CHAPTER 10

FIRING TECHNIQUES

OBJECTIVES

1) Explain the characteristics of head, flanking and backing fires.
2) Describe the application of four common ignition patterns.
3) Describe safety concerns associated with specific ignition patterns.
4) List the factors that determine the appropriate firing technique.
5) Develop an ignition plan for a specific scenario.

References: Appendix E "Introduction to Prescribed Fire in Southern Ecosystems" 2012

INTRODUCTION

Successful prescribed burns depend upon a well designed and properly executed ignition plan. Florida Certified Burn Managers are required to develop a written ignition plan as part of each prescription. Wind is a primary force that directly influences the direction and rate of spread of each fire. Wind, both speed and direction as well as any potential changes, is crucial to every ignition plan. In relation to winds, fires are described as backing, heading or flanking. Ignition plans and firing techniques are all based on these three wind driven fires. In most of Florida the terrain is relatively flat and as a result slope or topography usually has minimal influence in the direction and rate of spread of a fire. However, minor changes in elevation or slope can have dramatic impacts on plant communities, fuel loads and fire behavior. In mountainous regions slope may have a significant impact on fire. Selection of the proper firing technique or combination of techniques and ignition pattern should be based on the burning objective(s), fuels, weather, smoke management guidelines, and manpower and equipment available. Appendix E "Introduction to Prescribed Fire in Southern Ecosystems" includes detailed information and descriptions of techniques commonly used throughout the Southeastern United States.

WIND AND FIRE

Wind is the dominant factor for most wildland fires and three basic fire types may be described based on their relationship to the wind. The most dramatic of these is the head fire. The **headfire** moves and consumes fuel in the same direction as the wind is moving. Head fires are generally the fastest moving type of fire and they tend to have the broadest flaming front, longer flames and greater intensity. **Backing fires** move against the wind. A backing fire moves slowly into the wind. Flame lengths and intensity may be dramatically lower when compared to other types of fire and these fires often appear harmless. Backing fires are often preferred for prescribed burns because they are easier to control and may be less likely to kill trees or wildlife. A significant wind is often desirable for a prescribed backing fire. The wind provides a constant source of oxygen and allows the fire to consume fuel at a faster rate. The third type of wind driven fire is the flanking fire. A **flanking fire** burns perpendicular to the wind. These fires are generally exhibit intermediate characteristics when compared to other types of fire. Figure 7-1 in Chapter 7 shows a basic diagram of a typical wildland fire.

TECHNIQUE SELECTION

For each prescribed burn the burn manager must determine the best way to safely conduct the burn and meet all objectives. Each prescribed burn is unique and in most cases there are infinite possibilities for success and failure. The preferred firing technique or combination of techniques is determined by a variety of factors and conditions:

1. Burning Objectives- the desired results of the burn for example underburning for hazard removal, site preparation, etc.

2. Fuel Characteristics - fuel types present and how intense they will burn with each prescription technique, for example, backfire in palmetto-gallberry with a fuel accumulation of more than four (4) years. Or, headfire in palmetto-gallberry with a recent mechanical treatment of mowing or chopping.

3. Weather - most techniques are adaptable to different weather factors, for example strong NW winds ideal for backing fires.

4. Smoke Management Guidelines - will determine the size of the burn area and the length of burning time, using the predicted dispersion index as a guide.

5. Manpower and Equipment - used on a prescribed fire should be large enough to ignite and contain the fire within the target area and to suppress any escape which might occur.

6. Adjacent Fuels/Resources – techniques chosen should control fire intensity so as not to affect adjacent forest stands and/or threaten nearby structures or cultural resources.

FIRING TECHNIQUES

Selection of the proper firing technique or combination of techniques and ignition pattern should be based on a variety factors. Some of the more important factors include: the burning objective(s), fuels, weather, smoke management guidelines, and manpower and equipment available.

The five techniques to be discussed are backing, heading, flanking; and spot fires which combine all 3 components at the same time and ring fire. More than one technique is often used on a single burn. The need for a secure perimeter line around the area to be burned is common to all firing techniques, as is a secure baseline. The baseline is always established on the **downwind** side of the area to be burned and should be wide enough to stop a headfire. The baseline is called a blackline when it is established through the use of fire; usually a backing fire is set along the downwind edge and allowed to back into the unit.

