PRESCRIBED RANGE BURNING IN TEXAS

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INTRODUCTION

Fire was a natural ecological factor on most Texas rangelands before European settlement, therefore, native vegetation is well adapted to burning. Fire effectively suppresses most woody plants while encouraging grass and forb growth. However, sound range, livestock and wildlife management must accompany the use of fire if benefits are to be realized.

Prescribed range burning follows guidelines that establish the conditions and manner under which fire will be applied on a specific area to accomplish specific management and ecological objectives. This contrasts with wildfires that can occur any time fuels will burn, often under extremely hazardous conditions. The conditions selected for a prescribed burn (season, vegetational growth stage and weather factors) must be conducive to *safe* and *effective* burning. Management objectives determine the fire characteristics needed to maximize benefits, minimize damage and conduct a safe burn.

The most commonly recognized management objectives that can be accomplished by using prescribed fire include:

- Improved pasture accessibility
- Increased production of forage and browse
- Suppression of most brush and cacti species
- Control of selected forbs and / or grass species
- Improved herbaceous composition
- Improved grazing distribution of livestock and wildlife
- Increased available forage and browse
- Improved forage quality and / or palatability
- Increased animal production
- Removal of excessive mulch and debris
- Control of certain parasites and pests
- Improved nutrient cycling

Each management objective requires a particular set of conditions for burning and a specific type of fire to achieve the desired response. Therefore, carefully evaluate objectives before a fire plan is developed.

DIFFERENT FIRES – DIFFERENT RESPONSES

Plant response after a fire is influenced by the intensity of the fire, condition of plants at the time of the burn and weather conditions and grazing management decisions following the fire. However, fire effects differ depending on rainfall, fuel quantity and length of growing season (figure 1).

Several factors that determine a fire's intensity are fuel quantity and continuity, air temperature, humidity, wind speed, soil moisture and direction of the flame front movement relative to the wind. Generally, the intensity of a fire increases with greater quantity and continuity of fuel, higher temperature and wind speed and lower humidity and soil moisture. A fire set to move in the same direction as

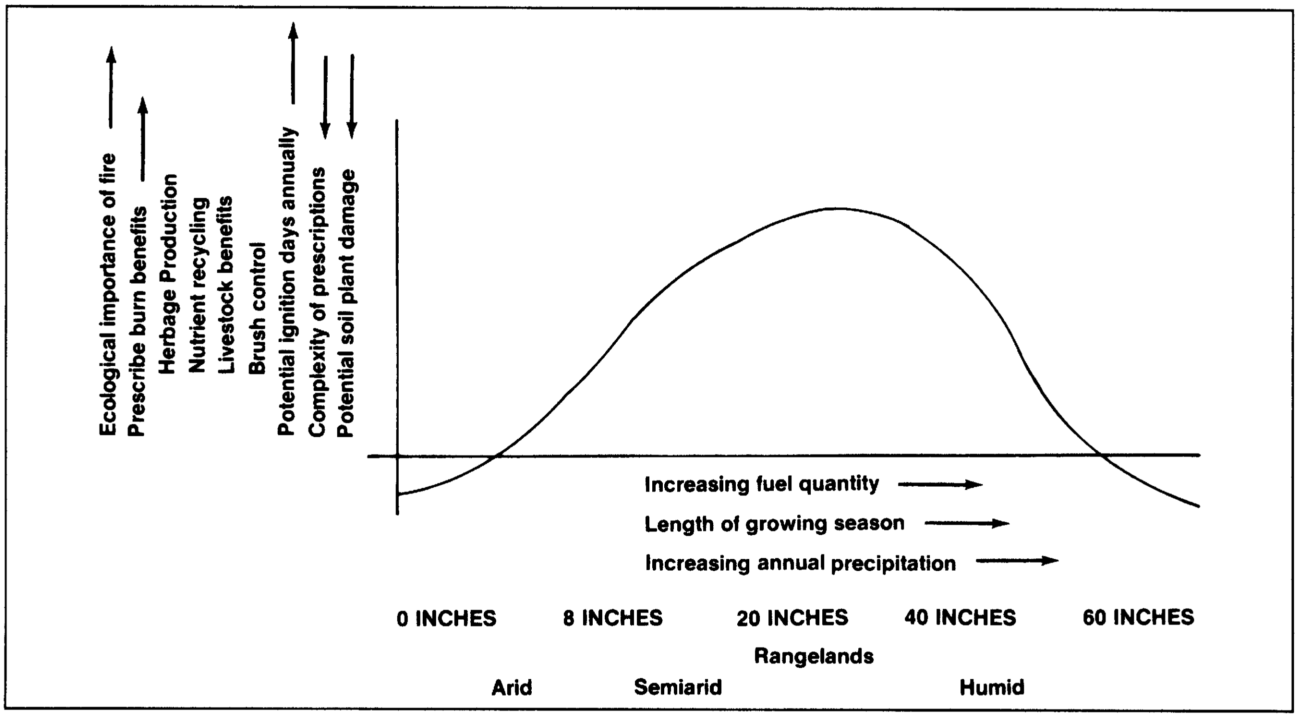

Figure 1. A variety of factors influence the impact of prescribed burning.

