Scheduling Prescribed Burns

for Hazard Reduction in the Southeast

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ABSTRACT — Twelve-year studies in the southeastern Coastal Plain revealed that pine stands should be burned every three years to reduce natural fuels and thus forestall damage from possible wildfires. Rates of overstory growth were not significantly different in burned and unburned stands. Guidelines for prescribed burning of pine stands in this region are presented.

Southern pines are resistant to fire because their cambiums are insulated by thick bark and their crowns can withstand repeated scorching. However, pines cannot survive when their branch tips are killed by the wildfires that develop in tall, heavy understories and litter accumulations. From their inceptions, pine stands in the Southeast are plagued by the threat of such wildfires.

Even if a freshly harvested area is burned to remove the slash, the grass and herbaceous vegetation that immediately colonize the area form a fuel complex that can destroy young pines if a wildfire develops. By the time grass fuels have been shaded out, there is often a heavy accumulation of dead needles from which wildfires of tremendous intensity can develop if conditions are right. When crown closure is complete, accumulation rates increase. As much as 16 tons of surface fuel per acre may accumulate in 18-year-old plantations of slash pine (*Pinus elliottii* Engelm.) with 5- by 10-foot spacing.[1] The presence of a tolerant understory and needle drape also brings the heat of a fire closer to the overstory. In the Coastal Plain, understory plants such as saw-palmetto (*Serenoa repens* Bartr. Small) and large gallberry (*Ilex glabra* (L.) A. Gray) are extremely flammable when preheated by burning ground litter, even though they remain green all year.

Prescribed burning to reduce hazardous accumulations of fuel has been used for many years in pine forests of the Southeast; but the burns—conducted at intervals of five years or more—are usually too infre-

[1]*Froelich, R. C. Effects of prescribed burning on the establishment and spread of* Fomes annosus. *1969. (Progress report FS-SO-2303-70.5 on file at South. Forest Exp. Sta., Gulfport, MS.)*

quent to protect the overstory during the entire interval between burns. One of the few studies of the cause-and-effect relationship between wildfires and hazard reduction burns was conducted in the Coastal Plain of north Florida in 1959 (*1*). Results showed that an increase in age of rough (fuel accumulation) was accompanied by a general increase in the number, intensity, and—most significantly—size of wildfires. In roughs more than five years old, seven percent of the acreage burned each year, whereas only 0.10 percent burned each year in roughs younger than five years. The 12-year study reported here was conducted to determine experimentally the optimum interval between hazard reduction burns in the southeastern Coastal Plain.

Burning Frequency Tested

In 1958, two areas were selected for study—one in north Florida and the other in southeast South Carolina. The Florida area contained a natural stand of 45-year-old longleaf pine (*Pinus palustris* Mill.); the South Carolina area was divided into two sites, one containing mature longleaf and the other mature loblolly (*P. taeda* L.) pine. All plots at the three sites were initially burned with backfires (against the wind).

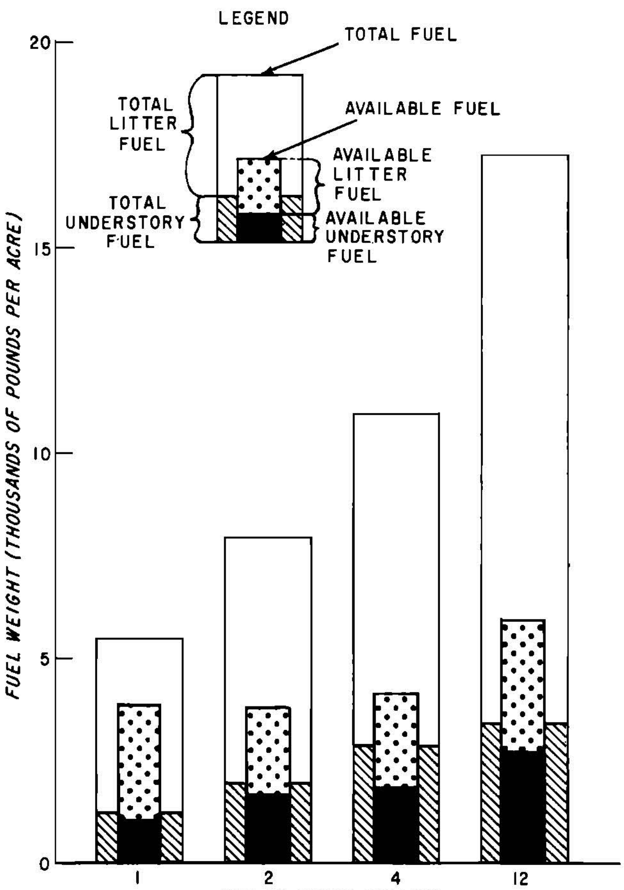


Figure 1. Weights of total and available fuel by age of rough in the longleaf pine stand in Florida.