BACKING FIRES

Backing fires are the safest firing technique. They result in more complete combustion during the flaming stage and thus produce less smoldering combustion than any other technique. This means they also produce the least amount of particulate (less than half the amount produced in a head fire). They are the least likely to produce crown scorch because stored heat energy is released at a slower rate than in other firing techniques, the result being lower fireline intensity. Backing fires have short flames concentrating heat at the base of a plant stem and are thus often used to control brush and young hardwoods which typically have thinner bark than southern pines of the same size. Disadvantages include the slow progress of the fire and the increased potential for feeder-root damage with increased exposure to heat if the lower litter is not moist enough.

This technique is not used as often as it would otherwise be because it produces the slowest rate of spread of any technique. It ranges from 1-3 chains/hour (66-198 feet/hr) regardless of wind speed. Large blocks where backing fires are to be used, therefore, require the construction of interior lines to ensure the burn will be completed by nightfall. A rate of spread of 2 chain/hour (1 chain=66 feet) is often used when determining how many interior lines will be needed to assure completion of a burn before sunset. Interior firebreaks should be constructed 5 to 15 chains apart prior to the day of the burn. Once constructed; interior lines limit useable wind directions.

After the downwind line is blacklined, all remaining interior lines can be ignited at the same time. Escapes are most likely when igniting the downwind firebreak because the flames will be leaning across the line toward fuels outside the intended burn. In older roughs, aerial portions of the understory vegetation often hang over both sides of control lines unless extra effort is taken to remove them.

The most critical weather element is a steady wind; **any** change in direction results in an increase in intensity, any lull will let flames stand up which increases the probability of crown scorch. Do not burn when 20 foot wind speed exceeds 18 to 20 mph because of the spotting potential and ensuing control problems if the fire escapes.

Important fuel parameters are fine fuel moisture and fuel continuity. A backing fire will not carry well when the fine fuel moisture content exceeds about 20% in pine litter, or 15% in hardwood litter.

Backing fires often do not carry well in the summer because of higher fuel bed moisture contents and lower wind speeds. Transpiration from low vegetation and reduced wind speeds close to the ground result in a zone of slightly higher relative humidity beneath the understory canopy.

HEADING FIRES

Heading fires produce the highest fireline intensity because they have the fastest rate of spread (9 to over 90 chains per hour or 10 to over 100 ft per minute), the widest flame zone depth and the longest flames. They are also the most inefficient from a combustion standpoint and thus also produce the most particulates. But they also result in good convective lift which is needed to disperse combustion products and are a quick way to complete a burn (so larger areas can be burned).

Their use is generally confined to areas with only a 1 or 2 year rough, although conditions do exist when experienced burners prefer this technique in much heavier roughs. Head fires can be used with higher RH and higher fine fuel moisture than other techniques. They can accommodate lower wind speeds than backing fires, just enough to give the fire direction. The probabilities of crown scorch increases as the ambient temperature increases, so be careful when using this technique during the growing season.

A variation of the head fire technique is the strip head fire which is defined as: A series of lines of fire upwind of a firebreak or backing fire that will burn with the wind toward the firebreak or backing fire.

When using strip head fires, interior control lines are not absolutely required, but their absence allows heading fires from one strip and the backing fires from the previous strip to merge as a line resulting in higher flame lengths and higher fireline intensity. These conditions can create control problems and often produce parallel lines of crown scorch which may adversely impact trees. The absence of interior lines allows the ignition team to adjust ignition patterns with changes in fuel, topography, and weather which affect fire behavior. By changing the distance between lines or by adjusting line direction the igniter maintains fire behavior within acceptable limits.

When using strip head fires, flank fires are often used to secure the hot flank between strips. When doing so, make a curved turn as you begin the next strip rather than a 90 degree turn to minimize the possibility of creating small fire whirls that can jeopardize fire containment. If both flanks are brought up, you essentially have produced a ring fire which almost invariably results in overstory damage as the lines of fire converge.

