Prescribed Use of Fire in the South—A Means of Conserving Energy

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SOUTHERN pines supply the basic raw material for a wide spectrum of forest products from lumber to plastics. The appetite for this basic renewable resource seems insatiable. Projected demands continue to exceed allowable cut. Further, as shortages in fossil fuels develop and their prices become prohibitive, a shift from these petroleum-based products to wood-derived cellulose as a basic raw material will accelerate. The challenge is clear—forest managers must increase production of this renewable resource to keep pace with the demand.

Intensive management of our southern pine forests, an outgrowth of this demand, enabled the South to produce 45 percent of the Nation's timber harvest in 1970. The problem is how to further expand production and maintain an acceptable forest environment in the face of increased taxes, increased labor and equipment costs, and predicted petroleum shortages.

The forest manager should learn how to optimize the use of allotted fossil fuels. He must use energy-efficient methods to carry out forest management tasks. Prescribed fire is one such method. It converts forest litter and understory plants into a useable source of energy to accomplish many of these tasks. A large portion of the understory contributes little toward achieving the various forest management objectives. In fact, it is usually a deterrent, competing with the overstory for available nutrients and water.

As the costs of intensive management and forest stand values continue to climb, the need to protect this investment also increases. Prescribed fire is the only practical means of reducing the fuel buildup and thus the acreage lost to, and damage caused by, wildfire. Even though about the same number of wildfires can be expected to occur on recently burned areas, they can be suppressed more rapidly with less equipment. Thus, machine wear, diesel fuel costs, and damage to the forest stand are all reduced.

Prescribed fire—although archaic to some and unproven to others—is currently being used on over 2 million acres of high-investment, high-yield southern pine forests each year (Fig. 1). Estimates suggest another 10 million acres a year are in need of burning just in the South (Cooper, 1971). Three generations of loblolly, longleaf, and

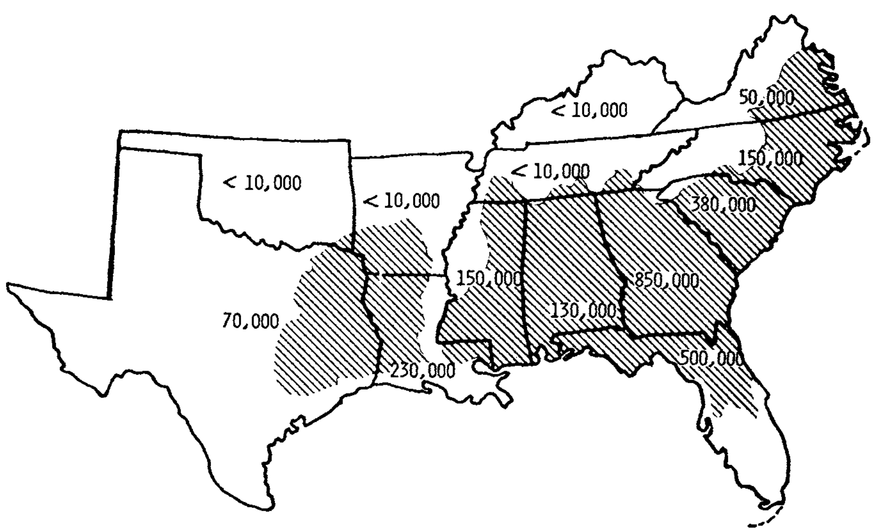

Fig. 1. Distribution of three major southern pines superimposed over prescribed burn acreage by state for the South in 1970.

slash pine including attendant wildlife and livestock have benefitted from the proper use of this low-cost tool. This controlled use of fire differs from wildfire in that the release of energy is regulated by the land manager through the fuel and weather conditions under which he chooses to burn, and the firing techniques he prescribes to accomplish specific land management objectives.

