



Prescribed Range Burning in Central Texas

The Texas A&M
University System



**Texas
Agricultural
Extension
Service**

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Cover Photos:

Front - Prescribed burn in previously herbicide treated mesquite-whitebrush near Cotulla, Texas, February 26, 1979.

Back - Vegetation response May 1979 following the prescribed burn of February 26, 1979, near Cotulla, Texas. Note the openness of brush and excellent response of California cottontop (Digitaria californica).

PREScribed RANGE BURNING IN CENTRAL TEXAS

Proceedings of a Symposium held October 28, 1982
at Goldthwaite, Texas

Edited by Tommy G. Welch
September 1982

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TABLE OF CONTENTS

	Page
INTRODUCTION TO PRESCRIBED RANGE BURNING IN CENTRAL TEXAS by Tommy G. Welch	1
NATURAL ROLE OF FIRE IN CENTRAL TEXAS by Fred E. Smeins	3
BRUSH MANAGEMENT WITH PRESCRIBED FIRE by Henry A. Wright	16
MANIPULATING HERBACEOUS VEGETATION WITH PRESCRIBED FIRE by Darrell N. Ueckert	19
IMPACT OF PRESCRIBED BURNING ON WILDLIFE by W. E. Armstrong	32
PRINCIPLES, REQUIREMENTS AND TECHNIQUES FOR PRESCRIBED RANGE BURNING by Larry D. White	37
PLANNING A PRESCRIBED BURN by R. Q. Jake Landers, Jr.	55
ENVIRONMENTAL CONSIDERATIONS AND REGULATIONS ASSOCIATED WITH RANGE BURNING by Gary I. Wallin	63
EDUCATIONAL ASSISTANCE by Danny W. Long	69
TECHNICAL ASSISTANCE AVAILABLE FOR RANCHERS by Rhett H. Johnson	71
FINANCIAL ASSISTANCE by Allen W. Mills	73
VOLUNTEER FIRE DEPARTMENTS by Robert H. Bloom	74
WEATHER FORECASTS FOR PRESCRIBED BURNING by James A. Harman	76

INTRODUCTION TO PRESCRIBED RANGE BURNING IN CENTRAL TEXAS

Tommy G. Welch

The use of fire as a range improvement tool is not new. Research on use of prescribed burning has been conducted in the United States for many years. Although information has been available on effective use of prescribed fire, it had been used only on limited basis in Texas until the past three years. A surge of use and interest in use of fire has occurred during this period. Many people attribute the increased interest in fire to increased cost of brush and weed control methods and a general concern that uses of herbicides may become severely restricted. I believe some of the interest has resulted from an educational effort to inform ranchers that fire can be used effectively and safely as a range improvement tool. Research results reported by scientists from the Texas A&M University System, Texas Tech University, Kerr Wildlife Management Area, and Welder Wildlife Foundation, as well as symposia, workshops and field days conducted by the Texas Agricultural Extension Service have certainly played an important role in this educational effort.

In most areas of Texas, fire is being used primarily as a brush management tool. In addition to brush management, fire can be effectively used to improve livestock distribution, increase forage utilization, improve wildlife habitat, and suppress parasites. However, prescribed burning is not a cure-all. Proper use of fire requires good management and prescribed burning will not substitute for good management. For the potential of prescribed burning to be realized, the fire must be conducted safely and effectively. Therefore, before an individual uses prescribed burning, he should receive training in the proper use of fire and have a thorough understanding of fire and its effects. The major objective of this symposium is to provide you with basic information on the use of fire. Before you conduct a fire, you should receive additional training and experience by participating in a workshop and assisting with installation of prescribed burns. Several years of prescribed burning experience may be necessary before an individual is competent to routinely plan and conduct effective and safe burns.

Fire is considered a relatively low cost practice. The major costs of a burn are loss of forage, manpower, equipment, fire lane construction, insurance and training. Because the use of fire requires an investment and prescribed burning cannot be used in all situations, White (1980) has identified the following questions each rancher must answer when considering a prescribed burning program:

- 1) Is prescribed burning a viable practice?
- 2) Do my employees and I have sufficient training and experience to do the job?
- 3) Where would burns most benefit the ranch?

- 4) What are the burn objectives, and are they realistic?
- 5) How will I evaluate the successfulness of planning, conduct of the burn, and response?
- 6) Will repeated fires be necessary?
- 7) Should several practices be combined with fire?
- 8) What are the disadvantages and problems?
- 9) What should my management program be before, during and after burning?
- 10) What preparations are necessary?
- 11) What should be the burn prescription?
- 12) What equipment and manpower are needed?
- 13) What are the legal and community restrictions on using prescribed fire?

The use of prescribed burning for range improvement in Central Texas has great potential. It can be effectively combined with other brush management practices to provide longer term control and improve the economic returns. The information you receive during this symposium should provide the first step toward learning the proper and safe use of fire. Hopefully, you will obtain further training and experience with use of prescribed burning and will successfully apply the knowledge gained from these endeavors.

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NATURAL ROLE OF FIRE IN CENTRAL TEXAS

Fred E. Smeins

Highlight

Vegetation of Central Texas prior to about 1850 was apparently much more open and less wooded than today. Nonetheless, mesquite grasslands, cedar brakes, oak savannahs and oak thickets existed. After 1850 and up to the turn of the century woody vegetation became more abundant and widespread. Herbaceous vegetation was correspondingly reduced in area and in stature. During this period there was a marked reduction in the frequency and extent of prairie fires. Removal of fire is considered to be a primary contributor to the spread of woody plants into the grasslands. Fire, however, interacted strongly with continuous heavy overgrazing during this period, and periodic droughts, to produce the condition that existed by 1900, and that in many places, persists to the present.

Introduction

Evaluation of the natural role of fire within Central Texas is a challenging subject. Many divergent opinions exist, but few documented, factual accounts are available on the subject. Most evidence is circumstantial and often conflicting. Nonetheless, I will attempt to provide an analysis of the existing information and hopefully establish a perspective for later symposium presentations on the contemporary use of fire as a management tool. My definition of Central Texas will be very broad and will include portions of the Blackland and Grand Prairies, Edwards Plateau, Cross Timbers, Post Oak Savannah, North Central Prairie and Rolling Plains Resource Areas.

Ecological Perspective

Any ecosystem or rangeland area is the result, and expression, of a multitude of interacting factors. Climate, soil, plants, animals, microbes, fire and the historical, as well as the current interactions of these components all contribute to the landscapes that we observe today (Odum 1971). To single out one factor such as fire is to almost certainly error in interpretation since the impact of fire is tempered by climatic conditions, such as drought, soil and topographic factors, grazing impacts and other variables (Wells 1965; Norton-Griffiths 1979).

To illustrate, it is a historical fact that two major simultaneous changes occurred across Texas and much of the western United States during the period from about 1700 to 1900. Grazing by free-roaming large native herbivores changed to grazing by relatively free-roaming livestock and ultimately to confined livestock (Smith 1899; Webb 1931; Perkins 1977). Concomitant with this change was the influence of early settlers on the frequency, timing, placement and extent of fires (Jackson 1965; Sauer 1975). It is difficult, if not impossible, to adequately separate these two impacts since they often operate in a synergistic fashion.

If we take a longer view of history, it is documented that prior to about 7,000 years ago our rangelands were populated by a diverse collection of large grazing and browsing herbivores including elephants, mammoths, camels, antelope, giant bison, horses and many others (Martin 1975). Sometime about 12,000 years ago or earlier, primitive man arrived on the scene (Sauer 1975). What impact did these large herbivores have on the origin and maintenance of our rangelands and how did they interact with man and fire to produce today's ecosystems? Of course, we may never completely answer these questions. However, I believe it is important to recognize the existence of these changes. If for no other reason, it points out that change, often drastic change, is a feature of natural systems that occurs with or without man. As our knowledge of these changes increases, hopefully, they will contribute to our understanding of ecosystem structure and function and ultimately, to more intelligent use and management of our grazing lands.

Fire in Central Texas

An analysis of the historical role of fire for a region requires that several questions be answered. Did fires occur? How extensive were they? How frequent were they? At what season did they occur? How did they start? What impact did they have?

There are two major sources of information that can provide answers to these questions. One is the historical record (military expedition reports, early naturalist reports, railroad surveys, etc.) which furnishes descriptions of the occurrence of fires and the kind of vegetation and wildlife found in the region. The other source is our current knowledge of how fire, vegetation and animal life interact to produce our contemporary ecosystems. These two sources can be blended to produce a reasonable interpretation of the natural role of fire.

Generally speaking the vegetation of an area is the best integrator and best expression of the interacting factors of climate, soil, animal influences and fire. Thus, if the vegetation of Central Texas, at the time of settlement can be ascertained, we have some indication of the influence these factors have had on the development of that vegetation.

Vegetation of Central Texas at the Time of Settlement

The historical record is not totally consistent and at times contradictory about the kind of vegetation that existed. Most often comments are not specifically about the vegetation but some other feature of the landscape such as difficulty or ease of travelling through an area, degree of difficulty in working livestock or in hunting game, degree of openness of the area as it influences vision, availability of firewood and building materials, etc. Most observers, of course, had their own biases about what they saw. Some were primarily interested in the amount and kind of grass present while others emphasized woody plant growth as indicators of potential cropland areas. Also, what was tall grass to one traveler may have been short grass to another, depending on their experience and frame of reference. All these things must temper our interpretation of their observations.

Marcy's expedition of 1849 traversed the very northern limits and to the west and northwest of the Central Texas area. At one point just before crossing the divide into the watershed of the West Fork of the Trinity River, mesquite and oak openings were reported with occasional prairies. Mesquite was observed throughout the headwaters regions of the Brazos and Wichita Rivers (Marcy 1849). Marcy summarized his information and defined the limits of mesquite, based on his travels, as between 97° and 103° longitude and 28° and 36° latitude. He records the presence of mesquite trees up to 15 inches in diameter and also notes that mesquite often grew "upon the most elevated arid prairies, far from water courses" (Marcy 1849).

Marcy (1849), traveling eastward, notes in his diary:

We are passing near the borders of the Upper Cross Timbers all day, and gradually approaching them until we are within a mile. We have seen but little mesquite timber today, and the mesquite and grama grasses have almost entirely disappeared; but we find the other kinds of prairie grass in abundance.

The other prairie grasses are presumed to be bluestems, based upon other comments in his account.

Olmsted (1857) writes of his travels after crossing the Colorado River on the Edwards Plateau above Austin:

. . . The live-oaks, standing alone or in picturesque groups near and far upon the clean sward, which rolled in long waves. . .

. . . We were, in fact, just entering a vast region, of which live-oak prairies are the characteristic. . . The live-oak is almost the only tree away from the river bottoms, and everywhere gives the marked features to the landscape.

The live-oaks are often short, and even stunted in growth, lacking the rich vigor and full foliage of those further east. . .

In the 1880's Krueger (1976) relates:

Five days later we reached the Colorado River near Austin. . . Above Austin the country became very brushy . . .

. . . Continuing my journey, I passed from the level prairie into the hill country, great stretches of which were covered with a growth of mountain cedar. These cedar forests, being almost impassable, were a safe retreat for many beasts of prey . . .

He continued on across the central granite region:

I now left the granite country behind and continued my way in the direction of San Saba. To the northwest of Lampasas I found small prairies alternating with large cedar forests . . .

Smith (1899) evaluated the vegetation of the Texas ranges and recognized the results of many years of overgrazing:

The disappearance of the buffalo was nearly coincident with that of the Indian and there was a period of fully ten years

after the destruction of the buffalo herds before the number of cattle and sheep on any portion of the ranges equaled the great herds of game. These years, from 1874 to 1884, may be called the "golden period" of the Southwestern stockman, or at least a golden one for those whose flocks and herds were already on the ranges. During this intermediate decade there were few head of stock, wild or domestic, than at any previous period. There were also abundant rains and the seasons were mild and favorable to the full development of the grasses. Grasses and forage plants, ungrazed, grew and thrived, reseeded themselves, and increased to a wonderful degree of luxuriance, so that the stockmen on entering his pastoral paradise thought that it was not possible to put enough cattle and sheep on the land to eat down all of the rank growth of vegetation. It is the common testimony of the older stockmen that in the early eighties the grass was often as high as a cow's back, not only along the river bottoms, but also on the uplands far from the creeks and rivers.

. . . With the building of the railroad the stock industry underwent a very rapid development. Newcomers who had not seen the land when it was possessed by the Indian, the buffalo and mustang, at the time when the herbage was eaten down, or kept in check by fires or drought, naturally thought that this rich profusion of vegetation was the normal condition and that the saying that it was impossible to put enough cows on the land to eat all the grass was literally true. The result was a rapid and exhausting overstocking of every available square mile of rangeland. The best grasses were eaten down to their very roots, the roots were trampled into the earth, and every green thing was cut down so that it could neither ripen seed, and thus perpetuate its kind, nor recover from the trampling and exposure of its roots to the air and sun So also the mesquite bean and the cactus, both of which may be destroyed by fire, grew in numbers and commenced to crowd out the grasses.

Bray (1904) analyzed vegetation changes on the Edwards Plateau:

It is of fundamental importance to note that the type of vegetation in this region is undergoing a change. This change, broadly indicated, consists in a transition from grass to woody growth. This transition is very apparent even to the casual observer. Everyone has observed how the mesquite captures the open pastures and many have watched the scrub oak timber occupy uplands that formerly were open prairies.

Some of the causes of this are reasonably evident. In the first place, dissection of the old plateau surface by the process of erosion has favored the establishment of forests in the rougher parts. Progress due to this cause, however, is too slow to be apparent. The presence of trees upward of 500 years old in some of the canyons is an index to the length of time forestation has been in progress. As one passes from the canyons and hills to the level plateau divides, the timber gives place more and more to open prairie, which, until within recent years, was free from woody growth of any kind.

A summary of conditions that existed early in the 20th century is provided by Foster (1917):

A remarkable transformation of grasslands into forest areas is now taking place from isolated patches of original woodland on rough lands to the rolling uplands in general and across intervening prairies. Capture by tree growth is still more remarkable in sections far removed from forest belts as in the western portion of the Edwards Plateau, the denuded region and elsewhere. It is safe to say that fully 50 percent of the grassy uplands of the Edwards Plateau is now occupied by some form of woody growth. The mountain cedar is not only maintaining itself, but is spreading to new areas on steep slopes where no other species except perhaps sumac has succeeded in gaining a foothold. Sumac seems to be a forerunner to the spread of cedar and other important trees; at least under certain conditions where its seed germinates and furnishes temporary protection to other species which follow. Mountain oak thickets are spreading downward from the ridges and mesa tops to the youngest marking the lower limit of tree growth can be seen in many points of Central Texas. The shineries now occupy many square miles in compact areas, crowding out the grass over low divides and on uplands where the grass cover was formerly complete. An open stand of mixed cedar, mesquite, mountain oak, and live oak, with a ground cover of prickly pear, occupies vast areas of rolling upland which, within the memory of men now living in the region, was covered only with grass. Within the last 25 or 30 years the change has been so marked as to become a matter of common discussion and of considerable apprehension on the part of stockmen. Every old resident can point out thickets of oak, mesquite areas or scattered cedars, live oak, and mesquite growing on his ranch which in the years gone by did not exist.

To conclude it appears that prior to about 1850 the vegetation of Central Texas consisted of essentially the same species that exist today. The woody vegetation was, in many places, more open than today, however, extensive areas of cedar brakes, mesquite grassland, oak savannah and oak thickets occurred in Central Texas, particularly on shallow soils, on rocky slopes and in canyons and river valleys. Cactus was commonly encountered and mesquite occurred on upland soils and in river valleys throughout Central Texas. It occurred in both the tree and switch type of growth form. Grasslands were apparently more extensive than today and the vegetation was of a taller stature, however, shortgrass areas, probably dominated by curly mesquite, buffalograss and grama grasses were common.

After 1850 the woody vegetation became more abundant and widespread, and grassland acreage was correspondingly reduced. The stature of the grass vegetation became generally shorter. By the turn of the century reliable observers document the radical change from prairie to wooded vegetation types (Smith 1899; Bray 1904; Foster 1917). Similar changes are documented for the Rio Grande Plain (Bogusch 1952; Johnston 1963), the High Plains (Box 1967) and the Coastal Prairie (Lehmann 1965).

Many of the accounts quoted above also describe the wildlife of the area. They mention the presence of buffalo and antelope throughout

Central Texas and on the Rio Grande Plain as well as to the north and west into the plains country. As indicated by Krueger (1976):

The buffalo never liked country obstructed by bushes. The grand, open prairies . . . were their favorite haunts.

Occurrence of these open grassland animals, particularly the antelope, in Central Texas, also suggest that the vegetation was less densely wooded than today.

Occurrence, Extent and Frequency of Fires

There is little doubt from the literature that fires were a common phenomenon at the time of settlement. The earliest records (1528) of the use of fire by Indians in Texas is reported by Cabeza de Vaca (Nunez 1905):

The Indians go about with a firebrand, setting fire to the plains and timber so as to drive off the mosquitoes, and also to get lizards and similar things that they eat, to come out of the soil.

Parker (1836) wrote:

. . . the prairies near the coast were . . . all burnt over twice a year - in mid-summer and about the first of winter.

Roemer (1935) witnessed fires during his travels. On February 6, 1847 he recalls:

I left Fredericksburg toward evening and found my companions camped about four miles northwest of the city. Since the grass had been burned everywhere in the vicinity of Fredericksburg, they had hurried to the place to find some for their horses.

The next day he observed:

Later we came to a stony infertile plateau, which on account of the stunted oaks and exposed limestone visible in many places, did not present a very cheerful view and it seemed all the more cheerless since all the grass had been burned as far as the eye could see.

On January 22, 1847, John Meusebach was traveling north out of Fredericksburg (King 1967):

A prairie fire raged at the second camp for thirty-six hours, destroying all forage for the horses for many miles.

The diary of Sam P. Newcomb (1958) contains the daily log of a horse-back trip from the Clear Fork of the Brazos in Stephens County, Texas, to the San Saba River and return:

On March 30, 1864 the party encountered many buffalo on grazed off range, and from 3:00 p.m. to 9:00 p.m. the men traveled on burned-off range searching for grass for their horses.

George Kendall (1844) traveling near the Bosque River on July 14, 1941, witnessed his first prairie fire:

. . . for the first time, I saw the magnificent spectacle of a prairie on fire. It was purely accidental, and caused us little damage The dry grass flashed up like powder, and the fire spread over the prairie with alarming speed.

. . . All night the long and bright line of fire, which was sweeping across the prairie to our left, was plainly seen, and the next morning it was climbing the narrow chain of low hills which divided the prairie from the bottoms of the Brazos.

On the same journey on the last day of July near the western margin of the Cross Timbers, ". . . we found ourselves upon a "burn", on a place where the prairie grass had been lately consumed by fire."