This technique can be used soon after a rain under a strong wind to flash through herbaceous fuels with little fuel consumption. Such conditions are often used to control brownspot needle blight on grass-stage longleaf pine. Headfire rates of spread on ground level are always less than the wind speed (ignoring spotting). Watch out for spotting, particularly when the RH is below 30%. Temporary lulls in the wind or changes in wind direction will result in a decrease in fireline intensity while wind gusts will greatly increase intensity.

FLANKING FIRES

Flanking fires are lines of fire set by walking in to the wind. This technique produces a fireline intensity somewhat less than that produced by a heading fire, but considerably more than a backing fire. The most important requirement when using flanking fires is a steady wind direction.

Crew safety is a major factor with this technique because slight deviations in wind direction result in heading fires that can jeopardize ignition personnel that fall behind. When lighting more than one flanking fire they should all be lit at the same time. Lines of fire coalesce along a moving point (at least in theory) instead of all at once along a line, so crown scorch is less likely than when using strip head fires.

GRID or POINT SOURCE

The grid fire technique employs a series of small spot fires which burn in all directions as they come together. Grid fires are the ideal firing technique under light and variable winds and, when ignited from the air, allow fast ignition of an area.

Spacing of grids is critical. Hot spots with severe scorch are likely if spacing is incorrect. Start with relatively small grids and spacing especially near control lines. When the first ignition line has been completed the burn manager should evaluate the spacing. If this first line was too far from the blackline the crew can make adjustments. A square grid, 2x2-chain spacing will result in one ignition every 0.4 acre while 1x1-chain spacing will result in one ignition every 0.10 acre. Make sure the heading fires run into the previous line of grids before the flanks merge. This will help minimize crown scorch by allowing the fires to coalesce along moving points rather than as lines of fire.

The ignition pattern can be adjusted as necessary to compensate for changes in fuels (e.g., hardwood areas). Make sure any firelines are adequately protected whenever any spots are near firelines. Minor wind shifts can change a benign flanking fire into a raging inferno in seconds.

Strip head fires intensify much faster than grid head fires. Experienced prescribed burners often take advantage of this fact. They begin ignition as soon as a head fire will carry and use strip head fires, but as the day heats up and strip heads become too intense, they change to grid ignition. This reduces fireline intensity and conserves torch fuel. Spacing depends upon fuel loading, topography, and weather conditions. If grid ignition fires become too hot, stop ignition and the last line of grids will join to form a backing fire.

CENTER OR CIRCULAR IGNITION

This technique is often used on cut-over areas when a hot fire is needed to reduce logging debris and prepare the site for planting. It works best when winds are light but the procedure should not be used on areas with where the goal is to burn surface fuels only and protect other floral and faunal values.

Like other techniques this technique should include a test fire and ignition along the downwind side of the burn unit. Once the **blackline** is established the igniter(s) continue around the entire unit to complete the 'Circle.' If a center fire technique is used these fires should be ignited before the perimeter fire is completed. Depending upon fuels and unit size a flare gun or other ignition device may be used for firing the center. Both the center firing and circular firing technique will create an airflow pattern that will draw the perimeter or circler fire toward the center of the unit. This action will promote high intensity fire where the flaming fronts merge. Fires from either method often develop strong well developed convection columns which can cause long distance spotting.

AERIAL IGNITION

Aerial ignition requires considerable experience and is **not** for the novice, but is a very efficient way to burn depending on the size of the intended burn, the complexity of fire application, ground people available, and the location of other tracts scheduled for burning. Rapid burnout with aerial ignition allows the use of narrow prescription windows. When using **aerial ignition higher fine fuel moisture is preferred** when compared to a standard ground ignition plan. A small experienced crew can burn acreages as large as 8,000 to 10,000 acres of light fuels in 3 to 4 hours with a helicopter-mounted ping-pong ball machine. When using aerial ignition, direct radio communication between the aircraft and ground is mandatory.

