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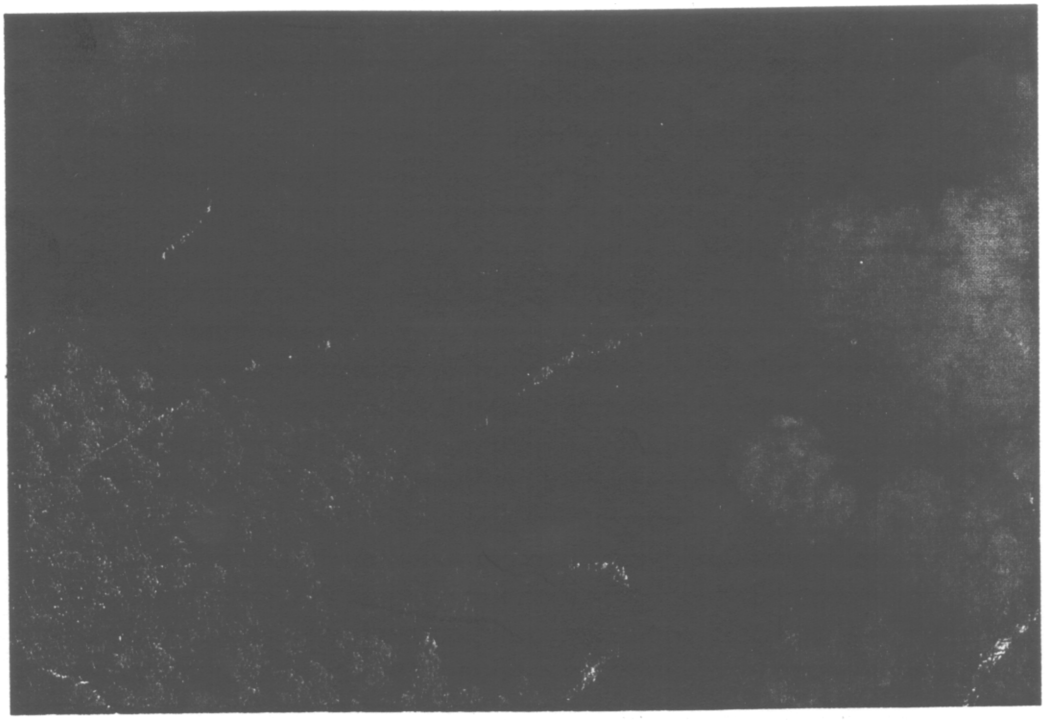

PRESCRIBED BURNING with SPOT FIRES in The Georgia Coastal Plain

by R. W. Johansen

RESEARCH DIVISION

GEORGIA FORESTRY COMMISSION

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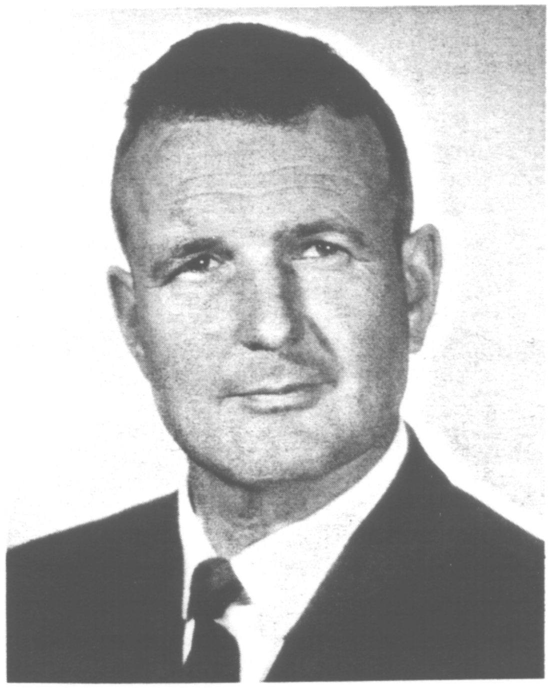

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by R. W. Johansen

The use of prescribed fire in the management of pine forests is common throughout much of the South, but one recurring problem that worries the forest landowner is not having enough suitable burning weather to satisfactorily complete all scheduled fires. Being able to burn areas considerably faster, without causing undue damage, could be a solution.

During the early 1960's, Australian foresters developed a spot-firing technique whereby ignition devices were dropped from aircraft onto 5,000- to 10,000-acre blocks of eucalyptus forests to consume the litter and reduce the fire hazard (Baxter and others 1966). The same technique has been successfully used in the pineries of eastern North Carolina (Sain 1979), and may have application in the palmetto-gallberry fuel type of Georgia and Florida.