Drummond (Geiser 194 , observed on September 26, 1884 near Little River, that:

. . . I am sorry to say that I have found no insects, as they are scarce in these and all prairie countries owing to the frequent burning of these lands. The whole country from the Rio Colorado to the Guadalupe, a distance of eighty or ninety miles, is as destitute of verdure as the streets of Glasgow. . . .

He is referring to the strip of Blackland Prairie between these rivers and apparently his reference to the Rio Colorado is actually the Brazos River.

Gregg's 1844 (Moorehead 1954) account of the prairies west of the Cross Timbers states:

It is unquestionably the prairie conflagrations that keep down the woody growth upon most of the western uplands. The occasional skirts and fringes which have escaped their rage have been protected by the streams they border Indeed there are parts of the southwest, now thickly set with trees of good size, that, within the remembrance of the oldest inhabitants, were as naked as the prairie plains In fact, we are now witnessing the encroachment of the timber upon the prairies, whenever the devastating conflagrations have ceased their ravages.

Smith (1899) attributed woody plant encroachment largely to reduction in fires:

In the early days, when the central prairies were sparsely settled, they were burned over each year, and the young seedlings of this and other trees were killed to the ground. Twenty years ago it was hard to find a mesquite bean on the open prairies that was larger than a small shrub. The only places where they occurred of any size were in the valleys and the "timber islands" --

small scattered groves at intervals on the prairies, usually about some swale or along a ravine or a rocky knoll. Since the more complete settlement of the country, fires are not allowed to sweep the prairies, on account of the possible loss of crops and improvements. There is nothing to check the growth of the mesquite bean, and they have grown to the size of small trees, at the same time largely augmenting in number.

Likewise, Bray (1904) implicates elimination of fire as a factor but points out the interaction of fire with grazing:

Though the encroachment of timber on the prairie is gradual and insidious, to those whose observation covers a space of twenty-five years the change is truly startling. Where at the beginning of that period the prairie held undisputed sway, the observer now finds himself shut in by miles of oak scrub on every side. Men who drove cattle in the earlier days say that they rode across an open country from above Georgetown to the Colorado breaks, in Williamson County. This same region is now all heavily timbered. A great deal of the shinnery country undoubtedly represents a recent gain of timber growth on prairie divides.

This struggle of the timberlands to capture the grass lands is an old warfare. For years the grass, unweakened by overgrazing of stock, and with the fire for an ally, held victorious possession. Now the timber has the advantage. It spreads like infection. From the edge of the brush each year new sprouts or seedlings are pushed out a few feet farther, or, under the protection of some isolated live oak or accidental briar or shrub, a seedling gets its start, and presently offers shelter for others. This has been going on all along, but in former days these members of the vanguard and the scattered skirmishers were killed by the prairie fires, and the timber front was held in check or driven back into the hills.

A succinct analysis of the situation is provided by Foster (1917):

The causes which have resulted in the spread of timbered areas are traceable directly to the interference of man. Before the white man established his ranch home in these hills the Indians burned over the country repeatedly and thus prevented any extension of forest areas. With the settlement of the country grazing became the only important industry. Large ranches in time were divided into smaller ranches and farms with a consequent fencing of ranges and pastures. Overgrazing has greatly reduced the density of grass vegetation. The practice of burning has during recent years, disappeared. The few fires which start are usually caused by carelessness, and with alternating wooded and open spaces and the close-cropped grass, they burn only small areas. These conditions have operated to bring about a rapid extension of woody growth. Almost unquestionably the spread of timbered areas received its impetus with the gradual disappearance of grassland fires.

Fires were common at the time of settlement and continued to be for some time thereafter. They tended to occur at almost any time of the year but were most prevalent during dry seasons whenever they occurred.

Descriptions suggest that fires often covered large expanses of territory, although topographic breaks, rivers and other barriers tended to restrict their advance. The terms annually, often, periodically and repeatedly, are used to describe the frequency of fires when reference is made to a particular area. This suggests that the same area may have been burned at a high frequency, however, it is almost certain that some areas escaped fire for long periods or that the fire frequency was very low due to lack of fuel, topographic limitations or random chance.

Lightning is given as the ignition source in some accounts in the literature, however, it appears that the Indians and later the settlers were the primary perpetrators of fire. They certainly increased the frequency and probably the extent of areas that burned.

The impact of fire has been previously discussed. It, along with other influences, particularly grazing, contributed to produce the landscape viewed by early settlers. Change in fire occurrence, frequency and extent, and in the grazing pattern and intensity of the area created a situation that resulted in a profoundly different community today than existed 150 to 200 years ago.

We must recognize, however, that while fire may have acted to prevent excessive invasion of grasslands by woody plants, it may not be effective in reducing woody plants once they are established. This is the problem that faces us today. I will defer to the other members on the program for them to unravel this dilemma. Fire alone can seldom be the cure-all for our modern day brush problems. History strongly suggests that it has long been a factor of the Central Texas environment and it deserves more consideration as part of a total management program for many ranchers.

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BRUSH MANAGEMENT WITH PRESCRIBED FIRE

Henry A. Wright

We began conducting prescribed burns in mesquite-tobosagrass in 1968, dozed Ashe juniper in 1970, and chained redberry juniper in 1979. In each of these fuel types our goals were to determine the potential uses of fire and how to use fire safely.

Mesquite-Tobosagrass

Fortunately, we began our burning research in mesquite-tobosagrass, which is a low volatile fuel and relatively safe to burn. Through a number of burning trials we learned that to burn down standing dead mesquite stems, we needed to burn when the average wind speed was above 8 mph and relative humidity was below 40%. Generally air temperature was 70° to 75°F. Aside from burning down dead stems and cleaning up logs on the ground, we killed 80% of the small pricklypear plants, 50% of cholla, 80% of tasajillo, increased forage yields 2- to 3-fold during wet years, increased forage utilization at least 10-fold for the first 2 years, and controlled common broomweed for 2 years. Our long-term data show that reburns can be conducted every 5 to 8 years without serious side effects.

The prescription for burning mesquite-tobosagrass is to plow an 8 to 10 ft fireline around the entire pasture (about 1 section). Then on the north and east sides, come in 100 ft and plow a second fireline. The area between the plowed firelines should be burned when relative humidity is 40 to 60%, air temperature is 40 to 60°F, and windspeeds do not gust above 10 mph. This forms a blackline on the north and east sides and prepares the pasture for a headfire that we ignite when relative humidity is 20 to 40%, windspeed is 8 to 15 mph (gusts should not exceed 20 mph), and air temperature is 70 to 80°F. Fine fuel (grass) should be at least 4,000 lb/acre to do an effective job in burning down standing mesquite. Chained mesquite can be burned effectively with 2,500 lb/acre of grass.

Red flag conditions under which we never burn include one or more of the following conditions:

1. Gusts of wind above 20 mph.
2. Relative humidity below 20%.
3. Air temperature above 80°F.
4. Cold front to pass within 12 hours.

Dozed Ashe Juniper

After burning mesquite-tobosagrass for 3 years, we felt that we knew a lot about prescribed burning and tried to transfer our

techniques to dozed Ashe juniper to remove dead piles of juniper and kill young trees. We had some frightening experiences during our first 2 years, and it took 5 years of experience before we felt confident with our prescription techniques. Firebrands (glowing embers) were a new problem for us and it took a while to learn when these glowing chunks of material would fall on cow dung and not ignite it.

Surprisingly, our prescription for burning out blacklines in Ashe juniper is very similar to that for tobosagrass, except that we prepare a 400 to 500 ft blackline on the north and east sides. We burn with 40 to 60% relative humidity, 40 to 60°F, and less than 10 mph of wind. However, when the relative humidity is 40%, air temperature is 60°F, and windspeed is 10 mph, we must be careful. The person on the lead torch must be one with experience and a lot of common sense. If he is approaching a large pile of juniper, he needs to alert the fire crews. After it is ignited, he should wait till it cools down before continuing onward. He needs to take the same precaution when burning near oak mottes, because the oak leaves are good firebrands.

Burning in the blackline area should be started in buffalograss areas when relative humidity is 40% and air temperature is 60°F. After relative humidity drops to 50% and air temperature rises to 50°F, less caution is needed and more people can be placed on torches. If there is very little wind, less caution is needed at the upper end of temperature and humidity levels prescribed. However, where there is a deep mat of leaves beneath red oak, these areas should be burned after relative humidity reaches 60% and air temperature drops to 40°F. Such areas burn very hot.

Headfires in this fuel type can be set when relative humidity is 20 to 40%, windspeed is 8 to 15 mph, and air temperature is 67° to 75°F. Headfires should be set to burn with the ridges to avoid forming firewhirls. If you have canyons near your blackline or a hill on one side of the pasture that can cause unusual winds, this is where you need to station a pumper or caterpillar tractor.

Reburns may be desirable after 20 years or so, but let me exercise caution. If you have smoothleaf sumac, red oak, shinnery oak, and possibly other secondary shrubs, these plants can become serious problems after a mechanical and burning treatment--not necessarily over your entire ranch, but in large areas. We can kill smoothleaf sumac with 1/4 lb/acre of Tordon 225 during June, but we have not touched the oaks. We are going to try GRASLAN at 2 lb/acre at a price of \$46.00 per acre.

Historically, I think single fires occurred in this area about every 25 to 30 years. After a single fire Ashe juniper germinated and emerged as the dominant plant in 25 to 30 years. Today, however, we have removed most of the juniper with a "two shot treatment" and now have the secondary species to contend with. On Bob Beckham's

Ranch in Callahan County, we have a serious problem with the secondary species on 1/3 of his ranch. In these areas, reburning would aggravate the problem.

Dozing and burning on Beckham's ranch enabled him to triple his stocking rate for about 10 years. Now, it remains at double his initial stocking rate but the problem shrubs have taken some of his land back to zero grass production.

Chained Redberry Juniper

Chained juniper is easier to burn than dozed juniper. We use a 400 ft blackline on the north and east sides of a pasture, just as we did for dozed Ashe juniper. Moreover, we have burned the blacklines with the same prescriptions and precautions as we did for Ashe juniper. Spot fires rarely occurred and we feel comfortable with our burning techniques. Headfire conditions are also similar to those for dozed Ashe juniper, except that we burn with a temperature range of 70° to 80°F.

Redberry juniper is a sprouter and will always be a dominant part of the community. Burning cleans up chained debris, kills trees less than 15 years old, and enhances forage production, quality, and accessibility. In these communities, we recommend burning every 15 to 20 years to suppress redberry juniper. Associated shrubs are very tolerant to fire and are generally considered more desirable than redberry juniper.

Summary

Grass and mesquite are very safe to burn, but we must be more careful in volatile fuels such as juniper and oak leaves. The primary precaution is to prepare a wider blackline in the more volatile fuels. Prescriptions for burning blacklines and headfires are similar for all fuel types, except that you need to proceed more cautiously in volatile fuels and station your suppression crews carefully. Radios are a must to conduct burns safely in any fuel type.

Let me repeat prescriptions for blacklines and headfires:

	<u>Blacklines</u>	<u>Headfires</u>
Relative Humidity	40 to 60%	20 to 40%
Air Temperature	40° to 60°F	70° to 80°F
Windspeed	less than 10 mph	8 to 15 mph

Always remember to take a good look at the understory before you embark on a burning program. Know how all species will respond to a fire before you start burning.

MANIPULATING HERBACEOUS VEGETATION WITH PRESCRIBED FIRE

Darrell N. Ueckert

Herbaceous vegetation on various kinds of rangeland can be effectively manipulated with prescribed fire to meet several management objectives, including: 1) increased forage production; 2) increased utilization of unpalatable plants by livestock; 3) control of annual weeds and grasses; 4) improved species composition; 5) more uniform distribution of grazing; 6) improved forage quality; and 7) removal of excessive mulch and standing dead plant material. Knowledge of the modes of action of fire on plants and plant communities facilitates more intelligent use of fire as a management tool. Prescribed fire is not a cure-all for all range management problems. The maximum potential of prescribed fire will be realized when it is used in range improvement systems to complement grazing management and other range improvement practices.

Fire, both lightning-caused and man-caused, has been a natural selective force in the development of many of the world's grasslands (Daubenmire 1968; Vogl 1974). Moreover, the intelligent use of fire appears essential for the well-being of many of our grasslands today. Early settlers in the tall grass prairies of the central Great Plains learned to use fire and continue to use fire as a management practice today (Owensby and Smith 1972). However, experience with disastrous wildfires in other regions and an attitude of "good conservation" at about the turn of the century caused condemnation of fire by ranchers as well as the general public (Daubenmire 1968). Overgrazing, fire suppression and periodic droughts have led to extensive deterioration of native grassland vegetation and concomitant encroachment of undesirable weeds and brush. Studies in recent years have shown that fire, coupled with good grazing management and other range improvement practices, can restore the productivity of many deteriorated rangelands (Scifres 1980). Ranchers and resource management agencies have become keenly interested in fire as a range improvement tool in the last decade, largely because they have learned that prescribed fires, planned to meet specific objectives, are not detrimental to the range ecosystem as wildfires frequently are.

Wildfires, usually caused by lightning or accidentally, normally occur in dry years, whereas prescribed burning is applied when the soil is wet or moist. Wildfires usually magnify drought conditions and may kill or seriously damage desirable forage species, but planned burning usually results in immediate initiation of plant growth. Wildfires generally occur where excessive accumulations of highly combustible material have accumulated and often occur during the growing season when desirable range plants are susceptible to fire damage, thus wildfires are often detrimental to the range ecosystem. Burning for range improvement is scheduled when desirable species are dormant, to remove old, rough top growth which is of little value to grazing animals. Wildfires are often unpredictable and very difficult to control, whereas

technology is presently available to permit the safe, controlled use of fire on many types of rangeland (Scifres 1980; Wright 1974a). In addition, wildfires often result in range deterioration because grazing cannot be controlled after the burn, whereas pre-burn and post-burn grazing management are carefully planned prior to prescribed burning (Hamilton 1979).

The purpose of this paper is to present information on how ranchers and other resource managers can use fire for manipulating herbaceous vegetation. Rangelands usually consist of complex mixtures of various grasses, forbs, shrubs and trees which react differently to fire, just as they react differently to grazing. It is pertinent to point out that research results and results from rancher application of prescribed burning will be divergent due to the variable nature of fire and the environments in which it is used. No two fires, or the conditions under which they occur, are alike. Many other variables can influence the results from prescribed burning, including: past history of use, post-burn grazing management, post-burn weather conditions, differences in accumulation of fuel, soil differences, and ecotypic variations within plant species (Vogl 1974). Research results and experiences of neighbors are certainly useful for predicting results from prescribed burning, but we must be mindful that results will vary for different burns, even on the same ranch.

Modes of Action of Fire

Prescribed burning can be intelligently used only if the modes of action of fire on the plant community are clearly understood. The primary effects of fire on plant communities include: (1) the direct action of heat on plants and soils; (2) the removal of mulch and standing crop of herbage; and (3) the redistribution of nutrients. These involve the effects of fire on organic compounds, stimulation of dormant plant organs, physical, chemical and biotic properties of the soil, microclimate, losses of volatile plant nutrients in the smoke, and deposition of nutrients in the ash.

The quantity of heat required to raise the temperature of living vegetation to the lethal temperature is directly proportional to the difference between the lethal temperature and the initial vegetation temperature. A temperature of about 140°F is usually lethal to shoot tissues of terrestrial plants. Hence, plants with an initial temperature of 50°F can endure twice as much heat as those at 95°F. Initial temperature of live aboveground plant parts is governed by ambient air temperature and radiant energy, both of which vary among seasons and even considerably among days within a season. This explains why plants may be damaged more by burning in summer or on warm winter days compared to cold days. However, heat damage to live plants is also a function of duration of exposure to heat as well as temperature, thus other parameters that determine the characteristics of the fire, such as wind speed and amount and nature of the fine fuel, will also dictate the damage of fire to live plants (Byram 1948; Daubenmire 1968; Hare 1961).

The physiological condition of the protoplasm of live, aboveground plant tissue also influences the effects of heat. As the moisture content of plant tissue increases its tolerance to heat decreases (Hare 1961). Thus succulent plants may be more susceptible to fire than plants containing smaller amounts of water and actively growing plants are more susceptible to fire than dormant plants.

The position of the perennating buds at the time of burning, as related to protection from heat, is also critical in the response of herbaceous plants to heat. Annual grasses and forbs may be killed by fire after they have emerged (Wright 1972; Ueckert and Whisenant 1980) but may be promoted if fire occurs prior to germination (Vogl 1974). Grassland fires often kill seeds of annual plants still in the inflorescences or in the upper part of the mulch, but seeds on the soil surface or in the upper soil usually survive (Daubenmire 1968). Annual species that depend on the microclimate provided by mulch for germination are usually hurt by fire (Heady 1956; Smith 1970).

Perennial grasses and other plants whose perennating buds are located below or near the soil surface during the dormant season are usually fairly well protected from the effects of fire, depending on the amount of mulch, soil water content, and intensity of fire exposure. However, some bunchgrasses with compact crowns and a high density of dead plant material near the crown may be damaged by fire (Conrad and Poulton 1966; Wright 1971).

Burning under proper conditions usually has minimal effect on grassland soils. Although maximum temperatures at the soil surface may occasionally reach 1000°F during some grassland fires, the duration of exposure is usually brief (Scifres 1975; Stinson and Wright 1969). The soil temperature is usually not changed to depths greater than 2 inches and the greatest changes usually are restricted to the upper 0.13 inch of the soil (Daubenmire 1968; Scotter 1979). However, removal of the insulating layer of mulch and standing vegetation by fire and blackening of the soil surface by ash deposition results in warmer soil temperatures during the growing season after burning, which accelerate microbial activity (Black 1968; Daubenmire 1968), stimulate nitrate ion production, rapid vegetative growth, and concomitant soil water and nitrate uptake by plants (Sharrow and Wright 1977). Sharrow and Wright (1977) reported that soil water and nitrate contents declined more rapidly on burned than on unburned areas even though more nitrate was produced on the burned areas in tobosagrass (Hilaria mutica) communities.

In summary, prescription burning under proper conditions does not normally affect grassland soils adversely (Hole and Watterston 1972; Lloyd 1971; Ueckert et al. 1978). Sediment loss in overland flow may increase on some soils following burning, but this loss can be minimized by burning when soil water contents are high (Ueckert et al. 1978; Wink and Wright 1973). Healthy green colors, larger sizes and higher water content of plants recovering from fire often reflect improved soil conditions (Vogl 1974).

Removal of mulch and dormant standing plant material often stimulates plant growth as well as is accomplished by burning. Heavy mulch accumulations often stifle growth by depriving plants of space and light (Scifres and Kelly 1979; Vogl 1974), by maintaining cooler soil temperatures (Sharrow and Wright 1977), and in some cases leachate of chemical substances from mulch may inhibit plant growth (Rice 1974). Removal of aboveground plant parts by burning or mowing triggers latent primordial regions which stimulate new growth in some species (Lewis 1964).