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the wind (headfire) tends to be more intense than a flame moving against the wind (backfire). Controlling the fire's intensity through correct firing techniques under appropriate conditions is a key factor in achieving the desired responses from a prescribed burn.

An equally important factor to consider when planning a burn to accomplish specific objectives is the stage and type of growth of desirable and target species. For example, the growth stage of forbs at the time of the burn greatly affects the current and following year's production. Forbs are prolific seed producers, but an untimely fire can destroy forb reproduction and wildlife food. Forb seedlings are highly susceptible to fire; therefore, a late winter burn after many annuals have germinated reduces their population. Burns conducted during early to mid-winter with good soil moisture results in late winter annuals and allows rapid recovery of perennials.

Non-sprouting shrubs are easily killed by fires even though the foliage is not consumed (for example, Ashe juniper). Most shrubs sprout from a bud zone at or below the soil surface. These plants are difficult to kill after the seedling stage. However, top kill is often achievable and greatly reduces competition with perennial grasses and forbs for several years. Because of the extensive root system on mature brush plants, sprouts often grow rapidly and produce canopies similar to pre-burn conditions in 3 to 5 years depending on species.

Perennial grasses are better adapted to burning than woody plants and forbs because of differences in location of growing points. For most grasses (during dormancy), the growing points are located near or below the soil surface. Annual grasses may be killed by fire after they germinate but may be promoted if burning occurs before germination. Fires that consume annual grasses before seed drop greatly reduce next year's seedling production and affect food supplies for some wildlife, such as quail.

The differences in growth cycles between warm and cool season grasses allows timing a burn to enhance one class over the other. Early greenup grasses, such as threeawn, can be harmed by an early spring burn with little damage to deep-rooted perennial grasses. However, cool and wet soil conditions can reduce heat penetration to the sprout zone of shrubs resulting in less damage. Usually, late winter burns improve forage quality, provide rapid grass recovery for earlier grazing, control winter annuals and reduce shrub competition by top removal and seedling kill.

Winter dormant plants recover faster than drought-stressed plants burned during the spring, summer or fall. Also, summer fires are extremely hot and more damaging to vegetation than winter burns. The vegetation is drought stressed and highly flammable at this time of year. High soil temperatures and low humidity combined with flammable fuels contribute to summer burn intensity. Use summer burns only after careful evaluation and planning. If the burned area remains bare for long periods, the potential for soil erosion is greatly increased.

In summary, much of the prescribed range burning involves the correct combination of firing techniques, seasonal timing and appropriate weather and range conditions on the day of the burn.

However, these are not the only factors that influence plant response after a burn. Precipitation amounts and season received have a significant effect on range recovery following a burn. Grazing management practices are also important in affecting the recovery rate and level of recovery.

PRINCIPLES FOR USING PRESCRIBED FIRE

A successful burning program involves three basic steps: (1) thorough planning which includes total ranch evaluation, pasture selection, management goals, training for conducting a safe burn and preparations for the burn; (2) safe and effective execution of the burn on the specified area(s); and (3) sound range, livestock and wildlife management before, during and after the burn(s).

The Fire Plan

The fire plan identifies the recommended guidelines, procedures, preparations and resources needed for conducting a burn. The plan should describe ignition procedures, location of control crews and location of firelines. Have a contingency plan for control if the fire should escape. Discuss this with your volunteer fire chief in advance of the burn. Volunteer fire departments should be notified of the burn date(s) and burn plan. Regulations for prescribed burning are controlled by the Texas Air Control Board. Obtain and follow current regulations.

Several points to remember in planning a burn are:

- Preburn grazing management (including wildlife population control) is necessary to allow adequate fuel build-up and improved desirable plant vigor.
- Prescribed burns require adequate preparation, equipment and experienced personnel.
- Fire plans and prescriptions are only guidelines.
- Fire behavior must be predictable for effective containment.
- Fire intensity is determined by weather, fuel conditions and type of fire.
- The greater the intensity of the fire, the greater the risk of escape.
- Fire primarily topkills perennial plants.
- Vegetation recovery rate is dependent on species, their vigor, fire temperature, weather conditions and management before and after the burn.
- Postburn management of livestock and wildlife is critical to recovery and improvement of desirable plant species.
- Repeated fires are usually necessary to meet objectives.

Prescribed fire can be used alone or in combination with other range improvement practices (table 1). If sufficient grass fuel cannot be produced, use more intensive practices combined with proper grazing management to promote range improvement. Using fire in combination with other practices often extends longevity and improves the economic rate of return.

Executing the Burn

Consider the day of the burn as judgment day. The first priority is to insure that preparations are complete and check local weather forecasts. The National Weather Ser-

Table 1. Relationship between range condition and optimum use of brush management practices.