THE IGNITION PLAN

Every prescription should include a map of the burn location and a detailed ignition plan. The burn unit map should illustrate important details about the burn unit and surrounding areas. The map should have a directional indicator that points north and a scale indicator that relates distance on the map to site conditions. The boundaries of the burn unit, special hazards in the burn unit, the size of the burn unit, escape routes, safety zones and other pertinent information should also be shown on the map.

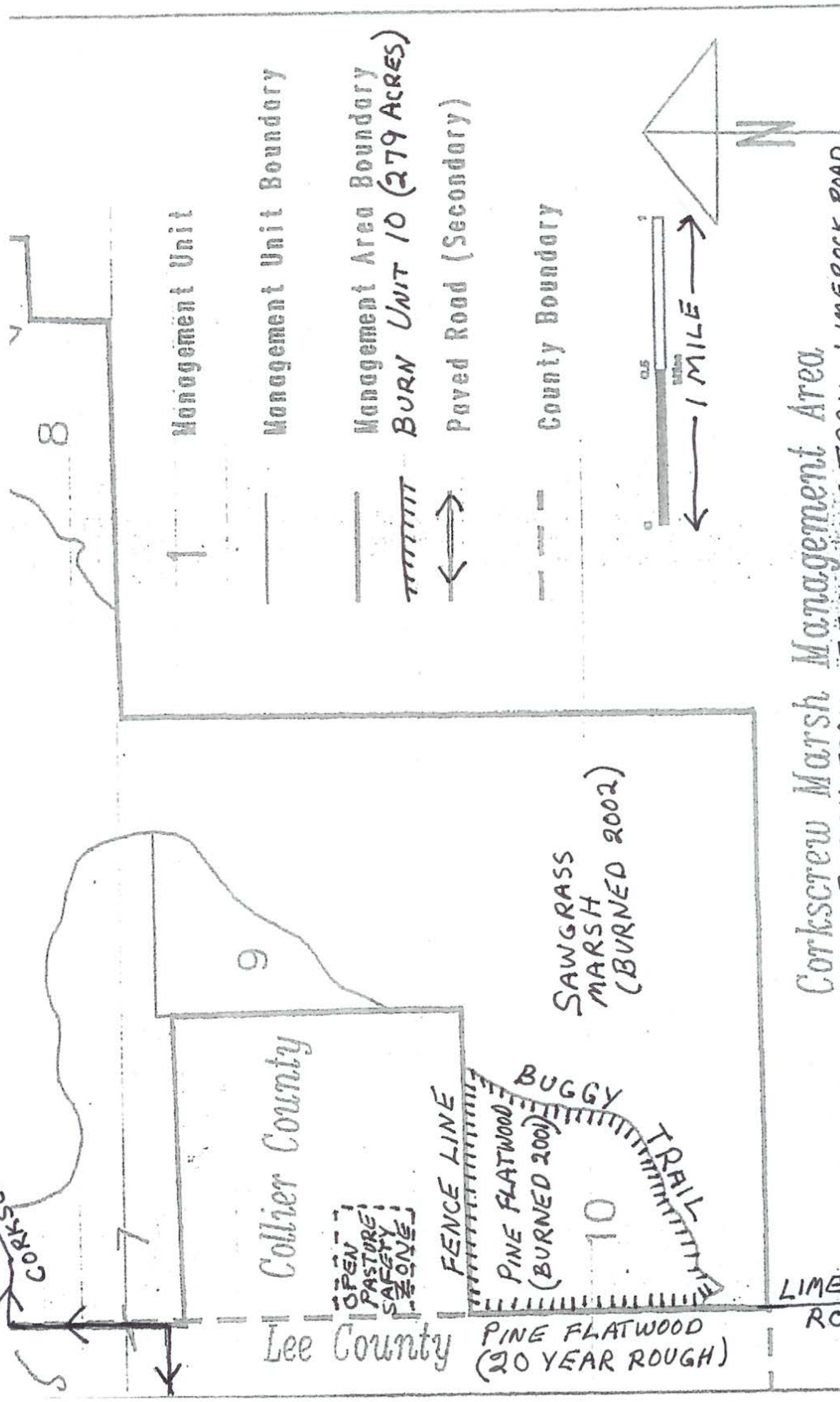
Figure 10-1 shows an example of a typical burn unit map. This management area is located in sw Florida near the county line dividing Lee and Collier counties. Burn unit # 10 is 279 acres of pine flatwoods currently managed on a 3-5 year fire return interval. The area was last burned in 5 years ago while the marsh to the east was burned in 4 years ago. To the west of the burn unit is pine flatwoods with a 20+ year rough. North of the burn unit is mostly pasture land with a thirty acre internal pasture that has been overgrazed. This overgrazed area does not have cattle on it at this time and it has been designated as the primary safety zone. In addition areas 'in the black' should cool quickly and will also be considered safety zones. Escape routes include the limerock road, the buggy trail and the fence line trail.