In many grasslands, culms, stems and leaves of plants remain erect when dormant and are very slow to decompose. Fire can be a primary nutrient recycling agent in these grasslands. Even though sulfur and nitrogen in mulch and standing dead plant material is volatilized by fire, all other nutrients are changed to water soluble forms and are deposited in the ash (Vogl 1974) where it can be used for plant growth or displaced by wind or water (Daubenmire 1968). About 70% of the nitrogen in mulch and standing dead material is lost, but there is no evidence that nitrogen stress is imposed on the vegetation by burning (Christensen 1977; Daubenmire 1968; Lloyd 1971; Oefinger and Scifres 1977; Sharrow and Wright 1977; Vlamis and Gowans 1961). Most studies have reported that the nutrient gain from ash is of no detectable significance, and that increases in production following burning result from litter removal (Adams and Anderson 1978; Hulbert 1969; Lloyd 1971; Old 1969).

Burning for Manipulating Herbaceous Vegetation

Where prescribed fire is an applicable tool, herbaceous vegetation can be manipulated to meet several specific objectives, including, increased herbage production, rejuvenation of decadent stands, increased availability, palatability, nutritional value and utilization of forage, removal of excessive litter accumulations, shifting species composition, and control of annual weeds and grasses. The following paragraphs give information on use of fire for manipulating selected herbaceous range plants.

Tobosagrass (Hilaria mutica), a highly productive, climax grass on heavy clay soils, is a coarse plant that is relatively unpalatable to livestock during most of the year. Tobosagrass tends to accumulate large amounts of litter that reduces soil temperatures and stifle plant growth. Dense stands of tobosagrass can become decadent due to heavy accumulations of litter and standing dead stems and leaves. Late winter burning during wet years has increased production of tobosagrass up to 300%, while in dry years yield on burned areas may be slightly less than on unburned rangeland. Increased production may last for 3 to 4 years after burning in tobosagrass communities (Wright 1969; 1972; 1974b; Ueckert and Whisenant 1980).

New growth of tobosagrass after burning is preferred by cattle and is readily consumed during spring and fall. Cattle ate 2,388 lb/acre of tobosagrass on burned rangeland, compared to only 371 lb/acre on

adjacent unburned rangeland. Grazing pressure was shifted from buffalograss (Buchloe dactyloides) to tobosagrass during spring and fall (Heirman and Wright 1973). Sheep diets during the first few months after burning tobosagrass rangeland contained 17.1% crude protein and 62.1% digestible organic matter compared to 14.3% crude protein and 57.1% digestible organic matter in sheep diets on adjacent unburned rangeland (Huston and Ueckert 1980).

Wright (1978) reported that spring burning in tobosagrass communities effectively controlled annual broomweed (Xanthocephalum dracunculoides) and reduced Carolina canarygrass (Phalaris caroliniana) and little barley (Hordeum pusillum). Neuenschwander et al. (1978) reported that the response of herbaceous plants to burning in tobosagrass-mesquite communities was characterized by the response of tobosagrass, and the response of associated herbaceous species to tobosagrass. Burning decreased the importance of forbs during the first growing season after burning, but if soil moisture was adequate forbs were more important on burned rangeland than on unburned rangeland during the second, third and fourth growing seasons after burning.

Burning an ashe juniper (Juniperus ashei) community during a wet spring increased yield of herbaceous plants by 41% while burning in a dry spring reduced production 13% (Wink and Wright 1973). Burning during a wet spring increased production of little bluestem (Schizachyrium scoparium) 81% and meadow dropseed (Sporobolus asper var. Hookeri) 53%, but did not affect production of sideoats grama (Bouteloua curtipendula), tall grama (Bouteloua pectinata), or vine mesquite (Panicum obtusum). Burning during a dry spring decreased yields of little bluestem, sideoats grama and tall grama by about 50%, but yields of vine mesquite increased 112% and yields of meadow dropseed increased 24%.

Wright (1974b) concluded from several studies that buffalograss, blue grama (Bouteloua gracilis), and sand dropseed (Sporobolus cryptandrus) were neither favored nor harmed by fire. Species that appeared to thrive for one to three growing seasons after fire included Arizona cottontop (Digitaria californica), little bluestem, vine mesquite, tobosagrass, plains bristlegrass (Setaria leucopila), and Texas cupgrass (Eriochloa sericea).

Trlica and Schuster (1969) reported that fall, spring and summer burning significantly reduced total forage production on shortgrass rangeland in the Texas High Plains. Vigor of blue grama was benefited by burning while that of two less desirable grasses, red threeawn (Aristida longiseta) and sand dropseed was harmed.

We found that late-winter burning with good soil moisture in the southern Rolling Plains did not affect production of sideoats grama (Bouteloua curtipendula), red threeawn, Texas wintergrass (Stipa leucotricha), buffalograss, or forbs. Burning during late winter when soil water contents were low also did not affect production of these

species when May-June rainfall was normal (Ueckert and Whisenant 1980).

In studies on Texas wintergrass-dominated rangeland in Coleman County we found that burning during late-winter 1978 with good soil moisture increased production of perennial grasses 96% during the first growing season after burning and by 41% during the second growing season. Production of Texas wintergrass was increased 94% during the first growing season after burning and 50% in the second growing season. Production of low-value, cool-season annual grasses, including Japanese brome (Bromus japonicus), rescue grass (Bromus unioloides) and little barley (Hordeum pusillum), was decreased 74% the first spring after burning, but there was a trend toward somewhat more annual grasses on burned rangeland, compared to unburned rangeland, during the second spring after burning. Production of forbs was decreased 56% the first growing season after burning, but there was no difference in forb production on burned and unburned rangeland in the second growing season (Ueckert and Whisenant 1980; also Ueckert and Whisenant, unpublished data). Subsequent burning studies in Coleman County have indicated that production and vigor of sideoats grama, vine mesquite, meadow dropseed, Texas wintergrass, western wheatgrass (Agropyron smithii), and Arizona cottontop were improved by late winter burning with good soil moisture (Ueckert and Whisenant, unpublished data).

Whisenant (1982) found that Texas wintergrass responded similarly to burning and clipping in the northern Edwards Plateau and southern Rolling Plains of Texas, indicating that most of the responses are a result of mulch removal and associated indirect influences, rather than direct heat effects. The response of Texas wintergrass to burning was a function of fire intensity, growing conditions following burning, and post-burn competitive interactions with associated plant species.

Neither burning nor clipping significantly affected density, basal area or the number of reproductive culms of Texas wintergrass plants in dense homogeneous stands (Whisenant 1982). Burning in January or March reduced Texas wintergrass point frequency for one year and burning, regardless of season, reduced standing crops of Texas wintergrass for one year. Where annual cool-season grasses were abundant, Texas wintergrass density, point frequency, and standing crop tended to increase following burning, apparently a result of reduced competition from annual plants. These increases were greater following fall burning and less pronounced following spring burning. Cool-season annual grasses and forbs were usually killed if burned during their growing season. However, seed reserves in the soil and/or subsequent seed immigration into burned areas appeared to be sufficient to reestablish or even increase annual plant populations the second year following burning. Warm-season, perennial grasses were generally benefited by burning in the spring and damaged by burning in fall. Perennial forbs such as western ragweed (Ambrosia psilostachya), silverleaf nightshade (Solanum elaeagnifolium), and Engelmann daisy (Engelmannia pinnatifida) were stimulated by burning (Whisenant 1982; Wright and Bailey 1980).

Whisenant's findings have practical implications in the use of prescribed burning to alter species composition in communities containing Texas wintergrass. Texas wintergrass appears to be damaged the most by burning in late-spring and damaged the least by burning in the fall. Fire occurring after cool-season annual grasses have germinated, but early in the growth of Texas wintergrass have the greatest potential for increasing Texas wintergrass production when large numbers of annual grasses are present. A fire designed to benefit Texas wintergrass at the expense of warm-season perennial grasses should occur in the fall before growth of Texas wintergrass begins and while warm-season perennial grasses are still actively growing. If management objectives include favoring warm-season perennial grasses at the expense of Texas wintergrass, a fire during late winter or early spring while Texas wintergrass is growing and before initiation of warm-season perennial grass growth will best meet those objectives. However, the influence of fire on Texas wintergrass may last only one year.

Some additional factors which may modify the predicted response following burning should be considered before planning a burning program for Texas wintergrass: (1) Fires of low intensity, which do not consume ground litter, will have less effect on vegetation than intense fires which consume all standing and ground litter. (2) Plants not killed by the fire will be damaged less when burning is followed by several months of above-average precipitation. (3) Fire should be timed to plant phenology and environmental conditions rather than to a specific date. (4) A fire may be followed by critically-timed grazing to stress one component of the vegetation in favor of another. For example, a winter burn may be followed by intensive grazing at a high stocking density to stress Texas wintergrass but stopped before warm-season grasses initiate growth.

Gulf cordgrass (Spartina spartinae), a highly productive species, forms almost solid stands over large areas of the Coastal Prairie of Texas. Mature gulf cordgrass is coarse and unpalatable to livestock. Oefinger and Scifres (1977) reported that winter burning effectively removed old growth and litter from gulf cordgrass stands and that cattle heavily utilized regrowth following burning. Burning followed by grazing stimulated production of over 19,182 lb/acre of gulf cordgrass, compared to 1,218 lb/acre on adjacent unburned rangeland. Utilization of gulf cordgrass on unburned rangeland was negligible. Grazing maintained gulf cordgrass in a young, tender state throughout the winter on burned areas. New growth of gulf cordgrass following burning was higher in protein, phosphorus, and digestible energy content than mature growth on unburned areas (Oefinger and Scifres 1977).

Hamilton and Scifres (1980) reported that prescribed burning increased production of buffelgrass (Cenchrus ciliaris) by 93% for 4 months following a February burn in the Rio Grande Plains. Buffelgrass on unburned areas produced slightly more than that on burned areas during the following 12 months, which was an extremely dry period. However, when good growing conditions returned the burned

area produced 67% more forage than the unburned area for the next 5 months. Utilization of buffelgrass by cattle was 88% on the burned area, compared to 69% on the unburned area, for 17 months following burning.

Some grasses, such as threeawns (Aristida spp.) are objectionable to sheep and goat producers in Texas because the seeds become entangled in wool and mohair fleeces, reducing wool and mohair values, and because the sharp calluses of the fruit penetrate the skin and flesh, causing weight loss, decreased carcass quality, and occasionally death losses (Maurice Shelton, personal communication). In Kansas, prairie threeawn (Aristida oligantha) was effectively controlled by fall burning (Owensby and Launchbaugh 1977). Burning on dates later than early December did not control prairie threeawn. Mulch removal by burning was cited as the causal factor associated with control of prairie threeawn. Late winter and early spring burning has not harmed red threeawn (A. longiseta) in our studies near San Angelo (Ueckert and Whisenant 1980). Burning during September, November, January or March in McCulloch County, Texas tended to increase production, density, and numbers of reproductive culms of red threeawn (Whisenant 1982). Trlica and Schuster (1969) reported that basal diameters of red threeawn plants either were unchanged or increased by single fires on Texas High Plains rangeland. Fire had little effect on numbers of flowering culms of red threeawn the first growing season after burning, but production of flowering culms was stimulated during the second growing season after burning.

Several researchers have reported that prescribed burning controlled undesirable herbaceous weeds or resulted in other desirable shifts in herbaceous species composition. Scifres and Kelley (1979) reported that burning live oak-dominated vegetation in thicketized uplands on the Texas Coastal Prairie increased herbaceous species diversity for two growing seasons after burning. Burning in fall increased species diversity more than burning in spring. Burning decreased the proportion of grass species of poor grazing value in the stand and increased the proportion of grass species of good-to-excellent forage value by the second growing season after the fires. Gulf dune paspalum (Paspalum monostachyum) and Heller panicum (Panicum oligosanthos var. helleri) increased the first growing season after burning but began to decline as the proportion of little bluestem (S. scoparium var. frequens) increased during the second growing season on burned areas. Forb standing crop on uplands burned in the fall was five times that of unburned areas and twice that of areas burned in the spring.

Fire is also an effective tool for managing weeping lovegrass (Eragrostis curvula). Spring burning when soil moisture was adequate increases vigor, forage productivity, seed production, palatability, and protein content of weeping lovegrass (McIlvain and Shoop 1970; Carlton Britton, personal communication). Furthermore, spring burning causes weeping lovegrass to begin growth earlier in the spring, removes excessively thick mulch accumulations and standing old growth

that shades out new tillers and causes "center die-out" of individual plants, and removes manure so that hay can be harvested without contamination. Spring burning also killed winter annual weeds and grasses and helped alleviate spot grazing. Weeping lovegrass definitely should not be burned 1) every year, 2) when soils are even slightly dry, or 3) when the plants are in low vigor due to overgrazing or dry conditions. Unfertilized weeping lovegrass on sandy soils of low inherent fertility probably should not be burned more often than once every five or six years, whereas burning once every three years might be safe on pastures receiving adequate nitrogen fertilizer every year. The best time to burn weeping lovegrass pastures appears to be a day or two after a rain that comes on about the date of the last killing frost. Burning soon after a rain, while the plant bases and lower mulch layers are wet can effectively remove the old dead growth, yet leave adequate mulch to protect the soil and leave adequate stubble barrier to protect the perenneating buds.

Protein and digestible organic matter content of regrowth on recently burned rangeland is almost always higher than that in forage samples taken from adjacent, unburned rangeland. However, more of this difference is due to contamination of the sample from the unburned area with old growth than of actual differences in nutrient content of new growth. The nutritional quality of the diets of livestock on recently burned rangeland may actually vary very little from that of livestock on adjacent unburned areas because of the ability of animals to selectively graze, and because burning generally reduces the abundance of forbs during the subsequent growing season. Huston (1980) recently reviewed the facts in relation to the effect of burning on forage quality and livestock performance. He concluded the following:

- 1) Diets of animals range from slightly to greatly increased in nutrients following burning;
- 2) Burning of range forages which have excessive amounts of old growth (e.g. tobosagrass and weeping lovegrass) give the greatest benefit in diet quality;
- 3) Benefits of improved diet quality and increased animal productivity following prescribed burning are relatively short-term (3 to 6 months); and
- 4) The greatest livestock response to burning is in animals in a high productive state (young growing or lactating).

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IMPACT OF PRESCRIBED BURNING ON WILDLIFE

W. E. Armstrong

Highlight

Prescribed burning when applied to ranges that are properly managed for both domestic livestock and white-tailed deer can increase available deer food production which in turn controls antler size, body weight and reproduction. Conversely, prescribed burns applied to ranges improperly stocked with domestic livestock and deer can expect deer range destruction, resulting in poor deer body weights, poor antler development and poor reproduction.

Introduction

Over the past decade there has been an increasing interest in the use of fire as a brush management tool. In Central Texas, research has been primarily concerned with the control of regrowth cedar (ashe juniper, Juniperus ashei and redberry juniper, J. pinchoti), pricklypear (Opuntia spp.) and honey mesquite (Prosopis glandulosa). There has been little research on the effects of prescribed burning on wildlife in this region. The Kerr Wildlife Management Area initiated a prescribed burn program in 1978 to control regrowth cedar. In conjunction with this program, a series of studies dealing with the effects of prescribed burns on white-tailed deer were initiated. They consist of (1) quantitatively measuring vegetative responses of liveoak (Quercus virginiana), shinoak (Q. spp.), and ashe juniper to various burn treatments, (2) measuring deer use of burned areas versus unburned areas, and (3) measuring nutritional differences between burned and unburned ranges with emphasis on deer foods.

At this time most of the effects of fire on deer populations are drawn from vegetative observations following fire and a general knowledge of deer management. Some research on the effect of fire on white-tailed deer has been conducted on the Piloncillo Ranch in South Texas (Steuter 1980), the Aransas National Wildlife Refuge (Springer 1976) and the Welder Wildlife Area near Sinton, Texas (Box 1969). The effects of burn programs on livestock also provide some clues as to the effect of controlled fires on deer.

Fire and Deer Management

There are some basic facts about fire and deer that must be clearly understood in order to understand the role of fire in deer population dynamics.

The first basic fact is that fire is a management tool. Its effect on deer populations can be either positive or negative depending on how it is used in conjunction with a total ranch management program.

The second basic fact is that deer management consists of two simple principles. They are (1) providing food and cover and (2) genetic selection. If you can grow deer foods and provide suitable cover, you can grow deer. By genetically selecting for the better deer, a herd can be improved.

Fire affects the production of both food and cover. Knowing how to manipulate a fire, a deer herd, a livestock herd and a range in order to product more deer food is the key to raising deer. All the above factors are interrelated; no one factor by itself is a "cure all" for deer management. Research has demonstrated that deer produced on ranges properly managed for deer foods have heavier body weights, better antler growth and better fawn production than on unmanaged ranges (Armstrong and Harmel, 1978).

Deer Foods

An understanding of deer food habits and the response of deer food plants to fire is essential prior to initiating burn programs. Research has shown that deer are primarily forb consumers (McMahn 1964). Forbs are generally high protein plants (Fraps 1940). Most are seasonal plants, with the greatest abundance being in the late winter and spring period. Most forbs are annual plants. Once the top is removed from the plant, it does not grow back. Fire, therefore, should be conducted as early in the year as possible, preferably prior to the mid-January period. This is the time when many cool season forbs begin to germinate, forming winter rosettes. Burning later than this period of time will reduce many of these rosettes. For a period of time following a burn, there will be a reduction of deer forbs in a burn area. This reduction is usually followed by increased forb production as warmer season forbs begin to germinate. As forbs begin to decrease in the July-August period, deer begin to shift their diet to browse. Browse plants are usually lower in protein content than forbs; however, they are deeper rooted, more drought resistant perennial plants. Browse, therefore, is considered the more stable food in the deer diet.

For practical management purposes, deer are not grass eaters, as only a small portion of a deer's diet is grass.

Forbs are extremely difficult to measure and make intelligent, long-term management decisions by because they are annual, seasonal plants. For this reason, most deer management is based on browse production. The thoery being that if you can release grazing pressure on key browse species, you can assume deer are getting adequate amounts of forbs in their diet. Some key cool season deer forbs would be the plantains (tallow weed, Plantago spp.), wild chervil (Chaerophyllum tainturieri), Texas filaree (Erodium texanum), and prairie bishop (Bifora americana).

Browse can be divided into three major categories. They are the preferred browse such as Texas oak (Spanish oak, Q. shumardii var.

texana) and hackberry (Celtis spp.), the moderately preferred browse such as shinoak, redbud (Cercis canadensis), and gum elastic (Bumelia lanuginosa), (also in this category but of less summer preference is liveoak and green briar (Smilax spp.)), and the low preference browse such as mesquite (Prosopis glandulosa), cedar (Juniperus spp.), persimmon (Diospyros texana), and whitebrush (Aloysia lycioides). The following is a list of common deer foods and their response to fire.