Range Condition	Percent of potential	Brush management practice
Excellent	100 to 75	Prescribed burn Individual plant treatment Biological control
Good	74 to 50	Roller chop Individual plant treatment Prescribed burn Biological control
Fair	49 to 25	Roller chop and burn Shred and burn Chain and burn Broadcast herbicide Broadcast herbicide and burn Biological control
Poor	24 to 0	Root plow and seed Disk and seed Tandem roller chop, seed and burn

vice can provide an estimate of conditions during and following the burn. Also measurement of on-site wind speed, wind direction, air temperature and relative humidity are recommended before and during the burn for timely adjustments in procedures.

Only one person (the fire boss) should be in charge of the burn. Identify who the fire boss is to prevent false alarms and unnecessary expense to the fire departments. This person must decide whether to burn and constantly re-evaluate fire behavior, ignition and control during the fire. Even after years of experience, there is always a need for concern and constant alertness. No prescription can be followed to the letter but must be adapted each moment before and during the burning. Before beginning the burn give final notification to volunteer fire departments, sheriff's departments and neighbors. This cannot be overemphasized.

Use small test fires to evaluate fire behavior each time conditions change and adjust the plan as needed. The test fire allows better evaluation of existing conditions and potential outcome of the larger burn before a commitment is made. Changes may be necessary to maintain control or to alter intensity of the fire to accomplish specific management objectives. Once the fuel is burned, the opportunity for that season is gone.

Ignition crews must be constantly aware of fire behavior. The potential for escape is greatest during ignition if current factors are not fully appreciated. Make adjustments immediately for any changes in wind direction, velocity, fuel flammability and relative humidity.

The person igniting the fire must be careful never to allow a heat build-up that can escape. Do not get in a hurry; allow the fire to do its job. Flame heights become dangerous when they reach more than halfway across the fireline. Avoid conditions that carry ignited leaves and ash outside the burn area.

Maintain two-way communication between all personnel. Accurate and rapid communication allows proper decisions and immediate action.

Keep sprayers, along with an accessible water source, readily available for controlling small fires. The need for other equipment such as a dozer, chain saws, handtools and graders will depend on conditions. Everyone on the fire should understand their responsibilities and the burn plan. Only the fire boss should direct the actions on the burn, including control of any escaped fires.

Predicting Fire Behavior

Weather conditions and firing techniques significantly influence fire behavior. The variables most affecting fire behavior are topography, fuels, weather and firing techniques. These factors may be counteractive, additive or dominant.

Topography

Topography affects wind behavior and heat build-up which in turn affects flame front movement over the area. Prediction of wind patterns is necessary so that prefire control measures are taken and appropriate firing procedures are used. A fire moves faster upslope and slower downslope when compared to level terrain. Wind is channeled up canyons with increasing speed. In addition, wind in valleys and on slopes moves upward during the day because of surface heating and downward at night because of surface cooling unless prevailing winds are strong enough to overcome local conditions. Eddy currents over the crest of a hill and around objects create different fire intensities, rates of spread and direction of fire front movement. Sometimes these conditions create fire whirlwinds that can carry sparks, burning debris or flames across a normally safe fireline. Firewhirls are small, tornadic winds, like a dust-devil, created from intense hot spots and rapid rising air at a concentration point.

Fuel

Fuel moisture content directly affects ignition and flammability. Green, living tissue is more difficult to ignite than dead material, which ordinarily promotes the spread of fire. Temperature, humidity, wind, precipitation and dew, season, time of day, topographic location and microclimate determine fuel moisture. Completely dried grass crackles and breaks easily into pieces when crushed in the hand, while dry twigs snap. In general, grass fuels are relatively safe to burn, whereas plants with high oil content are explosive and can create serious firebrand problems.

Moisture content of dead grass, leaves and small branches changes quickly with atmospheric moisture, hence they are considered fast burning fuels. Logs, stumps and large branches, by contrast, take up moisture more slowly. Longer periods of atmospheric drying (several days) are required for prescribed burns to consume logs. Once these fuels have been ignited they may burn for several days. Do not concentrate these fuels near firelines.

The quantity of fuel that burns determines the amount of heat developed during a fire. Generally, 1,500 to 2,000 pounds of grass per acre are required for an effective broadcast burn. The heat generated affects fire characteristics and results. A good grazing management program allows for development of necessary fuel, especially in above average rainfall years.

Weather

Weather conditions before, during and after the burn have a major influence on fuels, conditions, procedures and recovery. Predicting wind speed and direction is necessary so that the fire burns in a predetermined manner. Wind movement can be predicted if burning is conducted with a knowledge of weather systems and the effect of high and low pressure cells. Winds associated with frontal weather systems will shift in a clockwise direction as the front approaches and passes over (figure 2). Wind direction changes quickly as a front moves through an area. The wind in South Texas will be from the southeast shifting to the southwest as a front approaches. In North and West Texas, winds are usually from the southwest shifting to the west. Wind speed increases and is often gusty and turbulent just before the front passes. After passage of the front, the wind direction is usually from the north and may be unstable for some time. After a day or two, the winds will be from the northeast or east. The shape of the front and rate of movement are important. Generally, movement of fronts during the winter causes constantly changing conditions in Texas.