The largest single use of prescribed fire in southern coniferous ecosystems is for hazard reduction (Hough, 1973). For example, in the State of Georgia over 70 percent of the forest acreage prescribed burned in 1972 was for hazard reduction (Fig. 2). Costs averaged 60¢ per acre (Hough and Turner, 1974), which is a bargain compared to wildfire suppression costs and possible timber damage. Properly executed burns yield many other ancillary benefits to the general public; fire creates vegetation mosaics, opens up vistas, improves forest accessibility, and increases the number and floral abundance of wildflowers. From a more economic viewpoint, this energy source can be harnessed to accomplish many other land management goals. The controlled release of heat can be used to manipulate vegetation—killing selected species and/or size classes while stimulating sprouting in others. Prescribed burning can enhance production and palatability of forage or expose a mineral seedbed prior to stand establishment. Further, the ash remaining after a fire is an excellent fertilizer—returning nutrients to the soil where they can again be utilized for tree growth.

Burning for seedbed preparation provides a good example of how fire can reduce forestation costs. Techniques for preparing the site for a new crop of trees are varied. Combinations of different mechanical techniques, herbicide usage, and fire prescriptions are all accepted methods. Fire does not do as thorough a job as mechanical methods, but it is the most economical. Furthermore, prescribed burning will result in a well-stocked stand on most sites providing other conditions are favorable.

Since most large companies had already invested in heavy equipment for other forest operations, it was good business to also utilize it for site preparation. But, with skyrocketing equipment replacement costs and shortages of diesel fuel such as the South experienced during the spring of 1974, blanket use becomes questionable and longer depreciation schedules become mandatory.

By the year 2000, the cost of site preparation, relatively speaking, could be significantly greater than in 1967 when approximately two-thirds of the costs were made up of machine expenses. The fact is that

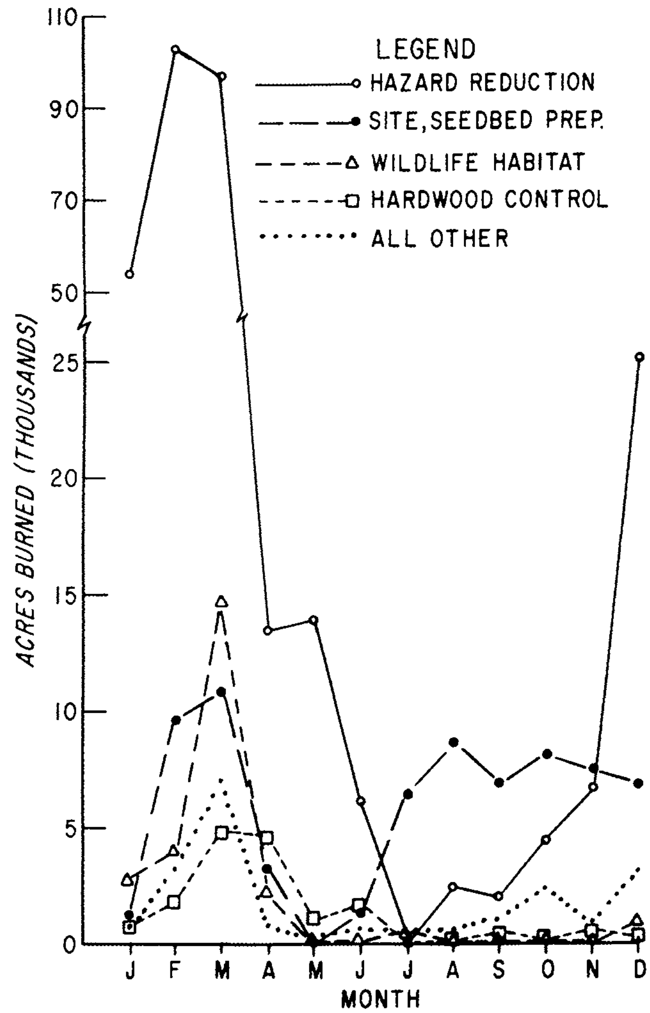

Fig. 2. Monthly variation in acreage prescribed burned for various reasons in Georgia.

by the year 2000, diesel fuel may be in short supply and will likely be rationed to only the most essential functions.