On January 26-27, 1982, in cooperation with the Georgia Forestry Commission, a prescribed burning study was conducted to measure the effects different densitites of spot ignitions have on both fire behavior and the level of needle scorch in the tree crowns.

PROCEDURE

Plots for spotfires were selected in a 26-year-old, 55 to 65-feet-tall, slash pine plantation on the Dixon Memorial State Forest in southeastern Georgia. Understory vegetation was primarily palmetto-gallberry.

Placement of spots ranged from one spot per 0.1-acre (1 chain x 1 chain spacing) to one spot per 1.6 acres (4 chain x 4 chain spacing), a sixteenfold difference in spot density. Plot size varied from 4.4 for the close spacing to 15 acres for the wide spacing. On the larger plots the spot fires were ignited by dispensing aerial ignition devices from a machine (Lait 1977) mounted in a helicopter. Spots in the smaller plots were ignited by a ground crew using ordinary wooden matches.

Immediately following the ignition of each plot 6-7 of the spots were manned individually to record, at timed intervals, the maximum flame height at the downwind edge of the fire perimeter and along the right flank.

Approximately 2 weeks after the plots were burned, a survey was made of how high needles were scorched (heat killed) in the tree crowns. The task was made easy at this time because all the scorched needles were brown in color, but had not yet abscised from the branches.

Four randomly selected, 20-feet-wide transects (two directed in a north-south direction and two directed east-west) were examined in each burned plot. Each tree within the transects displaying scorched needles was measured to the topmost height of scorched needles and its location recorded within the transect. When the entire tree crown of a dominant tree was scorched, the total tree height was listed as scorch height.

Burning conditions

The site and weather conditions existing at the times of the burn are summarized in Table 1. Winds generally ranged from 1 to 3 mph at eye level on the plots, and the sky was cloudless on both days. A .35-inch rainfall had occurred within 2 miles of the plot 2 days before the burn, and 1.79 inches had fallen during a 2-day period 12 and 13 days before the burn. The rather low relative humidities (in the 30 percent range) allowed for rapid drying of the surface litter.

Table 1.--Fuel and weather conditions at time of burn.

Plot no.1/	Basal area2/	Fuel amount: Litter fraction	Fuel amount: Total	Fuel moisture content3/	Weather: Temp.	Weather: R. H.4/
	ft^2	....tons/acres....		%	°F	%
1x1 A	72	2.1	3.0	30.5	45	41
1x1 B	71	3.2	4.1	24.4	53	33
1x2	66	3.6	4.8	24.7	55	32
2x2	46	2.6	3.8	23.6	46	32
2x4	72	3.5	5.0	27.7	50	35
4x4	61	3.3	4.7	23.8	48	29

1/ The first number denotes the spacing of spots (in chains) within a line running in a crosswind direction; the second number denotes the spacing between the lines of spots.

2/ The mean of four basal-area estimates, one at each fuel-sampling site.

3/ Mean moisture content of four surface-litter samples collected immediately before plot ignition.

4/ Observation made immediately before plot ignition.

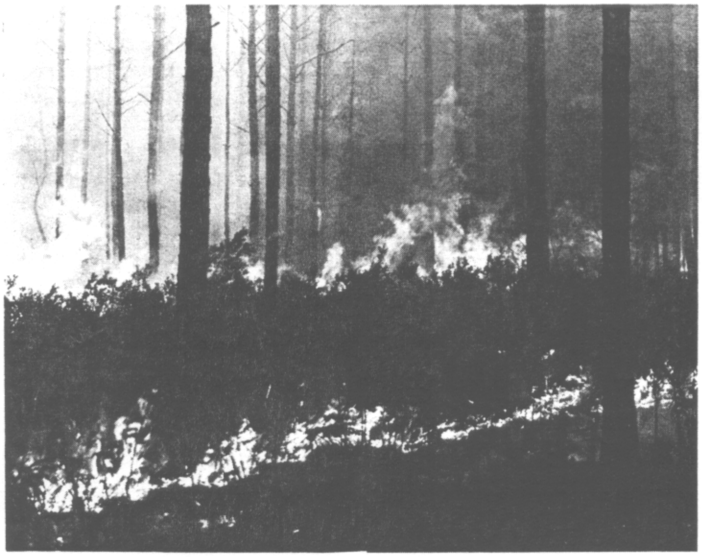
RESULTS AND DISCUSSION

Fire Behavior

Burn duration and flame height data are summarized in Table 2. Before each expanding spot fire was influenced by neighboring fires, the flame heights generally ranged between 3.5 and 5.5 feet, but as the flames drew closer together the average heights increased rapidly. Maximum flame heights observed exceeded 20 feet.