Wind speed greatly affects the flame height, rate of spread and uplift of embers and burning material. Speed must be sufficient to carry fire easily through the fuels but not high enough to cause the fire to jump the downwind firelines. Wind speed should be between 5 and 15 miles per hour for effective burning.

Low wind movement is dangerous because of possible whirlwind development and unpredictable direction of spread. High wind speeds may reduce fuel consumption and increase chances of escape. Wind direction must be consistent throughout the burn to avoid unpredicted fire behavior. Usually, large fires create their own wind around the convection column of smoke, heat and flame front. Two fires moving toward each other can create an intense hot spot or firewhirl.

The height and density of plants affect wind velocity. Unless sufficient fuel occurs within a brush stand, wind velocities may be insufficient to move flames properly and damage the brush. Also fuel should be uniformly distributed and in sufficient quantity to carry the fire under the canopy of a shrub or tree to generate the necessary heat to kill plant tissue. Mechanically cleared firelines and roads in brush or trees create openings that produce unusual wind movements.

Figure 2. Prevailing wind direction depends on the location of fronts and high and low pressure cells.

Relative humidity affects fuel moisture, fire intensity and rate of spread. The lower the relative humidity, the hotter the fire and the greater the risk. Fine fuels such as grass, burn with the same intensity when relative humidity is between 25 to 45 percent. Cooler fires result when the relative humidity is 45 to 60 percent. Less uniform and intense fires occur when relative humidities are above 60 percent. Do not attempt to burn when relative humidities are below 20 percent.

Day to night changes in air temperature and relative humidity create different fire behavior potentials. Fires of different intensities can be executed by selecting different times of day or night and different weather conditions. The density of a brush stand and the amount of shade created by the vegetation affects the relative humidity near the soil surface. Except under extremely dry conditions, brush stands burn slower and less intensely than open grassland areas.

Firing Techniques

Proper ignition procedures are needed to effectively contain a fire and accomplish management objectives. Ignition procedures greatly influence fire behavior and spread. Fires either move in the same direction as wind (headfire), in an opposite direction of wind (backfire) or at a right angle to the wind (flankfire) (figure 3). The headfire is the most intense because of its faster rate of spread, wider burning zone and greater flame heights. The flankfire is of intermediate intensity.

Backfires require higher fuel quantities and a more continuous fuel distribution than headfires. Since backfires move slower and have a less intense flame front, they are easier to control. Also, in heavy fuels, a backfire may consume more fuel and provide greater plant basal damage to brush than fast moving headfires by keeping heat closer to the soil surface. Set backfires as close to the fireline as possible to prevent high flames and embers from crossing the fireline.

Headfires are effective at top killing shrubs and trees with intense heat several feet above the soil surface. Headfires burn under a wider range of weather and fuel conditions than backfires but are more dangerous. Headfires may be required to burn large acreages in a reasonable amount of time. However, a series of firelines across a pasture can be used to set a number of backfires in a short period. Costs of fireline construction are higher.

A combination of the head and backfiring technique is the stripfire. This is simply a line of fire set within the pasture at right angles to the wind direction. The result is a headfire across the strip and backing fire into the wind. This technique is used to speed up the widening of firelines. The ignition crew should regulate the width of the strip so that the flame front does not leap the fireline or burned out area. Changes in fuel quantity and continuity require appropriate changes in width of the strip fired area.

Once a headfire moves 50 to 100 feet, its major flame front characteristics have developed. A 50- to 100-foot wide stripfire can be set to confirm the necessary width of the fireline before setting the major headfire. Properly station all control crews for this test burn. Do not set a second stripfire or the headfire until the flame-front from the strip has calmed.