- 1) Liveoak - It is a reasonably fire tolerant plant when burned with humidities above 45 percent. This plant root sprouts following top removal. Liveoak is considered important as winter grazing for deer. As a general rule, little grazing should be noted on liveoak during the summer months.
- 2) Hackberry - This plant is fairly fire tolerant. It will basal sprout following top removal. It is a preferred deer browse and should be protected from overgrazing.
- 3) Shinoak - This plant also root sprouts well after burning. It is an excellent plant to judge deer range usage. Heavy grazing on this plant in the July-August periods is a good indicator of an overbrowsed deer range.
- 4) Texas oak (Spanish oak) - This plant will root sprout if top-killed. It is an excellent deer browse. Root sprouts should be protected from overgrazing.
- 5) Flameleaf sumac (Rhus copallina) - Germination is stimulated by fire, the hotter burn areas seem to have the more vigorous germination. This plant is considered a moderate deer browse.
- 6) Red bud - A moderate deer food that is relatively fire tolerant. It will resprout if topkilled.
- 7) Gum elastic (Bumelia, chittum) - This plant is relatively fire tolerant and will resprout when topkilled. It is a moderate deer food.
- 8) Ashe juniper, cedar - Small (less than one inch in basal diameter) regrowth is easily killed by fire. Slow moving fires which hold the heat more uniformly around the cambium layer seems to give more uniform kills. This plant does not root sprout following topkill. It is considered a poor deer food. Removal of this plant will allow for more deer foods to be grown. Mature cedar breaks are fairly immune to controlled burns.
- 9) Agarito (Berberis trifoliolata) - This plant is easily topkilled by fire, but will root sprout. It is not uncommon for the more desirable deer foods to grow under its canopy. These are released following fire. Agarito is an undesirable deer food.
- 10) Persimmon - This plant is considered a poor deer food. It will also resprout following fire.
- 11) Mesquite - It is a poor deer food, which will resprout following fire.

- 12) Smilax, greenbriar - This plant is considered as winter forage for deer. It is relatively fire tolerant. It comes back well in hot burn areas, such as brush piles.

Nutrition

Research by various persons seems to indicate increased nutritional value of forage following burning. In Texas this has been demonstrated on the Edwards Plateau near Sonora through increased steer weights on burned ranges (McGinty 1980) and on the Aransas National Wildlife Refuge (Springer 1976) through vegetative analysis of deer foods and increased deer weights on burned ranges. On the Kerr Wildlife Management Area, observation indicates a preference for deer foods growing in hot burn areas such as brush piles. Spot grazing still occur on small burn acreages unless deer populations are controlled prior to burning.

Pre-Burn Considerations

There are some basic management principles that must be considered before utilizing fire. The most important is deer herd control. Prior to any burn program, the deer herd should be heavily reduced. A 50 percent reduction in deer in many places would not be excessive, since the objective of controlled burning for deer management is to stimulate deer food production. A hot controlled burn that removes canopy cover of preferred deer browse will stimulate root sprouting. Vegetation at this time is vulnerable to overgrazing. If too many deer are on the range, the deer will remove and possibly kill regrowth vegetation, leaving a depleted deer range. However, when a deer herd has been properly harvested prior to a controlled burn, an increase in available browse for grazing can be expected.

Rotational grazing systems, coupled with proper livestock numbers, should be used in conjunction with reduced deer numbers. A watchful eye must be kept on key deer foods to prevent overgrazing.

Another important factor which must be considered prior to burning is brush patterning. During daytime hours deer usually seek out dense cover. They usually come out of dense cover to feed on forbs and browse in the evening and morning periods. A hot fire which removes all cover over large acreages is not desirable as deer tend to avoid these areas. A mosaic pattern of brush to openings is the best deer habitat. Plan for leaving strips or areas of mature brush to act as cover.

Frequency of use of fire is another factor to be considered. Too frequent use of fire over a period of time can effectively control browse plant numbers and deplete deer range. At this time it is recommended that treatments with fire should not be more frequent than seven to ten years apart.

Conclusions

In summary, fire when properly used in conjunction with proper stocking rates, proper grazing practices, and proper deer numbers, can increase deer food production through control of regrowth cedar and stimulation of preferred forbs and browse. Conversely, fire when used in conjunction with uncontrolled deer numbers, overstocked ranges, and poor grazing practices can cause deer range deterioration and loss of deer habitat.

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PRINCIPLES, REQUIREMENTS AND TECHNIQUES FOR PRESCRIBED RANGE BURNING

Larry D. White

Introduction

Prescribed range burning follows a set of guidelines that establishes the conditions and manner under which a fire will be set to a specific area to accomplish specific management and ecological objectives. The conditions selected must identify season, phenology of the vegetation and weather factors conducive to safe and effective burning. Management objectives help determine the fire characteristics needed to maximize benefits and minimize damage. The risk of escape and damage to desirable species including wildlife plus the cost of different burns must be considered.

Successful burning requires a sufficient grass cover to carry the fire over the area. In addition, the grass must be at a flammable stage of growth to burn readily; hence, burning is usually restricted to seasons when grass is not actively growing. Each area and range site will be influenced by local conditions and species of vegetation. Entire management units should be burned where possible to prevent over concentration of grazing animals.

Rancher objectives often require an intense flame front with fast rate of spread to severely impact brush. In areas of light or patchy fuel quantity, the most flammable burn conditions are often required to achieve a satisfactory burn; however, the risk of escape and damage to desired vegetation is higher. Generally, the more severe the preburn and postburn conditions plus intensity and duration of the fire, the greater potential overall damage; however, the short term losses may be acceptable in light of longer term management and ecological gains. Since fire was a natural ecological factor on most Texas rangelands, the vegetation is well adapted to fire with promotion of grass over brush. Sound range, livestock and wildlife management must accompany use of fire if benefits are to be realized.

Principles for Using Prescribed Fire

A rancher must follow three basic steps for conducting a successful burning program: 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 prior to, during and following the burn(s).

Fire can be set any time fuels will burn; however, in view of safe and effective use of fire, a more "exact" set of conditions must be specified. Usually, dry grass is necessary for a fire to effectively spread over an area, hence with few exceptions either dry soil conditions or frost are required. Flammable fuel under target species is necessary for achieving adequate control. Local variations in weather, soil moisture, topography, etc. often create different fuel conditions hence different fire intensities and duration with different vegetation responses.

Several points to remember in planning a burn are: 1) fire primarily topkills plants; 2) the recovery rate is dependent on species, their vigor, heat experienced by the plants, weather conditions prior to and following the burn and postburn management; 3) intensity of the fire is determined by weather and fuel conditions and type of fire used; 4) the greater the intensity of the fire the greater the risk of escape if experience is inadequate; 5) fire plans and prescriptions are only guidelines; 6) fire behavior must be predictable for effective containment; 7) prescribed burns require adequate preparation, equipment and experienced personnel; 8) repeated fires at a frequency and intensity to promote and maintain a grass dominance are usually necessary; and 9) postburn management of grazing by livestock and wildlife is critical to recovery and improvement of desirable plant species.

Requirements for Safe and Effective Prescribed Burning

The key requirements of the prescribed burning process are: 1) skilled application of fire; 2) containment of the fire; 3) fire behavior and characteristics to accomplish certain objectives, 4) minimize adverse side effects; and 5) at an acceptable cost. The planning process in developing the prescription for the burn must consider all aspects of information and personnel skills available. The actual burn requires the skillful application of fire behavior principles under existing conditions of weather, fuel, manpower, equipment, terrain, etc.

Prescribed burning principles must encompass conduct of a safe, planned fire as well as proper timing of the burn to obtain management objectives. Both fire behavior and vegetation characteristics and known responses must be adequately evaluated and a prescription developed to produce the needed fire characteristics under local conditions to obtain necessary responses. Hence, until experience is gained, a rancher should utilize fire on the easiest to burn sites (primarily a maintenance and/or forage quality objective) under the safest of burn conditions. A rancher will learn to achieve successively better results with each burn and can utilize increasingly difficult to contain prescriptions. Breaks in fuel continuity are used to contain fires to the specified area. These may be natural or constructed firelanes.

The rancher through grazing management and/or alternative range improvement practices influences the fuel (quantity, flammability and dispersal) for a burn. Usually, the fuel characteristics and weather conditions under which a fire is set will determine the heat intensity, rate of fire spread, development of spot fires (small escape fires caused by air-borne embers), amount of dead and live fuel consumed and smoke dispersal. The techniques and weather conditions used to burn an area will control these fire characteristics and enable the burn to be conducted safely. The variables most influencing fire behavior are: 1) topography; 2) fuels; 3) weather; and 4) firing technique.

Topography

Generally, topography affects wind behavior and heat buildup that in turn determines to a large extent the flame front movement over the area. Prescribed burning requires successful prediction of these wind patterns so that prefire control measures can be undertaken to safely contain the fire. Fires move quickly upslope and slower downslope compared to level terrain. Winds are channeled up canyons with increasing speed as slope increases and increasing turbulence around and over features. Eddy currents over the crest of a hill, trees and around objects create different fire intensities, rates of spread, and direction of fire front movement. These can also create fire whirlwinds that can carry sparks, burning debris, or flames across a normally safe fireline. The firewhirls are small tornadic winds of counter clockwise circulation (in the northern hemisphere) created from intense hot spots and rapid rising air at a concentration point.

Turbulence and eddy currents near a fireline affect containment as well as firing procedures. Winds blowing over the area are influenced by every irregularity. Location of firelines should be along gradients with the least turbulence and lower fuel quantities. In addition, winds in valleys and slopes move upward during the day due to surface heating and downward at night due to surface cooling unless prevailing winds are strong enough to overcome local conditions.

Fuel

The flammability of a fuel is determined by the burning characteristics of individual materials and their combined effects. Dead fuels ordinarily promote the spread of a fire. Low volatile fuels such as grass are relatively safe to burn, whereas high volatile fuels are explosive and create serious firebrand problems. In addition, light fuels such as grass, small branches and most small brush pick up atmospheric moisture quickly and give it off quickly, hence these are fast burning fuels. Logs, stumps, large branches, etc., by contrast are heavy fuels and take up or give up moisture more slowly thus being slow burning fuels. Greater periods of atmospheric drying (several days) are required for prescribed burns to consume heavy fuels. Once heavy fuels have been ignited they may burn for several days, hence winds after the burn may carry sparks across firelines. These fuels

should not be concentrated near escape points; if they are ignited, flames should be extinguished before leaving the fire unattended.

The moisture content of fuels largely determines the rate of combustion and ease of ignition. It is a product of past and present weather conditions. Temperature, humidity, wind, precipitation and dew, season, time of day, topographic location, and microclimate all have a bearing on fuel moisture at a given time. Completely dried grass will crackle and easily break into pieces when crushed in the hand. Dry twigs will snap and are brittle.

The quantity of fuel that will burn determines the total heat that can be developed during a given fire. The total heat generated determines fire spread, intensity, and duration thereby determining the fire effects on the burn area. Also, the total heat generated determines the convection column characteristics and fire generated weather. Fuel quantity can be regulated by grazing management within the current environmental conditions. A good grazing management program should allow development of the necessary fuel, especially during above average rainfall years.

Weather

Weather conditions prior to, during the burn and following have a major influence on fuels, burn conditions, burn procedure and recovery. Wind is the most variable and least predictable fire weather element. Yet it can be predicted if burning is conducted under relatively stable weather conditions with knowledge of frontal weather systems and effect of high and low pressure cells (Figure 1). Since prescribed burning requires setting a line of fire that naturally burns over a prescribed area, wind direction and wind speed prediction are necessary. The wind speed will generally determine the rate of spread and flame height plus uplift of embers and burning material. Therefore, wind speed must be sufficient to carry fire easily through the fuels but not high enough to jump the upwind control lines. Wind direction must be consistent to avoid a backfire becoming a headfire or the headfire hitting a control line designed for a less intense flame front. Also, wind is necessary to carry the needed oxygen for combustion to take place. Insufficient oxygen results in poor combustion, less heat generated, and poor prescribed burns.

Usually, large fires will create their own winds around the convection column of smoke, heat and flame front. Whirlwinds can be created by this sudden on-rush of air. A headfire moving into a backfire can result in two headfires meeting and creating an intense hot spot or firewhirl.

The height and density of plants and crowns affect wind velocity. The more open the stand, the higher the wind speed near the ground surface. Unless sufficient fuel occurs within a brush stand, wind velocities may be insufficient to move flames properly and do little damage to the brush. Also, fuel must be distributed uniformly



Figure 1. Prevailing wind direction depends on the location of fronts and high and low pressure cells. (White 1981)

to carry the fire and in sufficient quantity under the canopy of a shrub or tree to generate heat needed to kill cambium tissue. Mechanically cleared firelines that create openings can produce unusual eddy currents and wind speeds not characteristic of the main fire creating problems for containment.

"The threshold moisture in which fine fuels will or will not burn in sunlight...is about 33 percent... Below 20 percent fine fuel moisture has relatively little effect on fire behavior in comparison to wind speed and relative humidity" (Wright 1980). "Below 5 percent fine fuel moisture (relative humidity less than 20 percent) spot fires are certain, whereas spot fires are rare when fine fuel moisture is above 11 percent (relative humidity greater than 65 percent)" (Wright 1980). Fine fuels burn easily with about the same intensity when relative humidity is between 20 and 40 percent (Wright 1980). As the relative humidity moves above 40 percent, the rate of spread of a fire slows considerably resulting in less uniform and intense fires. The potential of spot fires is low when relative humidity is above 50 percent or ambient temperatures are below 60 degrees F.

The diurnal change of ambient temperature and relative humidity creates different fire behavior potentials (Figure 2). The relative humidity is higher late at night and early in the morning because the temperature is lower; the relative humidity decreases as the temperature increases during the day and then increases as the temperature decreases at night. Hence, fires of different intensities can be prescribed by selecting the desired period of the diurnal cycle as well as macro-weather conditions. The openness of a brush stand and the amount of shade created by the vegetation will affect the relative humidity near the soil surface. Intensity of the fire and rate of spread both react to the diurnal change and change in micro-climate created by canopy cover. Except under extremely dry conditions, brush stands will burn slower and less intense (unless heavy fuels are ignited) than open grassland areas.

Firing Techniques

Firing techniques greatly influence flame front movement and build up. Care to select the proper ignition procedures and utilize the various types of fires is needed to effectively contain a fire under a given set of weather and fuel conditions. Prescribed burning can be accomplished by using a box of matches and simply setting a fire to run with the wind. This most resembles a natural wildfire; however, due to management goals, physical improvements and facilities, landownership boundaries, etc., fire must be initiated and conducted in a predetermined manner. "Based on behavior and spread, fires either move in the same direction as wind (headfire) in opposite direction of wind (backfire), or at a right angle to the wind (flankfire)" (Mobley et al. 1978). (Figures 3 and 4).

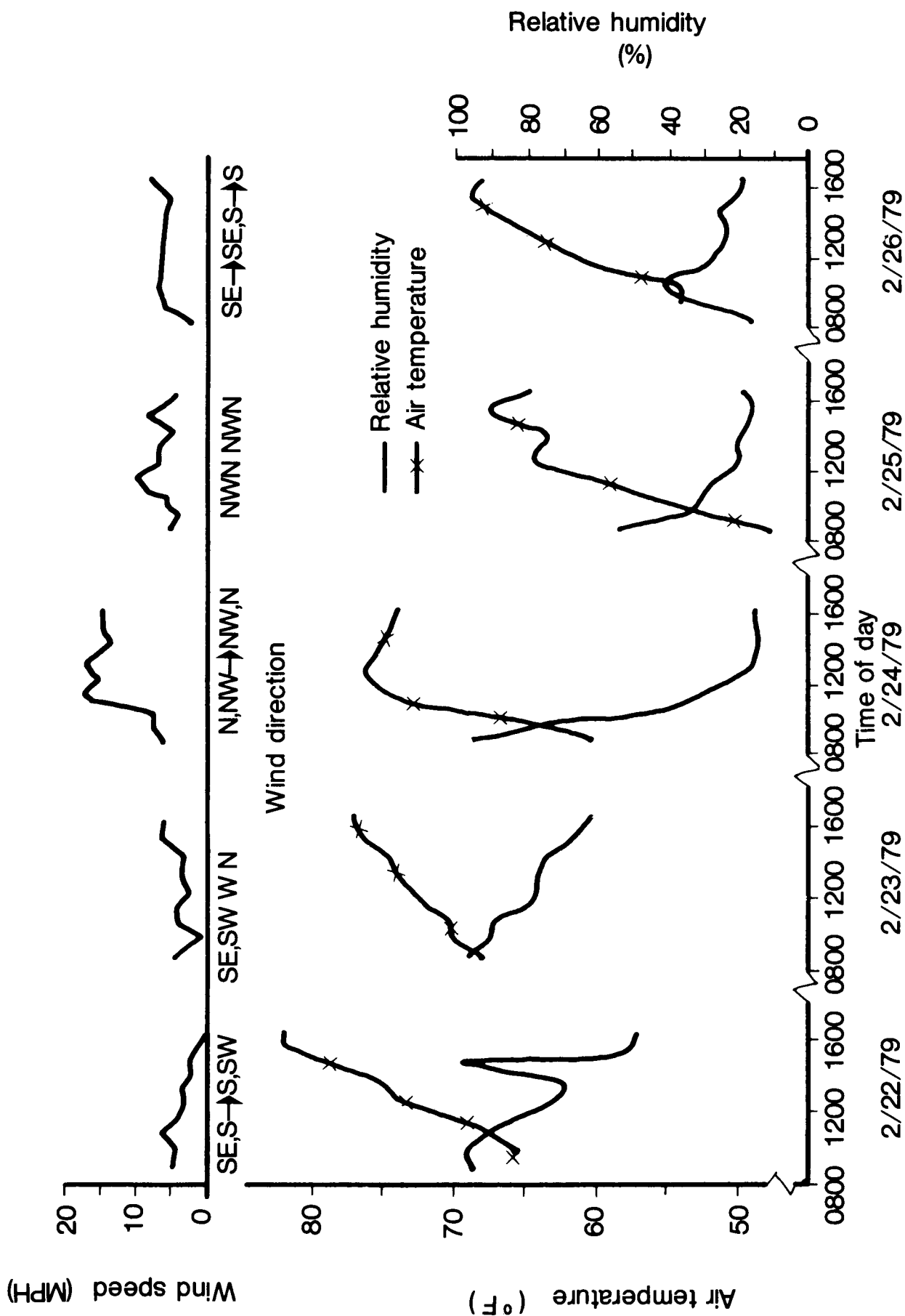


Figure 2. Weather conditions prior to and during the Cotulla Airport burn, La Salle County, Texas. Burning was conducted between 1200 and 1600 hours on 2/26/79. (White 1981)