The ignition plan should also include a written narrative that describes the actions to be taken during the **ignition/suppression** phase of the prescribed burn. The narrative should include a description of the sequence of actions, the distribution of equipment and personnel, and the desired starting and completion times. The equipment and personnel required to conduct the burn should be listed. How will these resources be deployed at the start and how will they move as the fire progresses. Every ignition plan should include contingencies and alternatives to deal with changes in weather, fire behavior, and/or site conditions.

A diagram of the ignition plan should also be included on the burn unit map. Because this diagram may contain detailed information it is sometimes better to use a second copy of the burn unit map for the ignition plan. For our example we have included Figure 10-2 which shows the ignition plan for Unit 10, Corkscrew Marsh Management Area.

Every prescribed burn should begin with a test fire. The test fire is conducted in fuels that are similar to those throughout the unit but it should be located where it can be extinguished if necessary. For this reason it is a good idea to locate the test fire close to the proposed blackline starting point. When this is done, a secure anchor point can be established by burning out the fuels between the test fire, the corner of the unit and the proposed blackline. The **test fire** is a final check to determine if fire behavior is within desired limits and conditions are suitable for the burn.

FIGURE 10-1 UNIT 10
LOCATION MAP



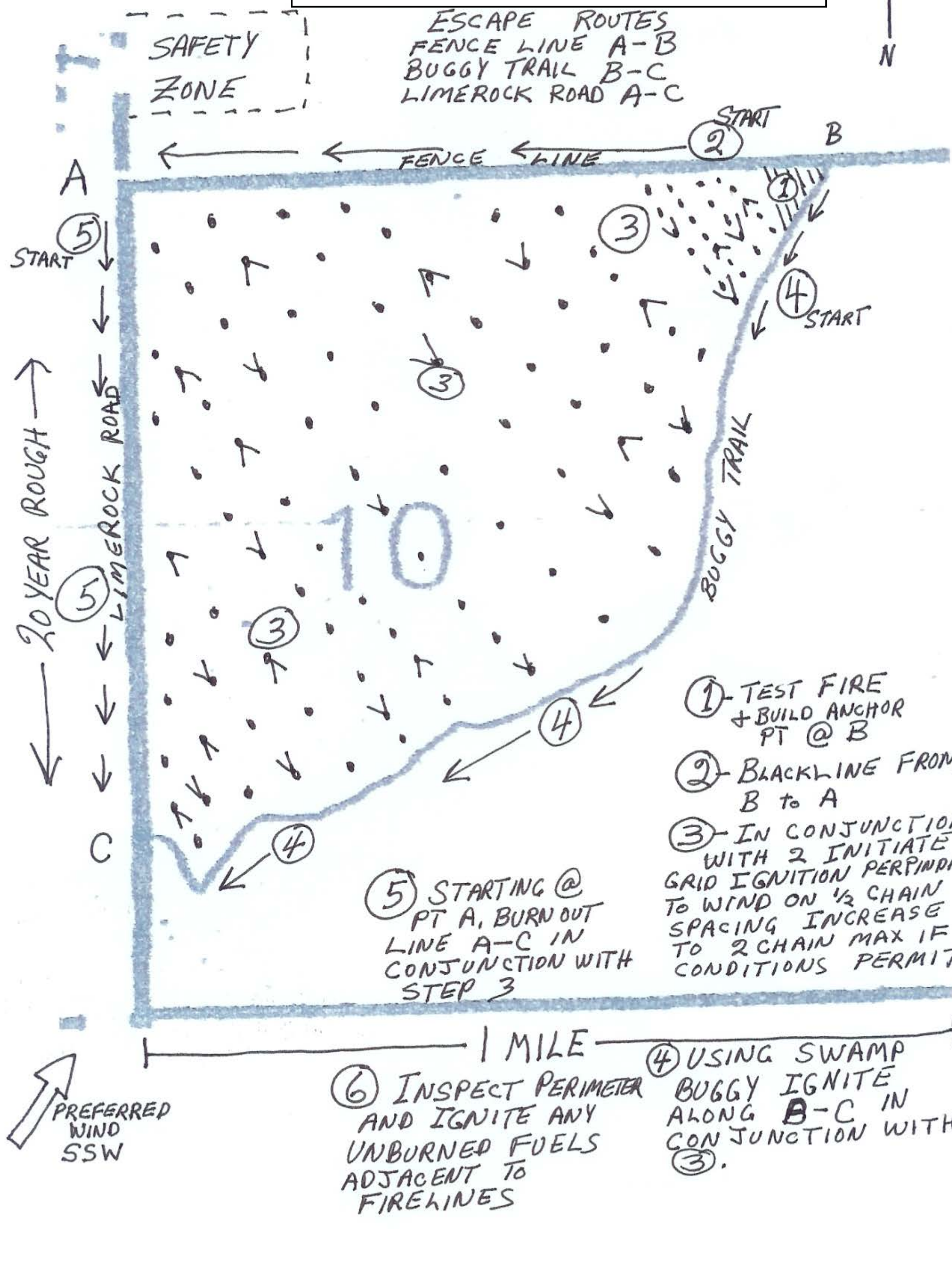
The second step is to establish a blackline on the **downwind** side of the burn unit. This blackline should be created by setting a backing fire. The first ignition should be as close to the actual line as possible. A second igniter can increase this distance if conditions allow. After the blackline has been established the actual ignition plan for the unit can begin. The distance and spacing of these first lines is critical. If these first ignitions create higher than anticipated intensity they may cause either spotovers or slopovers that are difficult to control. Under ideal conditions these activities should be completed as