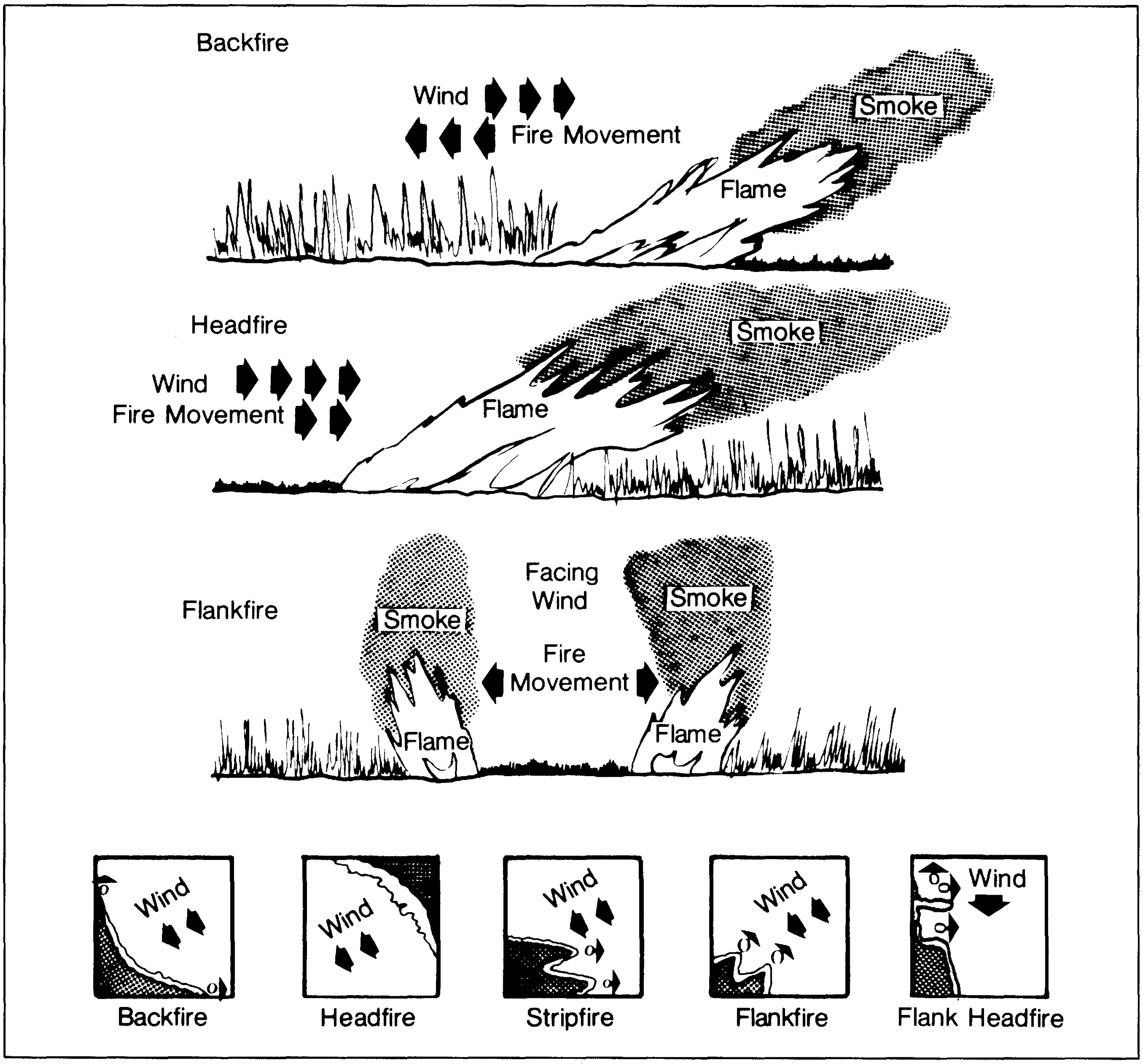

Figure 3. Firing techniques commonly used for prescribed burning.

Backfiring from a fireline, followed by headfiring, has been successfully used throughout Texas (figures 4 and 5). The backfire plus stripfiring is used to sufficiently widen the downwind fireline before the headfire is ignited. This allows flexibility in wind direction and potentially more suitable burn days during a season than when a plan requires a specific wind direction. Also, adjustments in firing can compensate for shifts in wind direction. Observing backfires and stripfires improves judgment on fireline width, potential escape conditions and flammability before setting the headfire.

Fire Containment Practices

Containing a fire to the specified area requires use of natural or man-made breaks in fuel continuity and burning under conditions that minimize chances of escape. Improperly set fires could escape across any fireline. Exercise constant vigilance by personnel throughout all burns. The key to containment is immediate response to any potential escape.

Usually, firelines are constructed using mechanical equipment to expose the mineral soil or by applying fire retardant compounds or water on the fuel. Always plow firelines away from the area to be burned to prevent burying fuel that can smoulder and create sparks for long periods. Usually a fireline 1 or 2 blades wide is adequate, depending on conditions and firing techniques.

Generally, adapt the firing procedure to the kind of firelines and natural barriers available. Use a 1- or 2-foot retardant fireline if care is taken to backfire precisely along the chemical line and not promote flames that can reach flammable fuels. Thus, fire is used under carefully controlled conditions to widen and create a sufficent fireline. Disking is satisfactory if mineral soil is well exposed and flammable fuel is eliminated in the disk strip. Often disking does not adequately destroy the fuel continuity, and use of hand tools or retardants is required to prevent fire from skipping through patches of fuel. Also, disking may reduce accessibility for trucks and sprayers to move quickly along the fireline.

Drip torches (using a diesel-gasoline mixture) are recommended to set uniform, narrow fires without considerable resetting. Burning tires, pear burners and matches are less reliable and create a wider initial flame front. Erratically set fires result in stringers of fire proceeding at different rates drawing each other and creating erratic behavior.

Use special care when burning volatile fuels to prevent embers from crossing firelines. For example, burn juniper piles within 500 feet of the perimeter during the growing season or under high moisture conditions when the surrounding grass is not flammable (figure 6). Use this same practice for any brush pile or concentration of dead fuel that poses a threat to containment. Hot fires under piles will destroy existing vegetation, especially if burned during the growing season. Hand seeding in the ash may be a valuable practice for more rapid recovery.

SAFETY IS THE KEY

If it cannot be done safely, do not burn. Escaped fires can damage property, life, equipment, animals and vegetation that negate the beneficial effects achieved with the planned burn.