Figure 2. Extreme differences in the vertical distribution of understory fuel in a 1-year rough (A) and a 12-year rough (B) on the Florida site.

They were then scheduled for reburning at specified yearly intervals: the Florida plots at one-, two-, and four-year intervals; the South Carolina plots at one-, two-, three-, and four-year intervals. Check plots were left unburned throughout the subsequent 12-year study. Reburns were conducted from December through March according to the firing technique best suited to the fuel-weather conditions. Weather and fire behavior were monitored in conjunction with each burn.

Before each burn, litter and understory fuels were measured. In many instances, the amount of fuel consumed (available fuel) was determined after the burn. Just before the 12th-year burns, the heights of major understory plants and the weights of specific types of fuel on the various plots were measured.

Fuel Accumulations

The Florida Study.—Fuel weights (total and available) by age of rough at the Florida site are shown in *Figure 1*. Of major concern for prescribed burning is the weight of available fuel—the material which will be consumed by a fire. At the Florida site, available litter fuel consisted of new needles, weathered needles, leaves, and twigs less than one-fourth inch in diameter. Annual measurements on the check plots indicated that weights of litter fuels increased for 8 to 10 years before leveling off. Available understory fuels consisted of above-ground parts of runner oak (*Quercus minima* (Sarg.) Small), blueberries (*Vaccinium* spp.), and the grasslike plants and grasses, including pineland threeawn (*Aristida stricta* Michx.), as well as the blade portion of saw-palmetto plants and gallberry material one-fourth-inch thick or less (*Table 1*). Saw-palmetto, both live and dead, made up the largest portion of understory fuel.

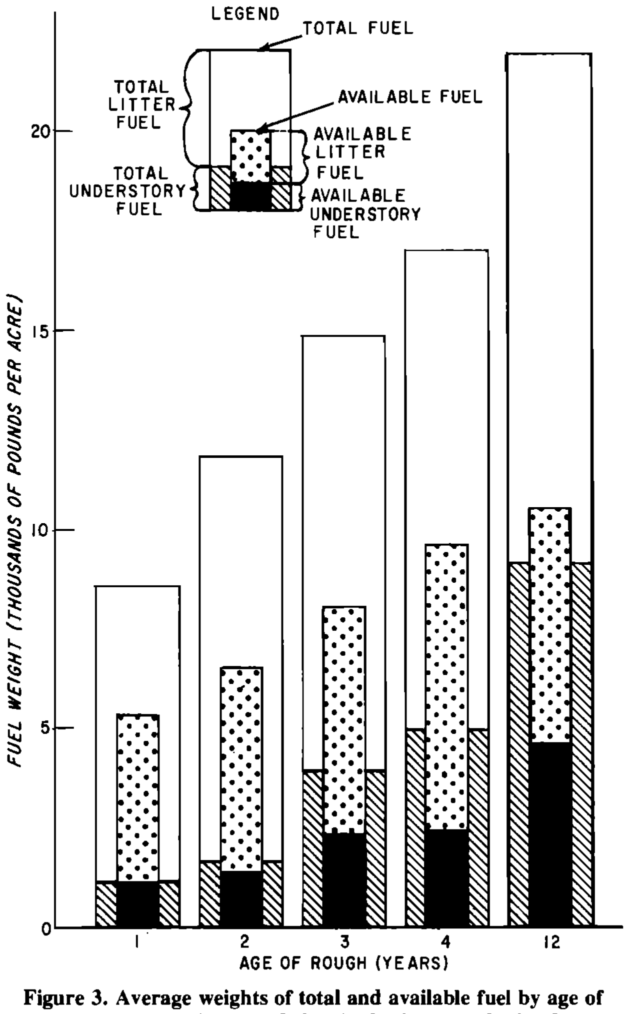


Figure 3. Average weights of total and available fuel by age of rough in the loblolly and longleaf pine stands in South Carolina.

Table 1. Total fuel weights by age of rough at the Florida and South Carolina sites.

Site and type of fuel	Age of rough (years) 1	2	3	4	12 (check)
	Lb./acre (ovendry)				
Florida:					
Saw-palmetto, live	673	976	—	1,800	2,344
Gallberry, live	204	379	—	673	598
Pineland threeawn	69	242	—	160	244
Blueberry	54	118	—	184	172
Runner oak	74	109	—	17	10
Miscellaneous	16	23	—	12	4
Grasslikes	67	57	—	26	16
Saw-palmetto, dead	154	306	—	761	987
Gallberry, dead	20	50	—	74	120
Needle drape	41	58	—	101	108
Litter, total	4,359	5,930	—	8,092	13,847
South Carolina:					
Gallberry	152	244	681	775	1,504
Switch cane	48	164	207	81	566
Other grasses	362	67	53	23	3
Sweet pepperbush	156	415	934	844	1,911
Blueberry	128	174	210	349	283
Miscellaneous	101	235	811	1,351	4,450
Needle drape	18	59	96	138	376
Dead stems	237	110	815	585	984
Litter, total	7,392	10,174	10,890	12,063	12,632

Understory vegetation not only increased in weight with age, it also grew taller. Gallberry ranged in height from 15 inches on 1-year roughs to 42 inches on the 12-year rough; corresponding heights for saw-palmetto were 26 and 45 inches (*Figure 2*). Such increases in fuel height change the behavior of a fire by giving it a much greater vertical dimension.