There is no doubt that flame height (an estimate of fire intensity) can build up rapidly in both the juncture zones of headfires and backfires and the merging flanks. In these tests, flame heights increased from threefold to tenfold as fire merging took place, regardless of whether headfires were merging with backfires or flanks were merging with each other. Generally, maximum flame heights occurred in the merge zone of headfires and backfires.

A 4-year-old palmetto-gallberry rough.



Burnout resulting from spot fires.

The understory fuel 2 weeks after the burn.

Some differences in fire behavior depended on whether the spots were placed in a square or a rectangular pattern with the long axis parallel to the wind direction (Table 2). In no instance did the flanks of the developing spot fire merge with the neighboring flank before the headfire merged with the downwind spot when spot spacing was square (1x1, 2x2, etc.). With rectangular spacing, however, there were instances when the flanks merged first (see 1x2). Early flank merger caused a rapid increase in width of flame zone at the moving fire front and an attendant increase in flame height.

There did not appear to be any definite correlation between spot spacing and any of the fire behavior parameters measured even though there was a sixteen-fold difference in spot fire density between 1x1 and 4x4 plots.

Theoretically, the closer together the spots are placed, the hotter the fire should be. More spots per unit area causes more lines of fire-merging zones, and it is in these zones where height is greatly increased.

Table 2.--Mean values of fire behavior in spot-fired plots, by fire type.

Plot no.[1/]	Duration total	High intensity duration factor[2/]	Flame height: Max.	Flame height: Low intensity ($\bar{x}$)	Flame height: High intensity ($\bar{x}$)
	min	%	ft	ft	ft
HEADFIRES					
1x1 A	8.5	35.8	10.8	3.6	8.2
1x1 B	8.0	28.0	18.7	3.8	13.8
1x2	12.7	38.4	23.4	4.0	15.2
2x2	14.0	41.1	14.1	4.4	9.8
2x4	19.1	28.5	22.5	5.0	16.7
4x4	19.2	39.7	20.4	5.4	14.5
FLANK FIRES					
1x1 A	11.2	16.7	8.7	2.4	5.5
1x1 B	8.1	14.4	17.4	2.9	13.3
1x2	11.6	20.4	14.0	2.2	9.8
2x2	16.7	17.0	10.0	2.4	7.7
2x4	20.9	20.0	20.8	2.2	15.0
4x4	25.1	34.4	17.4	2.4	10.7

1/ See Table 1, footnote 1.
2/ Fraction of time when merging fires influence each other.

Fire Effects

A summary of scorch height measurements is presented in Table 3. These data indicate that spot density, within the range used in this study, had no significant effect on mean scorch height within the stand. Scorch height, as variable as flame height in all the plots, averaged between 36 to 47 feet with extremes ranging from 15 to 68 feet.

Table 3.--Summary of maximum scorch heights measured along transects 2 weeks after burning.

Plot no.[1/]	No. trees	Scorch Height: Mean	Scorch Height: SD	Scorch Height: Range
		ft	ft	ft
1x1 A	90	38.06	7.3	22.0 - 58.1
1x1 B	93	43.01	8.6	22.0 - 59.7
1x2	81	47.37	9.1	20.7 - 67.9
2x2	76	36.37	9.3	18.0 - 54.8
2x4	132	45.93	10.4	18.0 - 66.3
4x4	307	39.45	10.2	15.4 - 63.6

1/ See Table 1, footnote 1.

CONCLUSIONS

The spot-fire technique allows for development of flame heights far in excess of those that would develop from backfires. The resulting higher scorch levels in the tree crowns reflect the higher fire intensities.

Under the weather and fuel conditions of this study, a significant fraction of the trees had total crown scorch. Fortunately, no mortality occurred in the entire study, but some growth loss could be expected in the severely scorched trees. These tests indicate that:

1. A 3-year or longer accumulation of understory fuel in the palmetto-gallberry type may be excessive for burning with spot fires in well stocked stands when relative humidities are about 30 percent and stand heights are under 50 feet.
2. To reduce the opportunity of the fire flanks merging before the headfires merge with downwind spots, the ignition points should be placed in a square grid.
3. Spotting density, within the range of spacings, tested in this study, has little effect on flame height and scorch height in the stands being burned.

I believe that slash pine stands, which were previously prescribed burned not more than 3 years before, can be prescribed burned without excessive scorch if fired within 3 days of at least 0.5-inch of rain, when relative humidity is between 45 to 60 percent, ambient temperature is under 60°F, and average stand height exceeds 35 feet. In essence, the amount of fuel available for combustion is being controlled through fuel moisture control. The same approach can probably be followed with older roughs, but the chances of developing excessive heat are much greater.

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