The fire boss is responsible for executing the burn safe-

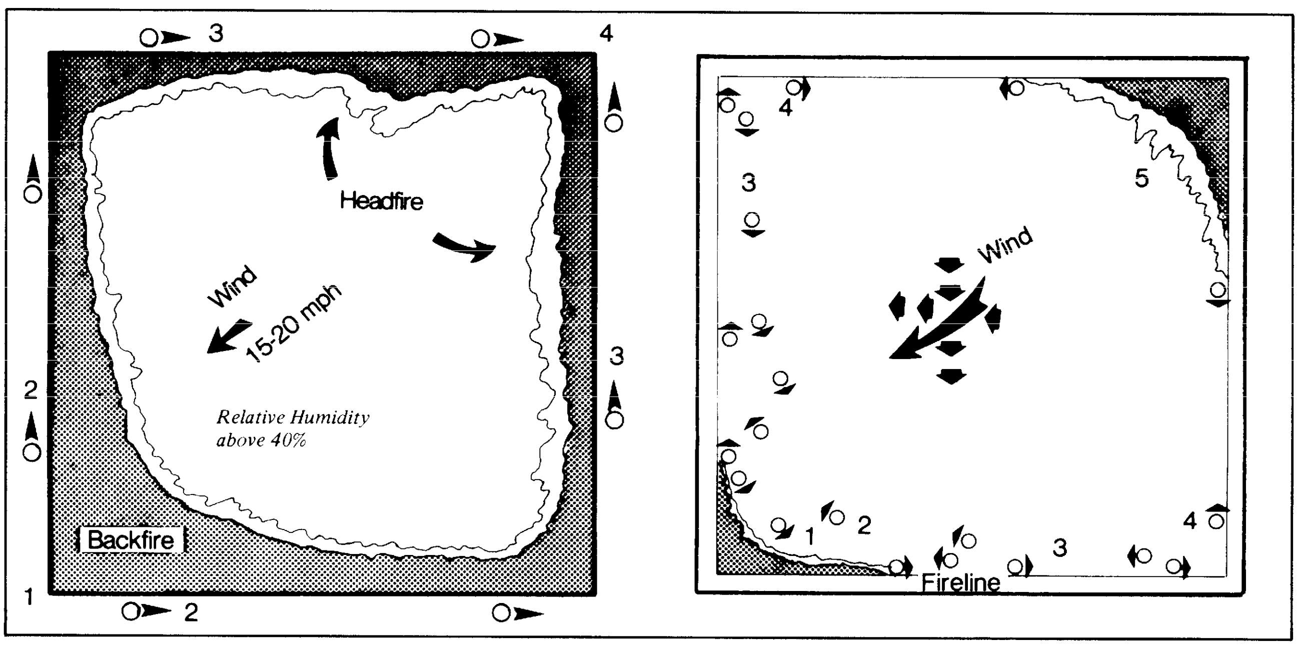

Figure 4. Using combinations of backfiring, stripfiring, flank headfiring and headfiring allows the fireboss and ignition crews to conduct successful burns with fire to help contain the burn. One procedure (left) utilizes a backfire (1) lit simultaneously in each direction. (2) After the backfire has burned 50 to 100 feet on the downwind sides, ignite the remainder of the area (3) and burn as a headfire (4). (From publications by Dr. Henry Wright, Texas Tech Univ.) By using all combinations of firing techniques (right), more difficult burns can be accomplished. The backfire plus narrow strip fires (1) are used to widen the firelines on downwind sides. A wider stripfire is used to increase fireline width and test burnout for containment of the headfire (2 and 3). A flank headfire is used to widen burnout of corners (4). The headfire is set using two torches to the burnout corners (5).