soon as practical and before the most active part of the fire day. As the ignition plan is implemented it is essential to have personnel on both flanks. These personnel are patrolling for spotovers or slopovers but they should also be igniting along the flanks. This is a difficult operation and it requires close coordination with the team lighting the interior. In some cases a single igniter may be responsible for all interior ignition but well trained crews may have multiple igniters working together. All ignitions should be conducted under an ignition boss. When bringing up flanks the goal is to protect each flank by igniting the flank and letting the fire burn away from the line before it meets the interior fire. The **convergence** of two or more fires can cause extreme fire behavior and when this occurs near a line it can have serious consequences. The last step in the Ignition/Suppression phase is to make sure that all control lines are safe. This is accomplished by igniting any fuels along the control lines that did not burn initially. The downwind line should have been secured at the start but the entire perimeter should be scouted after interior ignition is completed.

Example Ignition Plan Narrative
Burn Unit 10, Corkscrew Marsh Management Area

Map of Burn Unit The attached map shows burn unit # 10. This unit is 279 acres of pine flat woods which burned 3 years ago. Fuel loads are light to moderate. The area is roughly triangular with the three corners marked A, B, and C. A is the NW corner of the unit, B is the NE corner and C is the SW corner. Line AB is a disked on the south side of the fence which marks the N. boundary. There is also a disked line on the N side of this fence. Line AC is a private limerock road in good condition. Both AC and AB can be accessed by 4wd vehicles. Line BC is a swamp buggy trail which borders the sawgrass marsh adjacent to the unit. A good portion of this trail is underwater and access is limited to ATV's and swamp buggies.

Hazards/protected areas The unit was burned three years ago and has been on a 3-5 year return interval for several cycles. The only threats to fire control are several cabbage palms located along line AC. Any wind shift with an east component will cause a threat to the adjacent parcel.