The South Carolina Study.—Weights of total and available fuel at the two South Carolina sites were consistently greater than those measured in Florida (*Figure 3*). Weights of loblolly pine litter on the check plots tended to level off (reach equilibrium) in five years at about 11,000 pounds per acre. On the longleaf pine replicate, however, the weight of litter on the check plots did not reach equilibrium (about 15,000 pounds per acre) until age 8 through 10, just as on the longleaf pine site in Florida. Although available fuel at the two South Carolina sites increased less rapidly than total fuel after the fourth year, it is important to remember that much more of the lower litter becomes dried out during prolonged dry periods and, hence, becomes available as fuel.

Understory fuels on the South Carolina sites were made up of a conglomerate of shrub and hardwood species (*Table 1*). Sweet pepperbush (*Clethra alnifolia* L.), a deciduous shrub, was the most common. Among the changes that took place because of burning was the conversion of shrubs to grass, including switch cane (*Arundinaria tecta* (Walt.) Muhl.). Annual burning produced grass crops of 410 pounds per acre in a cured winter state (*Figure 4*). As burning rotation lengthened, however, grass production dropped off drastically. On the other hand, needle drape increased. In the junglelike check plots (12-year rough), hanging needles amounted to almost 400 pounds per acre (*Figure 5*).

As with litter, the weight of available vegetative fuels tends to reach equilibrium with time. On the South Carolina sites, total fuel weight continued to increase; but as the fuels grew larger, a smaller percentage of the live vegetation was available for rapid combustion. Because of the large-stemmed hardwoods in the understory, available fuel never quite equaled total fuel even during the most severe fires in this area. In Florida, on the other hand, the gallberry and saw-palmetto fuels increased continuously for about six years before leveling off. Unlike the South Carolina sites, the total weight of fuels on the Florida site was essentially the same as available weight for any high-intensity wildfire. Conditions need not be too severe for the entire understory complex to be incorporated into the fire.

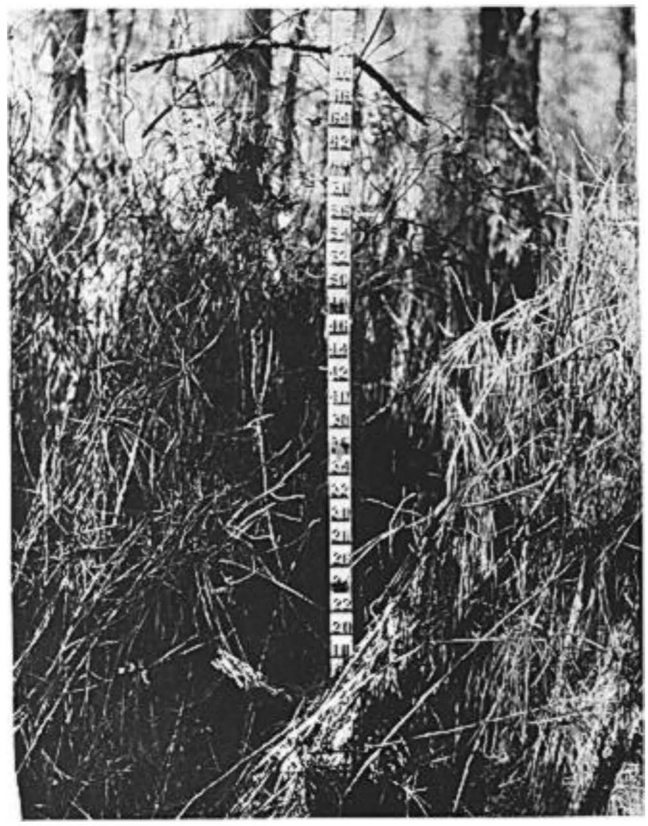


Figure 5. Needle drape forms a stairway for fire to reach the crowns of overstory trees.