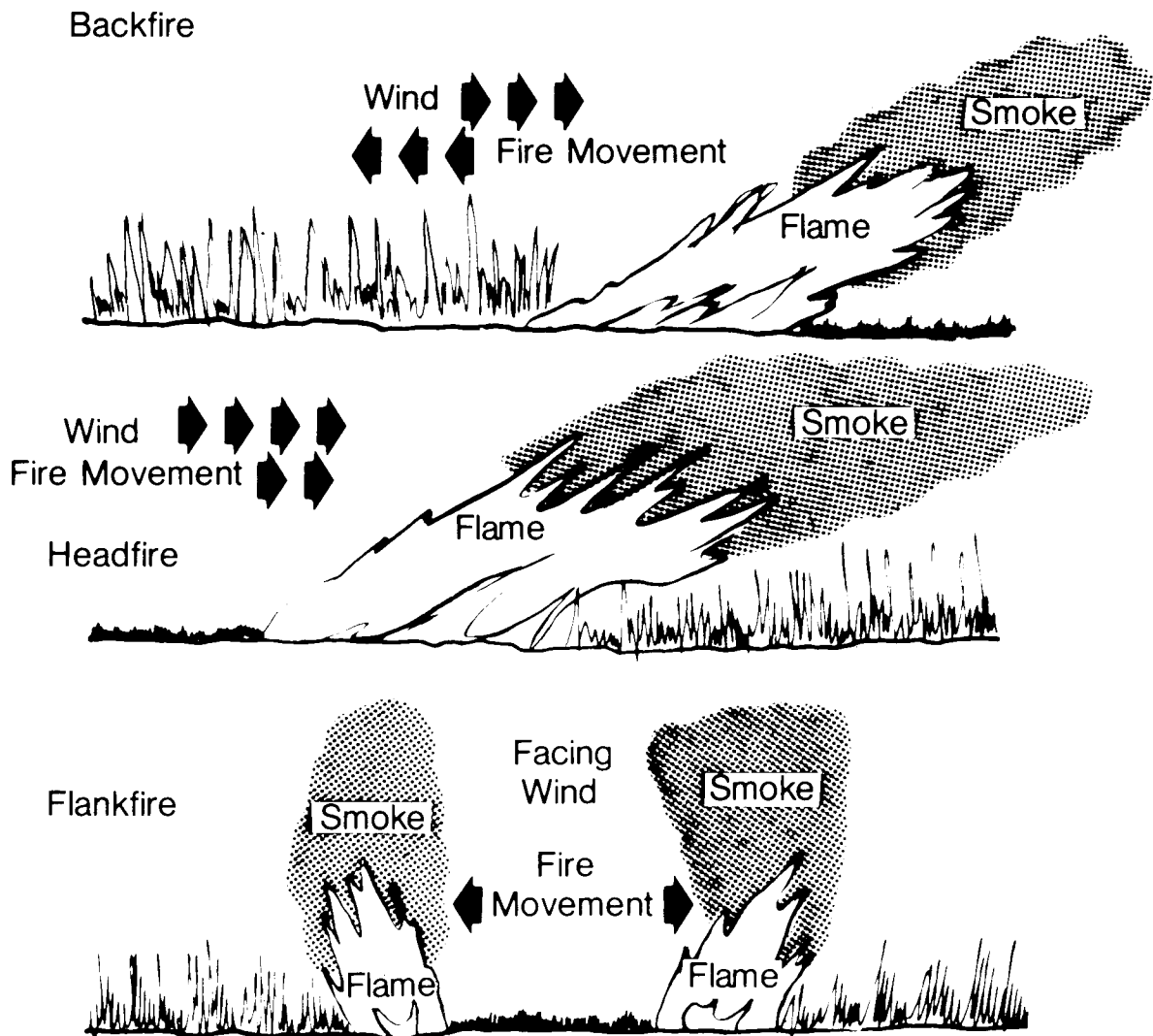


Figure 3. Backfires move into the wind with little preheating of unburned fuels (top). These move slowly and require heavier fuel quantities and more uniform continuity than headfires (middle). Headfires move with the wind with a high rate of spread. Flank fires result in fires moving at a diagonal to the wind (bottom). (White 1981)

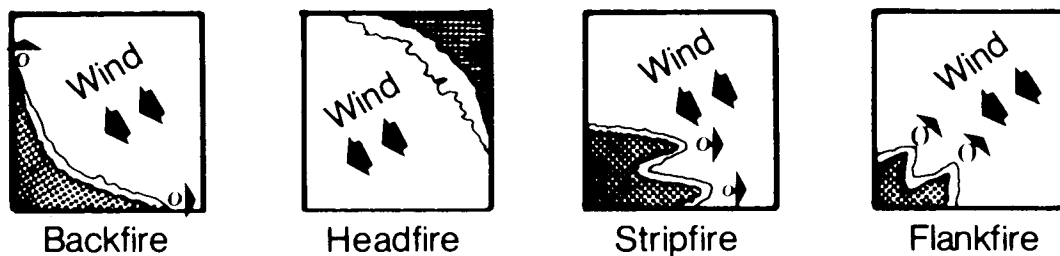


Figure 4. Firing techniques used for prescribed burning. (White 1981)

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. Four firing techniques are more commonly recommended for rangelands. Combinations of these fires when properly coordinated can be used to prescribe burn under variable wind directions.

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 keeping heat closer to the soil surface providing greater heat penetration to bud zones than fast moving headfires. Pratt and Gwynne (1977) concluded that burning against a light wind gives a slower moving fire, which can be expected to produce more heat around the trunks or stems of woody plants. Backfires are more docile and easily controlled; however, they require a more continuous grass cover and longer to burn hence are more susceptible to wind shifts.

Headfires are very effective at crown killing shrubs and trees with intense heat several feet above the soil surface. Preheating of fuel by headfires helps speed the combustion process. Headfires will 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 plowed lines or fire retardant lines across a pasture can be used to set a number of backfires in a relatively short time period. Costs of fireline construction would be considerably higher.

A modification of the head and back firing technique is the strip headfire. 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 a backing fire into the wind. This technique can be used to speed up the widening of firelines. The width of the strip must be regulated by the ignition crew so that the flame front does not leap the fire barrier. Changes in fuel quantity and continuity require corresponding changes in width of the strip fired area. Using strips of increasing widths will confirm the safety of the fireline against the major headfire. Once a headfire moves 50 to 100 feet, its major flame front characteristics are developed (exception being convection column and uplift of firebrands). The ignition crew should not run a strip fire into another strip fire until true backfire characteristics have been established and the flame front from the previous headfire calmed. Do not set more fire than can be safely handled. Do not leave the burn unattended until all fires that can potentially escape are out.

Techniques for Prescribed Burning

A "safe fire" is impossible to define because there is always some risk, but the amount of risk depends upon the judgment, planning, training and conduct of the entire operation. As the art of applying

prescribed burn principles are learned and judgment in interpreting and predicting fire behavior improves, more intense fires and greater flexibility in prescriptions can be utilized. Drought and local conditions needed for recovery should be carefully considered before following through with a burn.

The Fire Plan

The fire plan and prescription can be very specific or general depending on constraints imposed by the environment, man, etc. Generally, a prescription will define the range of guidelines resulting in satisfactory performance and benefits from using fire on rangeland. The number one priority must be safe controlled use of fire. If the fire cannot be safely contained to the specified area, benefits will be overshadowed by adverse reactions from neighbors, lack of forage for livestock, destruction of facilities, etc. The second objective of effective use of fire to meet management goals must be developed realistically within the above requirements. The fire plan should include evaluation and understanding of the following: 1) physical and biological characteristics of the area to be burned; 2) management objectives; 3) relationships between preburn environmental factors (including grazing), expected fire behavior and probable fire effects; 4) the art and science of applying fire under the prescribed conditions; and 5) previous experience from similar treatments on similar areas (Fischer 1978). The burning plan should describe the actual conduct of the burn including ignition procedures, location of control crews, location of firelines, etc. Have a contingency plan for control if the fire should escape. Discuss this with the volunteer fire chief in advance of the burn.

Burn Prescriptions

Generally, the prescription for a successful burn is: wind speeds of 5-15 mph, steady wind direction, air temperature 40-80° F., relative humidity (RH) 25-65% and uniform fuel continuity of 1500 pounds per acre or more. The drier the fuel (lower RH), the higher the air temperature, wind speed and fuel quantity; generally, the hotter the fire and faster the rate of spread.

Wright (1980) believes broadcast burning should not be attempted when fine fuels are less than 1000 pounds per acre; even though the fire may carry with less fuel, management objectives are seldom met. Using a fixed headfire wind direction, Wright (1980) recommends on shortgrass prairie, burning out between double firelines (100 feet wide) when relative humidity is 30 to 50 percent, air temperature is 60 to 70 degrees F. and wind speed is less than 5-10 miles per hour (Figure 5). Ignite the headfire when relative humidity is 25 to 40 percent, air temperature is 70 to 80 degrees F. and windspeed is 7 to 15 miles per hour (Figure 5).

Fireplan for Shortgrass Prairie

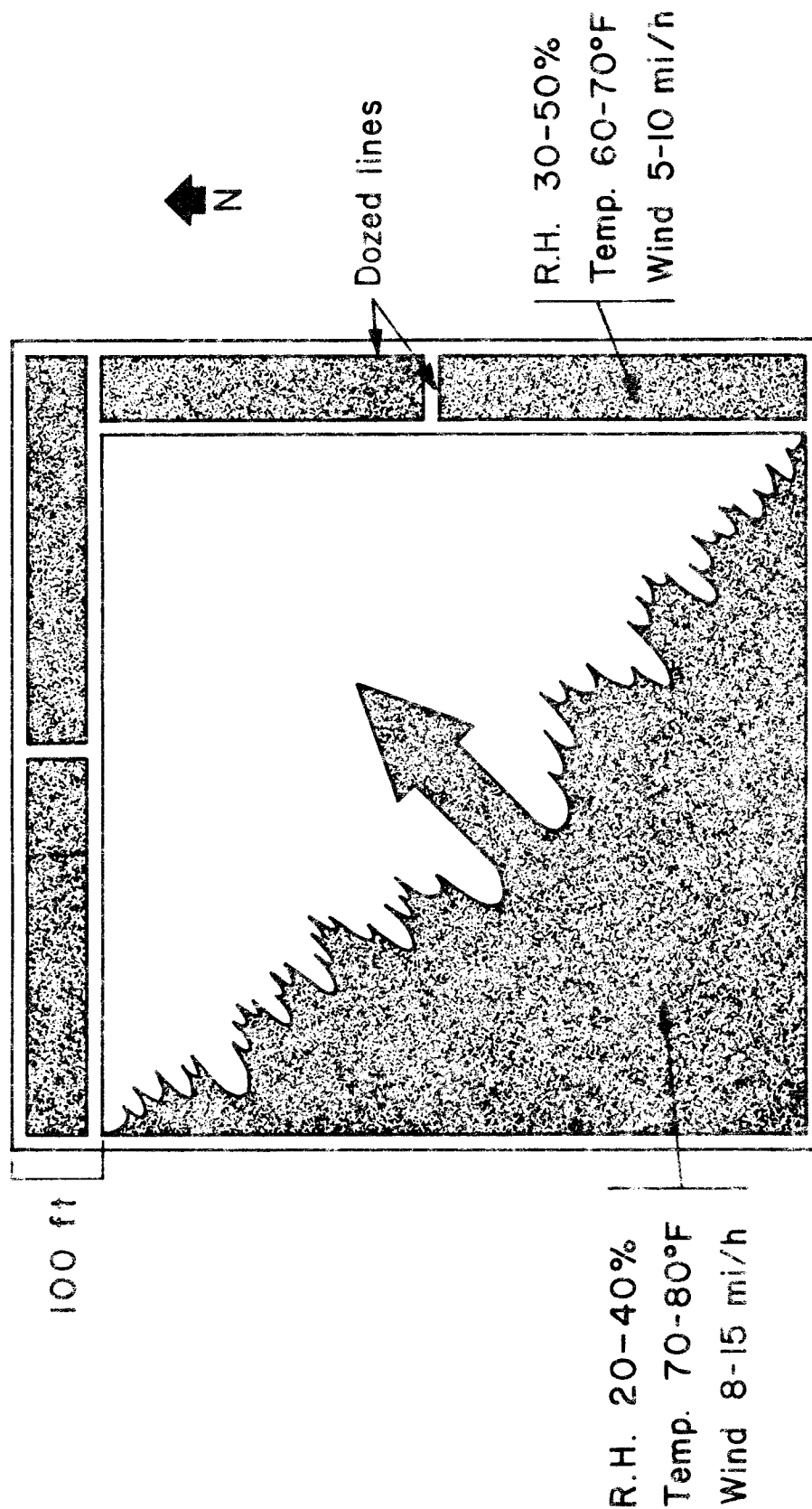


Figure 5. To burn fuels in shortgrass prairie, doze a 10 ft line around the entire area to be burned and around the area that you plan to burnout for a fireline as shown in the figure. Strip-headfire the fireline when relative humidity is 30 to 50 percent and wind speed is less than 10 mi/h. Headfire the remainder of the pasture when relative humidity is 20 to 40 percent, air temperature is 70° to 80° F and wind speed is 8 to 15 mi/h. (Wright 1980)

Since cedar (juniper) is a volatile fuel especially following chaining or dozing, special care must be undertaken to prevent embers spotting across the firelines. Wright (1980) recommends burning out cedar piles within 500 feet of the burn perimeter during the growing season when surrounding grass is not flammable (Figure 6). This same practice could be used for any brush pile or concentration of dead fuel that will pose a threat to containment. The hot fires under piles will destroy existing grasses, especially if burned during the growing season. Hand seeding in the ash may be a valuable practice for more rapid recovery. Observations in the Edwards Plateau indicate that carefully burning the piles in the winter allows more grass and forbs to survive.

The use of backfiring from a dozed or fire retardant fireline followed by headfiring has been successfully used in South Texas mixed brush, coastal prairie, buffelgrass (*Cenchrus ciliaris*) and Kleingrass (*Panicum coloratum*) pastures, oak-cedar areas of the Edwards Plateau, East Africa, southeastern U. S. ranges including marshes, and tallgrass prairie (Figure 7). The backfire plus strip firing 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 direction. Also, adjustments in firing can compensate for shifts in wind direction with the latter technique.

Fire Containment Practices

As already mentioned, prescribed fires require preparations to contain the fire to the specified area. Usually firelines are constructed using mechanical equipment to expose the mineral soil or use of fire retardant compounds or water (wetline) that rob the fire of fuel thereby stopping its spread. Gaylor (1974) concludes that "as far as man's ability to control fire is concerned, lessening or elimination of fuel is his most important tool." Certainly prescribed fires have an advantage because the time of the burn can be selected and "barriers" created to contain the fire. In preparing dozed firelanes, never turn soil over fuel inside firelines since this is a prime source of "hold-over" fires that smoulder and create sparks for hours. Always plow firelines away from the area to be burned. Fires have broken out from sparks that blew from dozed piles of soil and woody material 3 to 4 weeks after completing a burn.

Invariably ranchers ask how wide a fireline should be. The question seems simple, but the firing techniques, weather conditions, and fuel characteristics plus topographic features will alter the recommendations. Firelines can vary from a one foot wide line plus backfiring to a 500 foot burned out fireline in high volatile fuels.

Generally, the procedure of firing must be adapted to the kind of firelines and natural barriers available. A 1 or 2 foot fire retardant chemical line can be used if care is taken to backfire precisely along the chemical line and not promote flame height within proximity

Fire Plan for Dozed Juniper

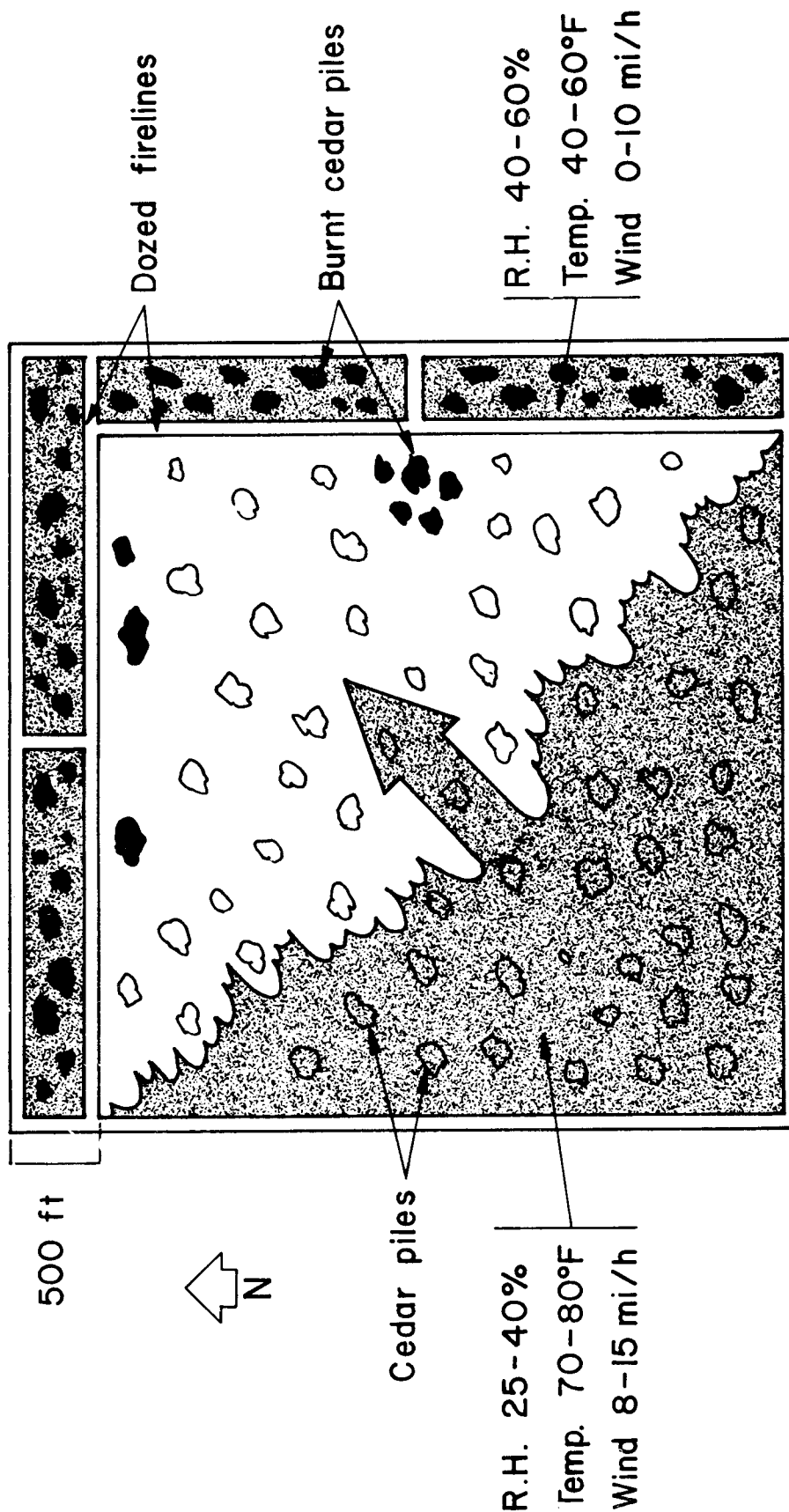


Figure 6. When the grass is green, juniper piles in the 500 ft strip (black splotches) on the downwind sides (north and east) are burned with wind velocities less than 10 mi/h and relative humidity above 45 percent. Eight months later (when grass is dormant), the grass in the 500 ft strip is burned (strip-headfire techniques) when the wind speed is less than 10 mi/h and relative humidity is between 40 and 60 percent. Lower relative humidities may be used if the grass fuel is less than 2,000 lb/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 mi/h and a relative humidity of 25 to 40 percent. (Wright 1980)

