet this challenge if it occurs.

One method for determining potential smoke management impacts on sensitive sites, such as roads, communities and neighborhoods, is to follow a five-step screening system:

1. **Category Day (Table 1).** Determined by the Ventilation Rate (m^2/s), which is the mixing height in meters, multiplied by the transport wind speed in meters per second.

Table 1. Determining Category Day.

Category Day	Ventilation Rate	Burning Guidelines
I	<2,000	No Burning!
II	2,000 to 4,000	No burning until 11:00 a.m. and not before surface inversion has lifted. Fire out by 4:00 p.m.
III	4,000 to 8,000	Daytime burning only after inversion has lifted.
IV	8,000 to 16,000	Burning anytime. For night burn use backfires with surface wind speeds greater than 4 mph.
V	>16,000	Unstable and windy. Excellent smoke dispersal. Burn with caution!

Current surface temperature inversion maps from the Oklahoma Mesonet can be found in the "Current Maps" section of the OK-FIRE website. Ventilation Rate can be found at the National Weather Service fire weather websites listed near the end of this publication, although formats and units vary between the sites.

2. **Screening distance (Table 2).** The distance downwind that should be examined for possible smoke-sensitive sites such as airports, highways, communities, recreation areas,