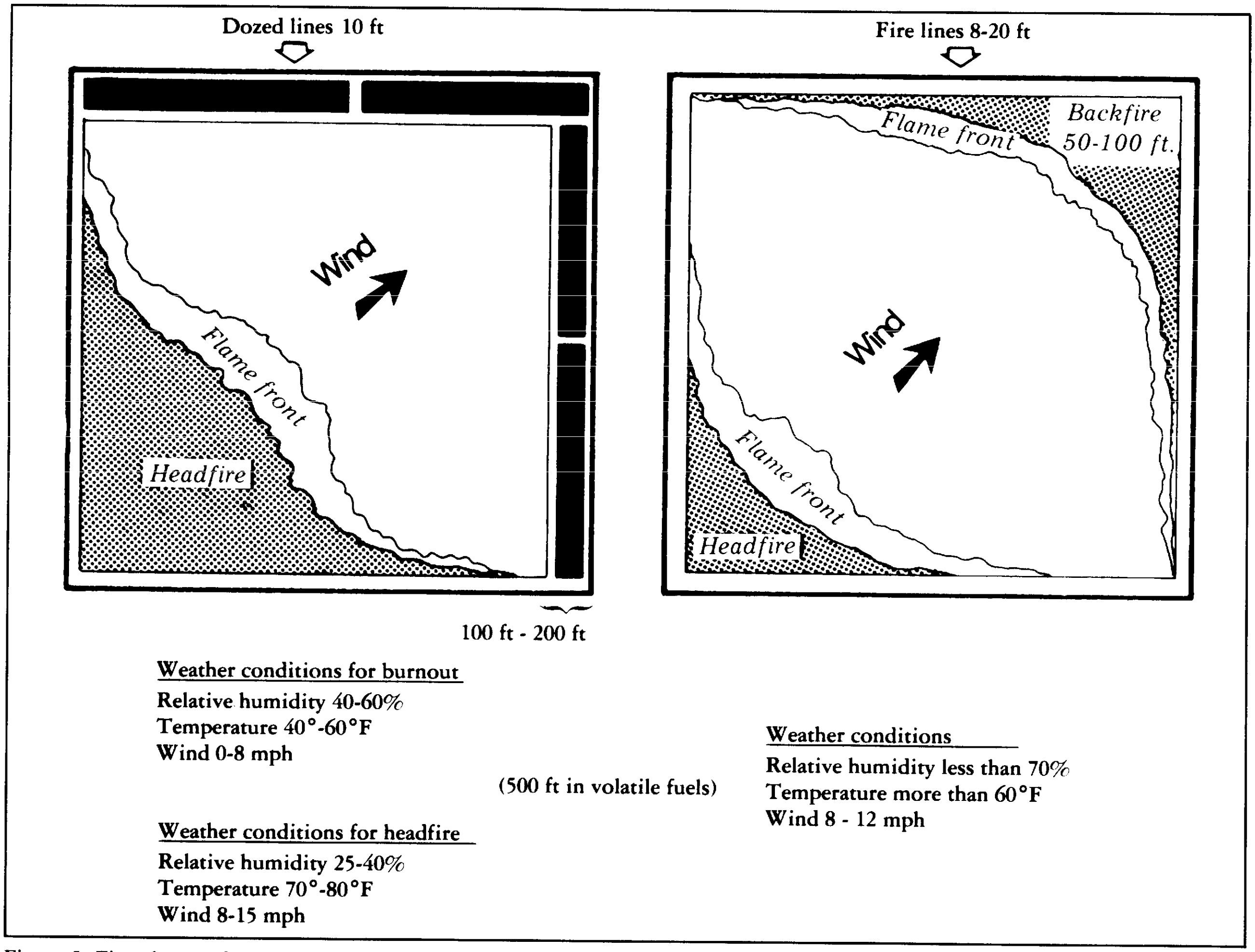

Figure 5. Fire plans and prescriptions differ with objectives, vegetation, personnel training, etc. Fixed wind direction (left) requires burnout of upwind firelines in January and February and ignition of the headfire in February or March. A fire plan using "simultaneous" backfiring and headfiring (right) requires greater coordination and on-the-ground judgment but does not require a fixed wind direction in the prescription. (From publications by Dr. Henry Wright, Texas Tech Univ.)

ly and effectively. Burn plans provide realistic guidelines for when, where and how to conduct the burn. However, actual burn conditions seldom perfectly match the desired guidelines. Apply techniques that best match the current and expected conditions and use experienced personnel to provide leadership. Do not wear clothing that is highly flammable or melts easily; cotton is recommended.

The landowner using prescribed fire is legally responsible. Arrange for liability insurance and involve neighbors in planning and executing the burn(s). Inform fire and sheriff's departments. Proof of planning and use of accepted burning practices may be invaluable in negating charges of negligence if a fire escapes, resulting in a lawsuit. The Texas Air Control Board in Austin has specific regulations on when and under what weather conditions prescribed burns can be legally conducted. Obtain a copy of the regulations. It is the manager's responsibility to have flagmen on highways to slow traffic if smoke obscures visibility. Generally, fires should move away from highways or houses with a good uplift of smoke. Do not burn when temperature inversions can occur. Ask your weather service if such conditions are likely during the burn and following night.

The bottom line in safety is to have a good plan, executed under appropriate conditions with adequate equipment, personnel and preparations. This includes a plan for containing any fire that escapes from the specified area.

BURN PRESCRIPTIONS

Generally, the prescription for a successful burn includes wind speeds of 5 to 15 miles per hour, steady wind direction, air temperature 40° to 80°F., relative humidity 25 to 60 percent and uniform fuel continuity of 1,500 pounds per acre or more. Generally, fire intensity and rate of spread increase with drier fuel, lower RH and higher air temperature, wind speed and fuel quantity.

COSTS OF PRESCRIBED BURNS

The cost of a prescribed burn differs for each ranch, pasture and time of year. Each ranch must develop a budget and keep records of actual expenditures for future analysis. In some counties cost-share assistance is available for fireline construction, labor and equipment rental. Costs range from 50 cents per acre to $8 to $10 per acre or more depending on fireline construction and manner of calculation. Costs of follow-up burns should be lower, however.