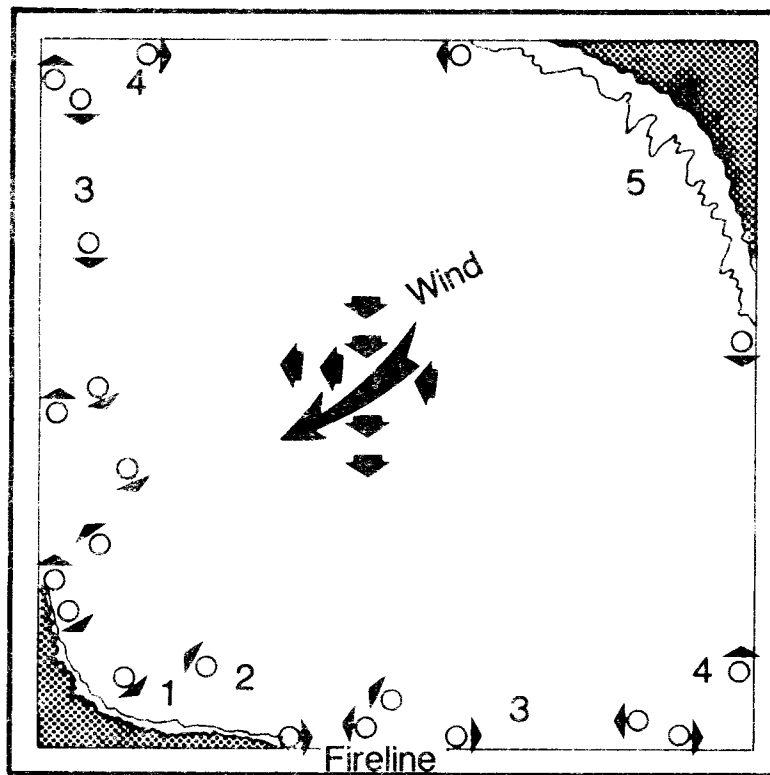


Figure 7. Using combinations of firing techniques to widen the firelines and contain a headfire under variable wind directions. Natural firebreaks, including roads, trails, and fenceline cowpaths, should be used to the extent possible. The backfire plus narrow strip fires (1) are used to widen the burnout of downwind sides. Increasingly wider strip fires are used to increase fireline width within the burned out back-fired lines (2 and 3). A flank-headfire is used to slowly widen burn out of corners (4). The headfire is set using two torches to the burned out corners (5). (White 1981)

of unburned or untreated fuels. Thus, fire is used under carefully controlled conditions to widen and create a sufficient fireline. The amount of retardant and width of fuel treated requires experience.

Generally, fire is one of the best control tools used to contain a fire; however, the ability to quickly set fire must be available. Drip torches (using a diesel:gasoline mixture) are necessary to set uniform fires without considerable resetting. Burning tires, pear burners, and matches are less reliable.

Erratically set fires result in stringers of fire proceeding at different rates drawing each other and creating erratic fire behavior. In addition, large acreage burns are difficult to ignite quickly with ground equipment, and a broadcast fire may not effectively burn large pastures due to differences in range sites and fuel quantities. A large

pasture should be divided into several smaller burns or a technique such as helicopter ignition used. Prescribed burns utilizing helicopters employ prescriptions and fireline construction similar to conventional methods. However, patchy fuels can be ignited more effectively, large flame fronts created, and larger acreages can be burned within a shorter period of time to take advantage of optimum weather conditions. The helicopter with special equipment can ignite a flame-front at one mile per minute; however, there is little time for adjusting the fire plan, therefore be sure! Also, the helicopter can quickly spot any escapes and direct control crews. Communication between the helicopter and fire boss and crews are important.

Executing the burn

The day of the burn can be considered judgment day. First priority is to review the proposed burn and check the local weather forecasts. The National Weather Service can provide an estimate of conditions during and following the burn. Utilize them! The fire boss must make the judgment whether to burn and follow through with constant reevaluation on fire behavior, ignition, control, etc. 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 by the fire boss each moment prior to and during the burn. The fire boss utilizes the weather, terrain, fuels and fire behavior with limited manpower input to accomplish the job. When these conditions are right, the job is easier. A fire weather kit used to monitor local conditions before and during the fire provides needed information for making proper decisions and improving future burns. Make final notification to volunteer fire departments, sheriff's departments, etc. before beginning the burn. This can not be overemphasized; work with the fire department--you may need their help.

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

The fire boss and ignition crews must be constantly aware of fire behavior. The potential of escape is greatest during initial ignition if proper planning and evaluation have not been conducted and current factors not fully appreciated. Any changes in wind direction, velocity, fuel flammability, and relative humidity must be adjusted for immediately.

The torch man igniting the fire must be careful never to allow a heat buildup that can escape. Flame heights become dangerous when they are reaching more than half the width of the treated line. Using fire to draw fire from the line can allow more intense fires and faster ignition.

Fireline widths and area burned out prior to setting the headfire will vary at different locations around a proposed burn area because of concentrations of fuel, topography effects on wind patterns, adjacent fuel concentrations and neighbor concerns, etc. The back and strip fire behavior will provide necessary observations to judge the width of "fireline" for containing the headfire. Because of firebrand problems and potential hot spots, control crews should be strategically placed. The boundary of the fire should be patrolled to quickly locate any spot fires that develop.

Two-way communication between the fire boss, weather monitor, ignition crews, and control crews must be maintained. Accurate and rapid communication allows proper decisions to be made and provides information to confirm what is happening.

A sprayer should be readily available for controlling small fires. Other equipment such as dozer, chain saws, etc. will depend on conditions. Local authorities should be informed of the burn with fire departments on alert. Also, adjoining ranchers should be informed of the entire plan including your backup plans for controlling fire if it escapes. Often they will volunteer to assist. Everyone on the fire should receive training. Only the fire boss should direct the actions on the burn. Too many bosses result in confusion and creation of a wildfire.

Wright (1980) concludes that "with the proper weather, a crew of 6 to 10 people, 2 pickups, 1 pumper, 1 dozer (or extra pumper), 2 weather kits, 5 drip torches, an adequate quantity of diesel-gas fuel (4 to 1 mixture), and 4 FM radios, burns in most fuel types can be conducted safely." With an experienced crew many burns are being conducted with less equipment on hand; however, backup control units such as volunteer fire departments are on alert.

Summary

Prescribed burning is a viable range improvement practice on many ranches in Central Texas. When coupled with other practices, fire can be used effectively to maintain grass production with reduced competition from brush and weeds. Many ranchers will not be able to use fire as a viable tool until they achieve better range conditions. Good grazing management programs go hand in hand with prescribed burning since both require production of grass for maximum benefits.

When a rancher decides to utilize prescribed burning; planning, training, experience, patience and assistance are a necessity. A series of small simple burns should be used to develop experience by the rancher and burning crews. The rancher must become a weather watcher and fore-caster extrapolating weather reports to actual ranch conditions. Each burn will add knowledge and skill; the success of a burn program will be the rancher's interest and ability to combine the local experience with known principles, etc. and adapt techniques and application to best meet objectives.

The basic principles affecting fire behavior are employed by the rancher in developing a realistic fire plan, prescription, and conducting the fire on any given day. The fire plan identifies the overall objectives for the ranch as well as for each pasture and range site. In addition, a single burn is usually only a part of a burn program encompassing several pastures. Burns should be sequenced to add safety and allow hotter fires where needed. If a frequent burn schedule is needed, grouping of adjacent pastures would have a specific plan identifying the best wind direction and conditions to burn primary range sites. Since each range site will burn differently, several burns within a pasture may be needed for near complete coverage. Some range sites may require prior treatment in order to effectively conduct a broadcast burn. In reality, seldom can entire pastures be burned with one fire if several range sites are encompassed. Ideally, entire management units should be burned to avoid overconcentration of livestock and wildlife. Stocking rate should be based on actual acreage burned and adjusted to recovery rate rather than pasture size.

Burning when the brush regrowth is young and when fine fuel loads are near maximum can more effectively maintain high production ranges. Heavy brush stands will require 2 to 3 burns before most rancher objectives are realized. The area selected for burning should be the better producing sites, hence the net return per dollar invested should be higher.

The techniques, prescriptions, etc. described in this paper should provide a basis for learning to use prescribed fire to advantage. Local experience should be considered when adapting prescriptions and plans. Safety should be emphasized but hinges on the conditions and manner in which fire is applied. Avoid overoptimism; this is dangerous in setting fire as well as expecting too much immediate improvement. Use fire where benefits can realistically be achieved and integrated with the ranch operation. Be prepared to take advantage of high forage production years using excess forage as fuel for a burn. Careful grazing management with deferment allowing grass recovery will increase short and long term benefits. Ranchers unwilling to properly graze and adequately prepare themselves and personnel for using fire should abstain and rely on other range improvement techniques.

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PLANNING A PRESCRIBED BURN

R. Q. Jake Landers, Jr.

For a rancher thinking about burning for the first time, the whole process of planning may seem largely unnecessary. The rancher may be thinking: "I'll wait until frost and burn out the southwest 40 acres of the Section Pasture. If I burn when there's no wind, I won't need any help. I can drive the cows to the other side of the pasture and shoot a few times to scare out the deer so they won't burn up. And the belly-high broomweeds should burn hot enough to kill the old mesquite, whitebrush, and prickly pear." This rancher needs help! There are at least eight misconceptions in his thinking about prescribed burning. They deal with proper timing, size of burn, wind, help, fuel, expected kill, grazing management and wildlife impact. If this rancher went ahead with burning, it is doubtful he would ever burn rangeland again on purpose.

Effective planning is absolutely necessary to achieve beneficial effects with prescribed burning. Checklists have been developed by the Soil Conservation Service that are used in working with individual ranchers on burning plans. These cover everything. Included is a briefer checklist that is slightly modified from one used in a previous fire symposium (Hamilton 1980). With the ninth or tenth burn some of the items on the check list become almost automatic; however, it is a good idea to plan each burn through as if it were the first.

Prescribed burning in Central Texas usually is scheduled for January, February and March, with the exact timing dependent on weather, ranch operations, and the purpose of the burn. Because burning is most effectively used in conjunction with other management techniques such as chaining, bulldozing, spraying, goating, etc., it is wise to plan ahead for such a combination effect. About six years ahead, in fact, gives adequate lead time for chained mesquite and prickly pear to be a high priority for burning. For example, the 1100-acre West Cochrin Pasture on the Gibson Ranch, Coleman County, was burned by Dr. Darrell Ueckert and crew on February 4, 1980. It is an excellent example of combining mechanical and chemical treatments with burning. Most of the downed wood from chaining 5 years previously was consumed. Mesquite sprouts and other brush were top-killed, and prickly pear was reduced by 80% or more. In addition, a considerable jump in grass productivity occurred following the burn. Actually this pasture was scheduled for burning two years earlier but postponed because of inadequate fuel.

PLANNING FOR ADEQUATE FUEL

One of the most difficult things for a rancher to accept is that it takes a lot of dry grass for an effective burn. We have grown up believing dry grass on the ground is better than hay in the barn. To

see grass go up in flames in the middle of winter is hard to take. However, no other vegetation in Central Texas works as well as grass does as a source of fuel. Broomweeds flare and go out without an understory of grass to maintain a continuous flame. Other forbs may look rank and dense enough to burn, but by mid-winter they usually have decomposed. Woody debris and standing dead stems are no help in spreading the fire. The first objective in planning is to make the necessary management arrangements to have adequate grass fuel at the right time. On ranges in good condition a deferment the last half of the growing season in an average year may be adequate. On fair and poor condition ranges, especially on low stony hill sites, a deferment of several years may not be adequate to supply enough fuel. About 3,000 pounds per acre of grass fuel is desirable for prescribed burning, but for some situations half that amount will result in satisfactory results. Some approximate values for different kinds of grass cover in mid-winter are shown below. Except for the first two, the values were measured on sites ungrazed during an average growing season.

	<u>Lbs./Acre</u>
Closely grazed buffalo grass	300
Curly mesquite and buffalo, mowed lawn	650
Buffalo grass	1,000
Texas wintergrass	2,000
Sand dropseed	2,200
Tobosa	2,300
Kleingrass	5,000
Little bluestem	6,200
Johnson grass	7,000

Deferment to retain enough fuel for effective burning is almost always necessary. Almost as important as the quantity of fuel is the coverage. Quite often on tobosa dominated range sites, for example, there is adequate tobosa grass to burn effectively, but buffalo grass and other species in between the tobosa patches have been grazed out. The fire doesn't carry well. It is a problem that should be avoided. By November you can determine whether there is adequate fuel on the ground to continue further planning.

PLANNING FOR CONTROLS

The second objective in planning is to arrange for appropriate controls. For physical control of the fire, pumpers and other equipment need to be in working order, firelanes cut, access roads checked out, fire retardant chemicals arranged for and communication equipment lined up. Although there is considerable flexibility in timing these arrangements, it is important not to wait until the last minute. Firelane construction should be delayed until after frost and until you are fairly certain that a burn will be carried out. For some financial controls it is wise to upgrade the liability coverage of your insurance.

The landowner carries the burden of liability for damages resulting from a prescribed burn. Damage may occur to fences, utility poles, buildings, feeders, hunter's blinds, vehicles, livestock, etc., if the fire goes beyond the intended boundaries. Smoke crossing public highways may obscure the vision of passing motorists and contribute to serious accidents. Because there have been so few test cases, there are very few decisions in the courts to guide the landowner in what "A reasonably prudent ordinary person would do in the situation." The landowner could be the object of a lawsuit if a neighbor can show a justifiable amount of damage or a motorist can show damage as the result of the fire and smoke. Also, it has been suggested that the cost of stopping an escaped fire should be assumed by the landowner.

One way to reduce the risk of escape is to enlist all the neighbors as part of the fire crew. Neighbors need to be informed at an early stage of your planning so that they can choose whether or not to be involved in the burn.

One of the best arrangements for prescribed burning occurred during the burning season of 1982 in Schleicher County. Six ranchers worked out plans to burn through Soil Conservation District personnel Fred Stumberg and John Wimberly. County Agricultural Agent Jerry Swift arranged a workshop before the burns were scheduled. The workshop was held, but the weather was too wet and cold for any burning experience. On the day of the first burn, ranchers assembled on Rick Hodnett's Ranch and with me in charge gained experience as the day progressed. The second day the burn was on the Lux Ranch. The third day the burn was on the Ballew Ranch and the last day it was on the Ballew-McCormick and Tom Enochs Ranches. Much experience was gained in prescribed burning, the ranchers helped each other, and seemed to enjoy the feeling of successfully accomplishing a difficult and controversial treatment.

Prior to burning on your own place, it would be wise to participate in conferences and workshops on prescribed burning. It would be desirable to assist in prescribed burns with someone else in charge before trying one on your own place. You should examine results of burning on range sites similar to your own to get some idea of what results to expect from a burn. Because each burn is different, as are growing seasons following a burn, results can be very different from year to year on the same range site even with similar fuel conditions. The more information you have, the more realistic you can be in anticipating results from your own burn.

COMMUNICATIONS

The third objective in planning is to notify local authorities of your intentions and to arrange for communications during the day of the burn. Every county is a little bit different in how emergency

calls are handled. In Irion County, for example, all calls go through the Irion County Sheriff's office, and if a range fire is reported, the volunteer fire department is called into action. A rancher should notify the Sheriff of plans for a prescribed burn. On the day of the burn inform the Sheriff who will call in if an emergency arises. Otherwise, someone might see the smoke and call in a false alarm.

In Tom Green County, fire emergency calls go to the San Angelo Fire Department Dispatcher who calls units into action within the county, both regular and voluntary units, depending on the location of the burn. The Tom Green County Sheriff's office is closely linked with the fire department dispatcher. Even so they prefer both offices be contacted ahead of time for a prescribed burn.

The Department of Public Safety (highway patrol) should be called when a prescribed burn is scheduled next to a highway or close enough that smoke could be expected to be easily visible (about one mile). Occasionally caution flags or signs will be provided. But the rancher is responsible for providing personnel to flag traffic if this is deemed necessary. It is not always possible to burn effectively next to a highway when the wind is in the right direction to carry smoke away from the highway. A potential traffic fatality or serious injury associated with smoke from a prescribed burn is a risk that should be taken quite seriously.

BURNING

The fourth objective in planning is to be ready for the burn itself. Weather changes which alter plans cannot be forecast with much accuracy more than two days in advance. National Weather Service information the day before and the day of the scheduled burn can give you reasonably good estimates of wind direction and velocity, temperatures, pressure and relative humidity. Instruments to measure wind, temperature and relative humidity should be used to monitor local conditions and to see how they compare with the forecast. With crew members in place, equipment ready, fireguards checked out, and local authorities contacted you are almost ready to strike the first match. Have you gone through the checklist and covered such things as drinking water for the crew (carbonated drinks and beer are best used when it's over), water or fire retardant in the pumpers, gasoline for the pumpers, diesel fuel and gas for the drip torches, lunch for the crew (a cooler with sandwich makings is handy), first aid kit, keys or combinations for locked gates, contingency plans for an escape, water locations for refilling pumpers, and cameras to record the historic event?

Burning procedure would have been spelled out in the fire plan. Changes and more specific procedure should be explained to the crew. By this time many individuals may have contributed to the fire plan, but it is the fire boss who is finally responsible for carrying it through to a successful burn. The fire boss must be confident enough to assert authority over the crew and guide the operation, and experience helps.