Burning Techniques

Head firing (burning with the wind) was attempted on each plot after the initial burns. Not only are head fires more likely to consume more understory fuels than backfires, but they spread faster and allow more area to be burned in a given period—a savings in money and manpower. It was found that one- and two-year roughs on both study sites can be burned safely with head fires under most conditions suitable for prescribed burning. Three-year roughs can often be burned with head fires, but considerable care is

Figure 4. Annual burning produced as much as 400 pounds of cured grass fuel per acre on the South Carolina sites.

needed when the moisture content of upper litter fuel (fresh needles) is lower than 20 percent and the wind is strong. Spotting (the carrying of burning embers ahead of a fire by the wind) has been noticed when the moisture in upper litter on these sites is lower than 15 percent. On both study sites, best results apparently occur when the moisture content of upper litter is between 20 and 25 percent as actually measured.

Wind is also of paramount importance in prescribed burning. It should be steady in direction and speed and greater than 1 m.p.h. in the stand. Lesser speeds result in poor fuel consumption and added crown scorch. If the heat of the fire is not dissipated properly, it can cause crown damage and subsequent kill. At in-stand wind speeds greater than 5 m.p.h., spotting and fire intensity often increase to dangerous levels in older roughs.

Relative humidity during the burns ranged from 30 to 60 percent, and good-to-mediocre consumption of fuel was attained within these limits. Lower humidities can add to control problems and spotting; higher humidities result in poor consumption.

Ambient temperatures also differed widely between burns. Colder temperatures were found to be more favorable because more heat from the fire is then required to raise live needles to lethal temperatures. Burns were usually scheduled after the passage of a dry, cold front.

Effect on the Overstory

When forest fuels are left untreated for many years, they build up heavy accumulations. Head fires can cause considerable mortality under these circumstances if the moisture conditions are low and wind speeds are high. Because the study plots contained mostly mature timber, only a few dominant and codominant trees were killed even when exposed to head fires. In those few instances where excessive scorch and crown damage were evident, one of the following conditions generally prevailed:

1. The wind subsided, and heat from either the head fire or backfire went straight up without being dissipated.
2. Heat increased at the junction zone formed by a head fire and backfire coming together.
3. Head fires were used in heavy, dry fuels (mostly four-year-old roughs) when moisture levels were low and wind was strong.

Other than the direct and indirect mortality (for example, insect attacks on weakened trees) sustained under these conditions by individual trees or groups of trees, overwood growth was not affected. No statistically significant differences between the growth rates of the dominant and codominant sample trees were detected on any of the burning rotations or unburned checks on either the Florida or South Carolina sites.

Conclusions

Prescribed fire has been, and continues to be, an effective, inexpensive means of reducing fuel accumulations and, hence, the risk of damage from wildfire. Southern pines as a group are more fire resistant than any other forest type in the United States, yet wildfire damage can and does occur when roughs are left unchecked. This study indicates that areas not burned by prescription at least every three years can be damaged by wildfires attaining intensities only slightly greater than those burned under "normal" conditions for prescribed burning. Weights of available fuel were considerably different (50 percent less in some cases) from weights of total fuel on a given rough. As drought conditions persist in "bad" fire years, more and more of the total fuel becomes available. Unless the total fuel is maintained at a low level by fairly frequent prescribed burns during "normal" fire years, wildfire damage can be extensive.

Fire is a vital part of the ecology of southern pines. By using prescribed fire wisely, foresters can perpetuate these fire-climax species and maintain a high level of productivity for the varied resources of the forest.

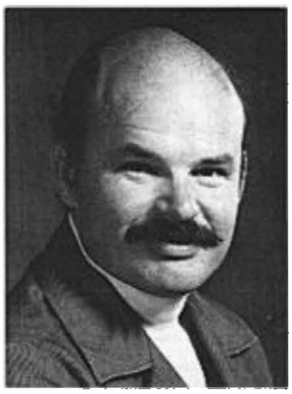
Recommendations

This 12-year study of prescribed burning for hazard reduction provides insight into the optimum burning rotation for typical southern pine flatwoods. A few recommendations, some specific and some general, follow:

1. A three-year burning interval is optimum for minimizing wildfire damage.
2. Start all burning programs in unburned, heavy roughs with backfires (two may be required).
3. Strip-head or head fires can be used in one- and two-year roughs, but they require more caution in three-year roughs.
4. Head fires can easily damage crop trees in four-year roughs.
5. Avoid junction zones wherever possible.
6. Avoid winds unsteady in either speed or direction.
7. Get an up-to-date forecast from the fire-weather forecaster.
8. Head fires reduce aerial fuels best and allow more area to be burned in a given period.
9. Backfires eliminate more litter.
10. A test fire before burning is still the best indicator of burning conditions and probable fuel consumption.
11. Notify neighbors and state fire control agency before ignition. ■

Literature Cited

1. Davis, Lawrence S., and Robert W. Cooper. 1963. How prescribed burning affects wildfire occurrence. J. Forestry 61(12): 915-917.



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