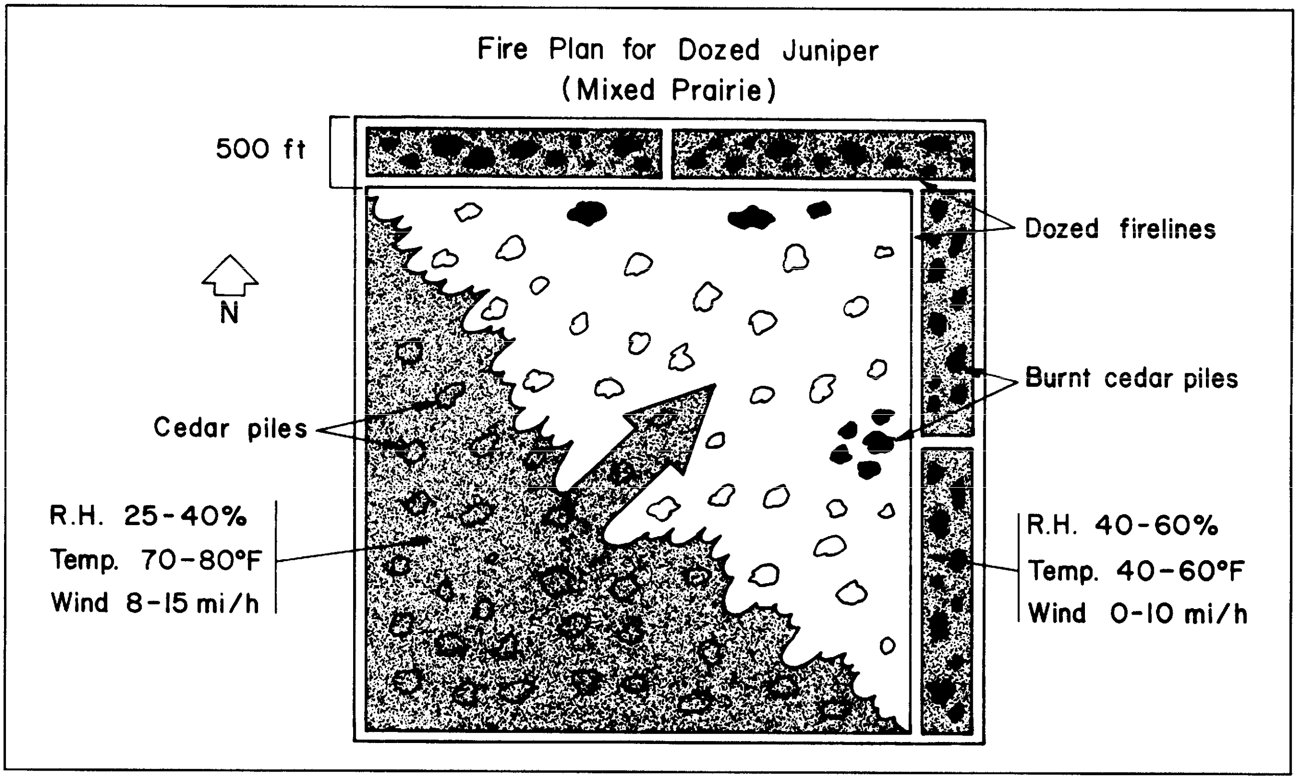

Figure 6. When the grass is green, juniper piles in the 500-foot strip (black splotches) on the downwind sides (north and east) are burned with wind velocities less than 10 miles per hour and relative humidity above 45 percent. Eight months later (when grass is dormant), the grass in the 500-foot strip is burned (strip-headfire technique) when the wind speed is less than 10 miles per hour and relative humidity is between 40 to 60 percent. Lower relative humidities may be used if the grass fuel is less than 2,000 pounds/acre. All large concentrations of piles are backfired on the downwind sides of main area to be burned, and then the entire area is burned into the prepared firelines with a wind speed of 8 to 15 miles per hour and a relative humidity of 25 to 40 percent. (From publications by Dr. Henry Wright, Texas Tech Univ.)

SUMMARY

Prescribed burning is a viable improvement practice for most Texas rangelands. When integrated with other practices, fire can be used to maintain desired vegetation composition and structure. Many managers are not able to effectively use fire until they achieve better range conditions. Good grazing management programs complement prescribed burning.

The basic principles affecting fire behavior are considered by the manager for developing a realistic fire plan. The fire plan identifies the overall objectives for the ranch as well as for each pasture and range site to be burned. Ideally, burn entire management units to avoid overconcentration of livestock and wildlife. Base the stocking rate on actual acreage burned and adjust for recovery rate. Control white-tailed deer and exotic game populations to prevent overuse of key browse and forb species.

Burning when brush regrowth is young and when fine fuel loads are near maximum can more effectively maintain high production ranges. Brush stands require two to three burns before most objectives are realized. Select the better sites for burning; hence, the net return per dollar invested should be higher.

Described techniques, prescriptions and guidelines provide a basis for using prescribed fire. Consider local experience when adapting prescriptions and plans. Emphasize safety avoid over-optimism. Use fire where benefits can realistically be achieved and integrated with the ranch operation. Take advantage of high forage production years, using excess forage as fuel for a burn. Careful grazing management is an important part of any prescribed burning program.

Assistance and training are available for developing your prescribed burn program. Agencies currently involved are the Texas Agricultural Extension Service, Soil Conservation Service, Texas Forest Service and Texas Parks and Wildlife.

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