FOLLOW-UP

The final objective in planning is to arrange for follow-up management. Grazing animals removed from a pasture to allow grass accumulation for fuel will need a place to go for 60 to 90 days after the burn. High quality forage can be expected in an average rainfall year following a burn. Livestock and wildlife quickly recognize this. If a small area is burned in a large pasture or if deer from a large area are attracted to a burn, recovery of desirable grasses, forbs and browse can be slowed considerably. On the other hand, if prickly pear is abundant in the burned pasture, cattle may be turned in immediately after the burn for two or three weeks to consume some of the singed pads. Charles Gifford, managing the Llano County School Lands near San Angelo used prickly pear on recently burned pastures to carry 300 cows through the 1981-82 winter without any other supplemental feed. In past winters some prickly pear had regularly been burned with butane rigs for these cattle thus they readily ate the burned prickly pear. Goats could be turned in temporarily when prickly pear pads are resprouting to obtain additional control. Ordinarily, grazing should be restricted until May or June. At this time full recovery of the better grasses should be expected.

If I have been successful in my story on planning a prescribed burn, the rancher thinking about burning for the first time might say: "I'll plan to burn the Creek Pasture this winter when weather conditions are right and get some control on the prickly pear and mesquite sprouts from that dozing job I had 5 years ago. To grow some grass I can put the cows in the Section Pasture until next summer and spray the broomweed if it comes on strong like it did this year. I'll get some help from the neighbors with the burn since I've helped them on fence building and shearing, and the County Agent wants to use this as a county demonstration on prescribed burning." This rancher is heading in the right direction.

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OTHER INFORMATION

An earlier symposium was held November 7, 1979 at Carrizo Springs, Texas entitled Prescribed Range Burning in the Rio Grande Plains of Texas. Also one was held October 23, 1980 at Junction, Texas entitled Prescribed Range Burning in the Edwards Plateau of Texas. Both were edited by Larry D. White. They are available through the Texas Agricultural Extension Service.

RANCH CHECKLIST FOR PRESCRIBED BURNING

This checklist is intended to enumerate areas of concern common to most burns, so that they will not be inadvertently overlooked. It is strongly suggested that the checklist be amended to fit each situation.

I. Preburn Considerations

A. Rationale for the burn (1 to 5 years preburn)

- _____ 1. Purpose (brush management, rough removal, etc.)
- _____ 2. Place (target pastures identified)
- _____ 3. Timing (cool or warm season, tentative date)
- _____ 4. How to burn (preliminary fire plan including firelane design)
- _____ 5. Preburn pasture treatments needed and timing (mechanical, chemical, deferment)
- _____ 6. Legal aspects (ranch liabilities)
- _____ 7. Training and experience (workshops and actual burns)

B. Planning for the burn (6 months to 1 year preburn)

- _____ 1. Determination and location of alternative forage needs for livestock
- _____ 2. Setting of required dates for preburn removal of grazing animals based on fuel load requirements
- _____ 3. Consideration of vulnerability (erosion, wildlife)
- _____ 4. Final fire plan preparation
- _____ 5. Budgeting costs of burn

C. Equipment arrangements (3 to 6 months preburn)

- _____ 1. Contracted equipment (bulldozer, motorgrader)
- _____ 2. Locally available (pumper truck)
- _____ 3. Communications (CB radios)
- _____ 4. Ranch owned (cattle sprayer, water trailer, water barrels)
- _____ 5. Dates firm for equipment work to be completed

D. Personnel (1 to 3 months preburn)

- _____ 1. Fire boss designated and authorization provided
- _____ 2. Assignment of ranch personnel, time provisions and training if necessary
- _____ 3. Considerations for other people needed

E. Notification (2 to 4 weeks preburn)	Telephone <u>Numbers</u>
_____ 1. Texas Air Quality Board (usually not required)	_____
_____ 2. Neighbors _____	_____
_____ 3. Sheriff's Office	_____
_____ 4. Fire Departments	_____
_____ 5. Department of Public Safety (Highway Patrol)	_____
_____ 6. County Commissioner	_____
_____ 7. Oil and gas lessees	_____
_____ 8. Hunters	_____

F. Preburn construction and patrols (1 week to 1 month preburn)

_____ 1. Construction of firelanes according to fire plan

_____ 2. Removal of remnant livestock

_____ 3. Facilities protection

_____ a. feeders

_____ b. pens

_____ c. highline poles

_____ d. oil and gas structures

_____ e. fences

_____ f. hunting facilities

_____ g. inspection of completed firelanes (if constructed more than 30 days preburn)

G. Weather information and final inspection (week of burn)	Telephone <u>Numbers</u>
_____ 1. 3 day forecast - National Weather Service	_____
_____ 2. 24 hour forecast - Local Weather	_____
_____ 3. Final inspection (firelanes, facilities protection, etc.)	_____

II Just before the burn

A. Last minute calls	Telephone <u>Numbers</u>
_____ 1. National Weather Service	_____
_____ 2. Sheriff	_____
_____ 3. Fire department	_____
_____ 4. Highway patrol	_____
_____ 5. Check with spouse	_____

B. Equipment and supplies

- _____ 1. Diesel fuel and gas for drip torch
- _____ 2. Gas for pumpers
- _____ 3. Fire retardant or water in pumpers
- _____ 4. Hand tools (garden rakes, ax, shovel, wire cutters)
- _____ 5. Matches
- _____ 6. Keys and combinations for locked gates
- _____ 7. Camera
- _____ 8. Weather instruments (wind, relative humidity, recording pad, pencil)
- _____ 9. CB radios

C. Crew support

- _____ 1. Drinking water and cups
- _____ 2. Lunch cooler
- _____ 3. First aid kit

III. After the burn

A. Postburn patrols of burned areas (immediately postburn)

- _____ 1. Fire-brands, hollow logs and trees near edge of burn
- _____ 2. Poles and posts
- _____ 3. Smoldering piles
- _____ 4. Livestock access, prickly pear cleanup
- _____ 5. Observations on effectiveness of burn

B. Grazing control (To 1 year or longer postburn)

- _____ 1. Deferment period provided
- _____ 2. Observations of vegetation changes
- _____ 3. Decision to restock pastures, stocking rate, grazing period

ENVIRONMENTAL CONSIDERATIONS AND REGULATIONS
ASSOCIATED WITH RANGE BURNING

Gary I. Wallin

In 1975 the Texas Air Control Board's regulations were changed allowing outdoor burning for specified purposes when certain conditions are met. Prior to this time the regulations did not contain any rules allowing outdoor burning for crop or range management purposes. Before changing the regulation, the Board held several meetings, a public hearing, received many written comments concerning outdoor burning and studied other state's regulations.

As you know, the burning of vegetable matter does produce air contaminants. Through research, emission rate factors have been developed for different types of burning operations. The copy of this paper in your symposium proceedings includes a table of emission factors for open burning of agricultural materials developed by the Environmental Protection Agency. This table gives emission factors for different types of crops and grasses. The factors given for grasses is probably representative of range burning emissions. The major contaminants are particulate matter, carbon monoxide and hydrocarbons. The general public's primary concern with outdoor burning is visible degradation.

Even though emissions from outdoor burning of vegetable matter for forest, range and crop management purposes can put large amounts of contaminants into the atmosphere, the Board decided to allow this outdoor burning when there is no practical alternative to burning and when the burning will not cause or contribute to a violation of any Federal primary or secondary ambient air standard.

The portion of Regulation I pertaining to this type of outdoor burning reads:

Outdoor burning is authorized in each of the following instances:

Outdoor burning in a rural area of trees, brush, grass and other dry vegetable matter at the site where it occurs and only when no practical alternative to burning exists for right-of-way maintenance, land-clearing operations, and for those forest, crop, and range management purposes not specifically governed by orders issued pursuant to paragraph (1) of Regulation I if all the following conditions are met:

- (1) Any burning conducted for salt marsh grass management purposes in the following counties may be conducted only after verbal or written notification to the Texas Air Control Board Regional Office having jurisdiction: Orange, Jefferson, Chambers, Galveston, Harris, Brazoria, Matagorda, Jackson, Calhoun, Aransas, Refugio, San Patricio, Nueces and Kleberg. Burning of salt marsh grass in these counties shall

not be conducted during periods of actual or predicted persistent (12 hours or more) low-level atmospheric temperature inversions (non-surface based) or in areas covered by a current National Weather Service (NWS) Air Stagnation Advisory. This meteorological data will be available from the Texas Air Control Board Regional Office having jurisdiction.

(2) Prior to prescribed or controlled burning for forest management purposes, the Texas Forest Service shall be notified.

(3) The burning must be outside the corporate limits of a city or town except when it is necessary to eliminate a naturally occurring fire hazard.

(4) Burning shall be commenced only when the wind direction is such as to carry smoke and other pollutants away from any city, town, residential, recreational, commercial or industrial area, navigable water, public road or landing strip which may be affected by the smoke. Burning shall not be conducted when a significant shift in wind direction is predicted which could produce adverse effects to persons, animals, or property during the burning period. If at any time the burning causes or may tend to cause smoke to blow onto or across a road or highway, it is the responsibility of the person initiating the burning to post flag-persons on affected roads in accordance with the requirements of the Department of Public Safety.

(5) The burning must be at least three-hundred feet (ninety meters) from any residential, recreational, commercial or industrial area except those located on the property where the burning is to take place, except when it is necessary to eliminate a naturally occurring fire hazard.

(6) Heavy oils, asphaltic materials, items containing natural or synthetic rubber or any material other than dry plant growth which may produce unreasonable amounts of smoke must not be burned.

(7) The hours for burning shall comply with the following:

(A) The initiation of burning for land-clearing and right-of-way maintenance purposes shall commence after 9:00 a.m. Material which will not be completely consumed before 5:00 p.m. shall not be added to the fire.

(B) The initiation of burning for crop and range management purposes shall commence after 9:00 a.m. The acreage to be burned should be adjusted to provide that the burning is completed by 5:00 p.m. on the same day or as soon as is reasonably practical.

(8) Burning shall not be commenced when surface wind speed is predicted to be less than 6 mph (5 knots) or greater than 23 mph (20 knots) during the burn period.

As you can see, the burning of salt marsh grass in specified coastal counties gets special treatment in the regulation. The reasons for this rule are due to the past problems we have encountered with this type of burning. Numerous accidents have been caused by smoke blowing across highways and severe visible degradation created when burns were conducted during atmospheric inversions. The worst problems have occurred in the more populated counties. Please contact our nearest regional office prior to burning any salt marsh grass. A list of our regional offices with addresses and phone numbers is included with this paper. Our regional office will be able to advise you about any air stagnation advisories.

With any burning always watch the weather. The wind direction, wind speed, time of day, and humidity play a big part in minimizing the effects of your emissions. Always think of your neighbors and try to burn under the conditions that will least likely bother them. For those with close neighbors, you may want to notify them prior to burning.

There are numerous burning procedures that tend to improve the effectiveness of your burns as well as keep your emissions to a minimum such as burning when your combustible material is dry, when the wind speed is not too high or too low and burning against the wind. The table of emission factors for open burning of agricultural materials which I referred to earlier contains factors for headfire burning and for backfire burning of several crops. These factors indicate backfiring will substantially reduce the quantity of particulate matter produced but will slightly increase emissions of carbon monoxide and organics. An effective burn and low emissions complement each other.

So in summary, the Board has recognized the need for outdoor burning for range, crop and forest management purposes. However, we do require that certain precautions are taken to minimize the effects of these burns. If everyone does their best to comply the right to practice outdoor burning will continue to be allowed by the Board.

Emission Factors and fuel loading factors for open burning of agricultural materials

Emission Factor Rating: B

Refuse Category	Emission factors						Fuel loading factors	
	Particulate		Carbon monoxide		Organics (as C ₆ H ₁₄)		(waste production)	
	lb/ton	kg/MT	lb/ton	kg/MT	lb/ton	kg/MT	ton/acre	MT/hectare
Field crops								
Unspecified	21	11	117	58	23	12	2.0	4.5
Grasses	16	8	101	50	19	10		
Headfire burning								
Alfalfa	45	23	106	53	36	18	0.8	1.8
Bean (red)	43	22	186	93	46	23	2.5	5.6
Hay (wild)	32	16	139	70	22	11	1.0	2.2
Oats	44	22	137	68	33	16	1.6	3.6
Pea	31	16	147	74	38	19	2.5	5.6
Wheat	22	11	128	64	17	9	1.9	4.3
Backfire burning								
Alfalfa	29	14	119	60	37	18	0.8	1.8
Bean (red), pea	14	7	148	72	25	12	2.5	5.6
Hay (wild)	17	8	150	75	17	8	1.0	2.2
Oats	21	11	136	68	18	9	1.6	3.6
Wheat	13	6	108	54	11	6	1.9	4.3
Vine crops	5	3	51	26	7	4	2.5	5.6
Weeds								
Unspecified	15	8	85	42	12	6	3.2	7.2
Russian thistle (tumbleweed)	22	11	309	154	2	1	0.1	0.2
Tules (wild reeds)	5	3	34	17	27	14		

(Adapted from Lahre, T. and P. Canova. 1978)

A map of Texas divided into 11 numbered regions. The regions are: 1 (Central, including counties like Borden, Comanche, and Stephens), 2 (North Central, including Hale, Floyd, and Motley), 3 (Central, including Mills, Coryell, and Hamilton), 4 (South Central, including Zapata, Jim Hogg, and Brooks), 5 (South Central, including Live Oak, Bee, and Refugio), 6 (West Central, including Loving, Whittier, and Ector), 7 (East Central, including Harris, Brazoria, and Galveston), 8 (North Central, including Tarrant, Dallas, and Kaufman), 9 (South Central, including Uvalde, Burnet, and Kerr), 10 (East Central, including Polk, Tarrant, and Dallas), and 11 (West Central, including Jeff Davis, Presidio, and Brewster).

TEXAS AIR CONTROL BOARD

REGIONAL OFFICES

EFFECTIVE SEPTEMBER 3, 1982

REGION 1

Commerce Plaza Office Building
1290 South Willis, Suite 205
Abilene, Texas 79605
(915) 698-9674 TX-AN 840-1160
John Haagensen, Acting Supervisor
Contact at REGION 6 Office

REGION 2

Gerald Hudson, P.E., Supervisor
Briercroft South #1
5302 South Avenue Q
Lubbock, Texas 79412
(806) 744-0090 TX-AN 862-0053
744-6055

REGION 3

Eugene Fulton, Supervisor
West Loop Plaza
900 North State Hwy. 6, Suite E
Waco, Texas 76710
(817) 772-9240 TX-AN 826-7293
772-9241

REGION 4

Robert Guzman, Supervisor
Matz Building, Room 204
513 East Jackson
Harlingen, Texas 78550
(512) 425-6010 TX-AN 827-3290

REGION 5

Tom Palmer, P.E., Supervisor
5602 Old Brownsville Road
Corpus Christi, Texas 78415
(512) 289-1696 TX-AN 827-6313
289-1697

REGION 6

John Haagensen, Acting Supervisor
1901 East 37th Street, Suite 101
Odessa, Texas 79762
(915) 367-3871 TX-AN 844-9305
367-3872
367-3873

REGION 7

Sabino Gomez, M.P.H., Supervisor
5555 West Loop, Suite 300
Bellaire, Texas 77401
(713) 666-4964 TX-AN 850-1330
850-1331

REGION 8

Melvin Lewis, Supervisor
6421 Camp Bowie Blvd., Suite 312
Fort Worth, Texas 76116
(817) 732-5531 TX-AN 832-6268
732-5532 832-6269

REGION 9

James Menke, Supervisor
4538 Centerview Dr., Suite 130
San Antonio, Texas 78228
(512) 734-7981 TX-AN 820-1220
734-7982

REGION 10

Michael Peters, Supervisor
4605-B Concord Road
Beaumont, Texas 77703
(713) 838-0397 TX-AN 856-9312
838-0398 856-9313

REGION 11

Manuel Aguirre, P.E., Supervisor
9615 Sims Drive
El Paso, Texas 79925
(915) 591-8128 TX-AN 846-8137
591-8129 846-8138

REGION 12

Richard Leard, P.E., Supervisor
1304 South Vine Avenue
Tyler, Texas 75701
(214) 595-2639 TX-AN 836-2295

EDUCATIONAL ASSISTANCE

Danny W. Long

Your attendance here today leads us to believe that most of you are familiar with that educational branch of the Texas A&M University System known as the Texas Agricultural Extension Service. Many of you have, in the past, been active in Extension programs such as training meetings, seminars, workshops, tours, and field days, and are therefore acquainted with the role of the Extension Service in educational endeavors. For those of you who may not be as aware of Extension's educational opportunities, please allow me to spend the next few minutes outlining the responsibilities of our organization with regard to education.

The basic function of the Texas Agricultural Extension Service is to aid in diffusing among the people of Texas useful and practical information on subjects relating to agriculture and home economics and to encourage the application of this information. The conduction of educational programs is based on specific problems which have been identified and assigned a high priority by the people who participate in both the planning and implementation of such educational programs. As a fundamental and unique part of the total public educational system of Texas, Extension educational programs are directed toward helping people help themselves in solving problems they encounter in their homes, communities, and occupations by the application of the latest scientific research findings.

Through the programs of the Texas Agricultural Extension Service, there is a two-way flow of information from the Texas A&M University System and the United States Department of Agriculture. In reverse, the needs and objectives of Texans are channeled back to Texas A&M where research and scientific studies are conducted in an effort to provide information related to these needs and objectives.

Extension education is a continuing process, and the work done by Extension staff members with the people of Texas can be grouped into four levels:

1. That work concerned with changes in practices which will make the labor of the people more efficient as based on research findings.
2. That work designed to help people develop decision making skills and to use scientific knowledge in the planning and utilization of available resources.
3. That work which helps individuals translate practice changes and decision making skills.

4. That work which is designed to involve the people themselves in the planning and coordination of educational programs of a particular need and interest.

I have said all this simply to say that the role of the Texas Agricultural Extension Service is that of education; the providing of background information, research data, and technical guidance. This, too, is the goal of Extension in Range Management, and in particular, prescribed burning as is related to today's program.

Range management, of which prescribed burning is but one management alternative, is one of numerous educational program areas addressed by Extension staff members on a continual basis. Our goal here today has been to provide initial information and instruction as related to the proper use of prescribed burning as a management tool. This symposium is but one of several educational alternatives. In addition to today's activities, the Texas Agricultural Extension Service is available to provide additional assistance to interested producers through group meetings, method demonstrations, result demonstrations and related mass media.

It is our hope that follow-up training will be scheduled and conducted in the very near future for those producers who feel that prescribed burning can serve as a management tool in their production systems. Based on producer requests, Extension staff members can provide assistance to producers who are interested in determining the feasibility of prescribed burning on their operations. Staff members can provide technical assistance in planning and conducting prescribed burns as method demonstrations to producer groups and then provide assistance in the evaluation of the results of such burns.

Producers in Mills County who have an interest in receiving additional training and instruction are encouraged to contact my office or indicate your interest to a member of the Mills County Crops and Livestock Committee. For those of you who have farming and ranching operations in other counties, we would encourage you to contact your local County Extension Agent concerning the possibility of participation in group meetings and training sessions. You are, of course, most welcome to join Mills County groups in any training which is scheduled and conducted on future occasions. If you will leave me your name and address, I will notify you of future activities to be conducted in our county.