FIGURE 10-2 IGNITION PLAN
UNIT 10 (279 acres)



This parcel is a 20+ year rough and any spots should be aggressively suppressed. There are two active alligator ponds marked by willow trees along line B-C. Alligators are sometimes seen in the buggy trail but they will normally retreat to the ponds when disturbed.

Equipment/Personnel This fire will require six people, a swamp buggy with 100 gallon water tank + pump, a medium tractor + 200 gallon water buffalo, a tractor-plow, and 2 ATV's.

1- Certified Prescribed Burn Manager
1- Wild Fire Qualified Tractor-Plow Operator
4- Prescribed Fire Technicians
** All equipment will be operated only by qualified personnel

1) Test Fire A test fire will be set near point 'B.' The test fire will be set in fuels that represent those found throughout the burn unit. If the test fire is satisfactory an anchor point will be established by burning out the fuels between the test fire and point 'B.' The anchor point should extend approximately 2 chains from point 'B' along line B-A and 1 chain from point 'B' along B-C. The Tractor Plow will be stationed at point 'A' and the Water Buffalo will be stationed along line B-A near 'B.' The swamp buggy will be stationed along B-C near 'B.'

2) Blackline Once the anchor point has been established the ignition crew will ignite a backfire along line B-A starting at the anchor point near 'B.' The water buffalo will handle any routine spotovers while the tractor plow will be assigned to any escapes. The igniter will cease firing during any suppression action outside the burn unit. Ignition may be resumed when the problem is resolved or when the burn manager determines it is safe to continue. The swamp buggy will maintain control of line C-B and will extend the anchor point along C-B as conditions permit or as directed by the burn manager.

3) Ignition Plan The blackline should be allowed to burn in approximately 1-2 chains depending upon fuel loads and fire behavior near the line. A second igniter may speed up the blacklining process by using spots or small strips spaced a short distance from the line to 'increase the width of the blackline. The interior ignition plan may begin before the blackline is completed since a SSW wind is not perpendicular to the blackline. If the wind is holding a west component the burn manager may commence interior ignition with the blackline partially completed. The interior ignition lines should be perpendicular to the wind as indicated on Figure 10-2. Interior ignition should occur in conjunction with proper management and ignition along the flanks and in conjunction with the blackline. Blacklining should stay several chains in front of any interior ignition. The swamp buggy should ignite along B-C in conjunction with interior ignition. The tractor plow will remain at point 'A' through the

start of ignition. The water buffalo will be assigned to line B-A until the blackline is complete. ATV#1 will be used for the interior ignition and ATV#2 will be used to patrol the blackline and the remaining perimeter as the burn progresses.

4&5) Managing the Flanks As shown in Figure 10-2 the water buffalo will manage line B-A while the swamp buggy will manage line B-C. As ignition progresses these units will secure the flanks by igniting fuels and minimizing fire convergence and fire behavior near the line.

6) Completing the Burn Once the interior ignition plan is completed the entire perimeter will be checked for unburned fuels. These areas will be ignited or cold trailed to insure they are not a hazard to the line. When this operation is complete, Crews will initiate mop-up and monitoring.

SUMMARY

The **ignition/suppression** operational phase of the prescribed burn is the obvious culmination of intense planning efforts. It is essential that each prescribed burner remain dedicated and focused during this phase. During this phase, the principles and techniques discussed throughout this manual are incorporated into a logical planned sequence of events that confines a fire to a predetermined area (the burn unit) and in a manner that certain objectives are met. Once in the field a test fire should precede every prescribed burn. A test fire, in representative fuels, is a final check to help the prescribed burner make sure that fire behavior will be within acceptable parameters and that the burn can be conducted safely.

The ignition plan and firing techniques must be carefully devised. The prescribed burner must consider an array of factors including burning objectives, fuels, weather, smoke management, personnel, and equipment. The prescribed burner strives to understand how fuels, weather and topography will interact with a specific ignition pattern. The successful burn manager does in fact manage the fire within an acceptable behavior range. A written ignition plan is a key ingredient that enables everyone to have a clear understanding of the proposed sequence of events. Every ignition plan should include contingencies and alternatives to deal with changes in weather, fire behavior, and/or site conditions.