TECHNICAL ASSISTANCE AVAILABLE FOR RANCHERS

Rhett H. Johnson

The Soil Conservation Service (SCS) recognizes that fire was an integral part of the ecosystem under which the rangelands of Texas developed. Much research has been accomplished in Texas concerning the use of fire to manipulate plant communities, improve forage quality, and improve wildlife habitat. Research has also been aimed at developing methods of applying prescribed burns to accomplish desired objectives and maintain the fire on the intended burn area.

Based on the above premise and the advancement of technology, the SCS in Texas has added prescribed burning to the list of alternatives to be provided to the rancher when giving him on-the-ground technical assistance.

We have provided training in prescribed burning to all of our personnel involved in planning and application assistance to ranchers. During the winter of 1981, we conducted 3-day training sessions in 15 of 23 areas, including 475 conservationists. In the winter of 1982, training was completed in all 23 areas, with refresher training in many of them.

The Soil Conservation Service policy on prescribed burning is as follows:

1. SCS will assist with prescribed burns on rangeland, pastureland, hayland, and wildlife land.
2. SCS will design prescribed burning management plans and assist with their implementation, but will not ignite fires. SCS will assist landowners to design prescribed burning management plans that are in accordance with SCS prescribed burning standards and specifications. Area conservationists will assign trained area plant scientists to review each prescribed burning management plan prior to application of the prescribed burn.

This assistance is consistent with other SCS assistance. We have always assisted in the design of practices and provided onsite assistance, but we do not fly the plane or drive the dozer to apply the practice.

3. SCS will conduct plot-size burns for training of field personnel in prescribed burning.

In order to learn how to design prescribed burns, we believe that our people must get their hands "hot." Experience is often the best teacher because of its lasting impression. We will continue to

conduct training sessions with our people in cooperation with ranchers, the Texas Agricultural Experiment Station, Texas Agricultural Extension Service, and university personnel active in prescribed burning research.

By the end of March 1982, SCS had assisted 294 ranchers to design prescribed burning plans on 98,425 acres, and we had assisted 206 of these to apply prescribed burns on 63,066 acres. We also had assisted 261 ranchers to design prescribed burns on 98,565 acres for application during 1983.

FINANCIAL ASSISTANCE

Allen W. Mills

The Mills County ASC Committee offers cost-share assistance for prescribed burning through the Agricultural Conservation Program. The program is available to farmers and ranchers who would not perform the practice without assistance.

The Texas State Committee makes the prescribed burning practice available to counties on an individual request basis.

Specifications contained in the Mills County ACP Handbook read as follows:

Control of Ashe Juniper, Eastern Red Cedar, Pricklypear and related Cacti by prescribed burning. This practice is applicable to rangeland and pastureland with brush that can be controlled by prescribed burning.

Cost-shares are limited to the construction of fire guards and labor necessary to perform the practice. (Costs for fire trucks and personnel, etc., are not eligible.)

Prescribed burning must be applied in accordance with a detailed plan that meets the appropriate practice standards and specifications in the local Soil Conservation Service Field Office Technical Guide.

FEDERAL COST-SHARES:

- a. Fire guards--60 percent of the actual cost, not to exceed an amount determined by the county committee.
- b. Labor--60 percent of the actual cost, not to exceed an amount determined by the county committee.

VOLUNTEER FIRE DEPARTMENTS

Robert H. Bloom

Proper "Prescribed Burning" requires two-way public relations, one by the landowners with the volunteer fire departments and the other by the volunteer fire departments with the landowners. This type of reciprocal relationship should provide for not only a safe but a successful prescribed burn.

Usually the basic objectives of a prescribed burn include improvement of forage for grazing, control of undesirable vegetation, and improvements of wildlife habitat. Two other objectives, often overlooked, are the reduction of hazardous fuels and training of area personnel - including volunteer fire department personnel.

Areas with a known wildfire history would be suitable for prescribed burning for hazard reduction purposes. These could be areas along railroad tracks, highways or remote rural roads that are persistent fire problem areas. These areas are usually familiar to the volunteer fire departments. They are usually problem areas for them and in many areas make up the majority of their fire calls. Working with the volunteer fire departments on these problem areas, by keeping these areas prescribed burned, could eliminate some of the undesirable and often damaging wildfires.

Prescribed burning, when properly planned and executed, can be a training mechanism not only for the landowner but also for the volunteer fire departments in the area. Where the V.F.D.'s can and will participate, it allows them an opportunity to practice fire control methods that can be used in containing and controlling wildfires. Some of the same firing techniques used for prescribed burning can also be used to contain wildfires - the main ones being strip head firing, spot firing, and flank firing.

The Texas Forest Service rural fire program makes some changes annually according to funding limits. These changes are made to improve the assistance to communities and increase the amount that can be made with the funds available.

Starting with the new state fiscal year, September 1, 1982, the following changes are being considered:

1. There will be no more truck units provided.
2. Fire fighting units to be provided will be of two (2) types:
 - a. Slip-on pumping units for 3/4 ton or 1 ton trucks provided by the V.F.D.'s.

- b. Small trailer unit complete with tank and pumping equipment.
 - c. The above will probably be on a 50-50 cost share basis to the local communities.
3. Other than fire units, a 2-way radio communications system is being considered. This will only be available to county-wide fire organizations composed of fire associations or fire districts involving all the fire organizations in the county. This would also be on a 50-50 cost share basis.

During 1982 we have also made some changes in our training program. Our entire program has been arranged around a contract trainer concept with eight contract trainers in various areas of the state. These men are available to offer training in wildland fire fighting techniques to the various V.F.D.'s. To supplement this we have also entered into an agreement with the Texas Chapter of the Society of Fire Service Instructors in a "Train the Trainer" program. We have completed two successful training sessions and have more planned. The initial classes involve Tactics and Fire Behavior for ground cover fires. When the training sessions are completed the trainees are provided with the lesson plan material and slide set to return to their departments and give them the training in the subject matter provided. The Texas Forest Service pays the expenses for the trainees involved.

WEATHER FORECASTS FOR PRESCRIBED BURNING

James A. Harman

There are three National Weather Service forecast centers in Texas. The Weather Service Forecast Offices are located at Fort Worth, San Antonio, and Lubbock. The Fort Worth office is the primary contact of the Texas Forest Service for which it prepares daily forest weather forecasts for East Texas. The Lubbock Forecast Office is the primary contact for the Texas Park Service in the Big Bend area of Texas. Normally, other groups in need of weather briefings for wild fires and prescribed burning should direct their requests to the Weather Service Forecast Office which has forecast responsibility for the area of operation. This division of area responsibility is shown on the attached map.

It may be of some interest to note that the San Antonio office issues the Coastal Marine Forecasts for Texas and that the Southwest Agricultural Weather Service Center at College Station issues a Texas Agricultural Weather Advisory daily each morning. Also, the Brownsville Weather Service Office has an Agricultural/Fruit Frost Program.

In addition to the forecast offices, there are Weather Service Offices at the following locations in Texas: Waco, Abilene, Austin, San Angelo, Wichita Falls, Beaumont, Galveston, Houston, Victoria, Corpus Christi, Brownsville, Del Rio, Midland, El Paso, and Amarillo. The Weather Service Offices prepare local forecasts for their city and distribute other forecasts and warnings.

The forecast products of main concern to the ranchers and for prescribed burning include:

- State Forecast. A general public forecast prepared every 12 hours, giving the expected weather, clouds, and temperatures for the next two days.

- Zone Forecasts. The forecasts which may be used by a radio, TV, and newspaper in that zone for the local forecast. It includes wind for the first 24 hours as well as the expected weather, clouds, and temperatures for the next two days.

- Agricultural Forecasts. A special forecast issued once a day during the winter months and twice a day the rest of the year. The minimum relative humidity, the drying potential (pan evaporation), dew, sunshine, and rainfall amounts are included in the Agricultural Forecast.

- Extended Forecasts. In general terms the weather and temperatures expected for the 3 day period beyond the two days covered in the state and zone forecasts. The extended forecast does not include wind or relative humidity. The extended forecast has a fair amount of skill in predicting temperatures, but only limited skill in precipitation and timing of frontal passages.

- The Extended Forecast Branch in Washington also issues a 6 to 10 day outlook, a 30 day outlook, and seasonal outlooks. These outlooks only indicate that temperatures and precipitation are expected to be near, above, or below normal for the period. They are only slightly better than climatology and will be of limited use in planning for prescribed burning.

- Other scheduled and unscheduled weather products include updated scheduled forecasts, warnings for tornadoes, severe thunderstorms, flash floods, hurricanes, winter weather, weather summaries, radar summaries, and many special statements and bulletins about severe or unusual weather. Of special concern related to prescribed burning would be dust storm and high wind warnings for your area or to the west of your area.

- The Texas Agricultural Weather Advisory. This Advisory is related to how the past and forecast weather will affect crops, range, and farm operations.

The National Weather Service policy is to distribute the forecasts to mass disseminators and to public agencies. In fact, we are required to refer requests for specialized and personalized meteorological advice for specific business or individuals to private meteorologists.

Most National Weather Service offices have a recording telephone. The recording usually gives the local forecast for the city and the current temperatures, weather and wind. The recording is updated every hour. At Fort Worth the telephone is on a rotary system serving several telephone lines at the same time. At most of the smaller offices, the telephone recording is a ring-through system. During administrative hours (8 AM to 4 PM weekdays) after the recording is finished, if the phone is not hung up, the telephone in the Weather Office will ring, and other information may be obtained.

The National Weather Service has a network of 27 NOAA Weather Radio Stations in Texas. The transmitters are located at: Abilene, Amarillo, Austin, Beaumont, Big Spring, Brownsville, Bryan, Corpus Christi, Dallas, Del Rio, El Paso, Fort Worth, Galveston, Houston, Laredo, Lubbock, Lufkin, Midland, Paris, Pharr, San Angelo, San Antonio, Sherman, Tyler, Victoria, Waco, and Wichita Falls. These transmitters provide continuous broadcasts of the latest weather information directly from the National Weather Service offices. The taped weather messages are repeated every 4 to 6 minutes and revised as needed. The broadcasts are made on one of seven high-band FM frequencies ranging from 162.4 to 162.55 megahertz. To receive these broadcasts, the radio must have this weather band. There are many inexpensive radios on the market with the weather band. The NOAA Weather Radio can usually be heard as far away as 40 miles. However, many of the ranches in Texas are not within this reception distance.

The National Weather Service operates the NOAA Weather Wire Circuit. This is a teletype system on which we transmit all of the public forecasts, warnings, weather summaries, bulletins, and other weather information of interest to the press, radio, and TV. Most TV, cable TV and radio stations as well as several newspapers and the press associations subscribe to this service.

Because of their visual presentation, the TV stations may be the best source of weather information. Many of the TV stations have professional meteorologists. Nearly all locations in Texas can receive the AM radio broadcast, and most stations broadcast the weather conditions and forecasts frequently. Some of the cable TVs have continuous weather channels.

When the group at Texas Tech first started prescribed burning experiments in the late 60s and early 70s, we would only receive 5 to 10 calls for weather information during the entire season. Last March, we received that many calls during a single evening on a few occasions. The National Weather Service is not staffed to be able to give services to a large number of personal calls. The staff will be reduced some more this season. However, we will try to continue to provide briefings of weather information for prescribed burning to individual telephone calls on the unlisted telephone number (817) 334-3401 at least for the following season. You may encounter difficulty in reaching our office because of busy signals.

For East Texas, the Texas Forest Service distributes the forecast to their own district rangers, to the National Forest Service to the National Park Service, and to the lumber companies doing prescribed burning. If the demand for prescribed burning forecasts for range management in Central Texas continues to increase, we may have to devise a better forecast and distribution system.

The number of observing weather stations in Texas continues to decrease. Because of automation, many of the stations operated by the FAA are closing. Many others are closed at night. There are large gaps in our reporting network. We in the Forecast Office may not know the weather conditions at the prescribed burn locations. We make extensive use of the satellite pictures, but they may give limited information, especially at night. In juniper covered hills, the winds will be considerably different than the wind reported at the airport stations. Melting snow increases the soil moisture and humidities. Heavy snowfall frequently falls in narrow bands of 20 to 40 miles wide and perhaps a few hundred miles long. The dewpoint "discontinuity" is a semi-permanent feature with the prevailing southerly winds across Texas. The humidities and winds can change drastically across this feature in a very short distance. This "discontinuity" separates the moist air from the Gulf of Mexico and the arid air flowing northward from Central Mexico. This feature normally progresses eastward during the day with sunshine and mixing, and regresses westward during the night. Another semi-permanent feature with a southerly flow is the stratus clouds which develop along the Balcones Escarpment at night

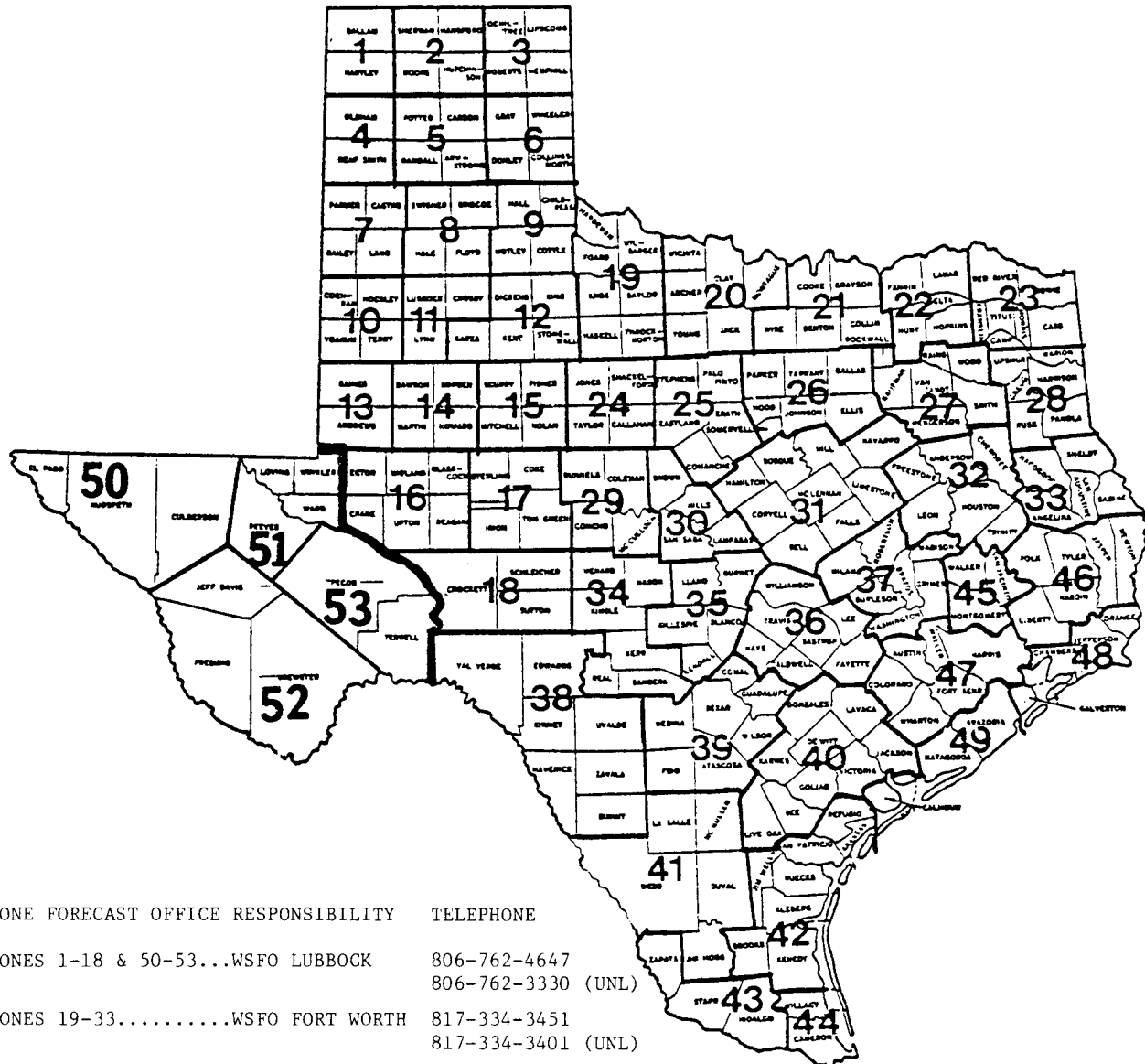
and spread rapidly northward. There are sharp differences in the weather along the western border of this cloud shield.

Cold fronts are more intense and frequent during the winter and early spring. Otherwise, no generalizations can be made about cold fronts. Depending upon the strength amplitude, and persistence of the upper air flow, storm tracks and frontal movements sometimes develop a definite pattern, which may persist for a few weeks. Some fronts have large temperature variations across them, while other fronts have no noticeable temperature change. Some fronts produce widespread precipitation, while frequently there is no precipitation with the front. Strong winds prevail behind some fronts, other fronts have strong winds preceding the frontal passage, while with other fronts the winds are light. Fronts may be almost stationary, while other fronts may plunge southward at 50 mph.

Climatology shows that Central Texas has the lowest frequency of air stagnation of any place in the nation. With conditions favorable for prescribed burning (wind 8 to 15 mph, relative humidity 20 to 50 percent, the temperatures above 40 degrees, and between 9 AM and 5 PM), it would be rare for the mixing heights and the transport winds to be too low for prescribed burning. The main concern with smoke management will be when certain wind directions are required to keep smoke away from a populated area. If there are heavy fuels that may burn and smolder after 5 PM, smoke management may be a problem at night.

Please use your usual source of weather information to the maximum extent for your prescribed burning operations. The extended forecast for beyond two days will be of limited value, as the forecast of winds and relative humidities is beyond the state of the art. At least for this season, the Forecast Office at Fort Worth will provide forecasts and weather information on the unlisted phone 817-334-3401, but try to limit your calls to essential information. Give the county and the distance from a well-known city or county seat when you call. It is often easier to forecast the trend or changes rather than the actual values at a given location, especially when nearby observations are not available. If you attempted prescribed burning on the day you call, let us know the results of the burning.

TEXAS FORECAST ZONES



ZONE FORECAST OFFICE RESPONSIBILITY	TELEPHONE
ZONES 1-18 & 50-53...WSFO LUBBOCK	806-762-4647 806-762-3330 (UNL)
ZONES 19-33.....WSFO FORT WORTH	817-334-3451 817-334-3401 (UNL)
ZONES 34-49.....USFO SAN ANTONIO	512-826-4679 512-522-3001 (UNL)

NOTE: UNLISTED NUMBERS ONLY FOR FIRE WEATHER REQUESTS



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL WEATHER SERVICE

JANUARY 19, 1981



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900—9-82

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