When do mechanical site preparation techniques become too expensive relative to other techniques such as fire? Does the future demand for wood cellulose justify using diesel fuel and heavy equipment for site preparation? The added cost of mechanical site preparation can only be justified by an offsetting return in the form of additional wood at harvest time. The principles involved are complex and depend upon interest rates, land values, stumpage prices, and site quality. As interest rates increase, the amount that should be spent per acre for site preparation decreases. But, as site productivity increases, the amount that can be spent on site preparation increases. An increase in land value decreases the age at which the maximum rate of return occurs. Increases in stumpage price also tend to decrease the rotation length. Thus, any model that only examines one variable, while assuming the others remain constant, will be open to error.

To determine expected rates of return, current expenses must be projected forward in time and compared with expected harvest revenue. However, times are rapidly changing, equipment replacement costs are exceeding capital fund allocations, and energy costs are becoming prohibitive. Under these circumstances, it becomes necessary to frequently reevaluate management alternatives from an economic standpoint. The various site preparation treatments can result in different levels of wood production. Investment differences in relation to productivity ultimately determine the utility of a technique.

Table 1 illustrates the net increase in volume growth (cords per acre) required to offset the higher initial investment for mechanical seedbed preparation compared to using prescribed fire. As estimated future costs change, so does the acceptability of one seedbed preparation technique over another. The costs in Table 1 for mechanical and prescribed fire techniques for 1967 and 1972 are published averages for the South but will, of course, vary depending upon local conditions (Merrifield, R. G., et al., 1968; Southeastern Area, state and Private Forestry, 1972; Yoho, J. G., 1971). Other published sources showing higher mechanical but lower burning costs could have been used, resulting in increased economic benefits from the use of prescribed fire. Wood values are realistic through 1974, but are projected

Table 1. Increased production necessary to justify investing money for site preparation based on 1967 and 1972 data for 20- and 25-year rotations.

	YEARS							
	1967		1972		1974[1]/		2000[1]/	
Rotation Length (years)	20	25	20	25	20	25	20	25
Interest Rate (percent)	5	5	6	6	7	7	8	8
Interest Rate Multiplier	2.653	3.386	3.207	4.292	3.870	5.428	4.661	6.849
Wood value per cord at Harvest Age (dollars)	10.00	10.00	11.00	11.00	15.00	15.00	30.00	30.00
Mechanical:								
Seedbed preparation costs per acre (dollars)	15.00	15.00	25.00	25.00	35.00	35.00	70.00	70.00
Costs carried to harvest age (dollars)	40.00	51.00	80.00	107.00	135.00	190.00	326.00	480.00
Production requirement (cords per acre)	4.0	5.1	7.3	9.7	9.0	12.7	10.9	16.0
Prescribed Fire:								
Seedbed preparation costs per acre (dollars)	1.00	1.00	1.50	1.50	2.00	2.00	4.00	4.00
Costs carried to harvest age (dollars)	3.00	3.00	5.00	6.00	8.00	11.00	19.00	27.00
Production requirement (cords per acre)	0.3	0.3	0.5	0.5	0.5	0.7	0.6	0.9
Increased Production Necessary to justify mechanical preparation over prescribed fire (cords per acre)	3.7	4.8	6.8	9.2	8.5	12.0	10.3	15.1

1/ 1974 and 2000 data projected from 1967 and 1972 data.

through the year 2000. Costs were projected for both 1974 and the year 2000. The interest rate trend has been estimated for all cases.

The differences in volume yield by site index class between 200 and 600 trees per acre, and between 400 and 600 trees per acre, are plotted in Figure 3.[1] It is assumed that 200 trees per acre are the minimum acceptable stocking at harvest. Even a poor burn will meet this minimum requirement during all but the worst seed years, and 400 or more trees per acre are the usual case. Our illustration assumes mechanical seedbed preparation techniques will result in 600 trees at harvest, while prescribed fire will give either 200 or 400 trees. Although these assumptions are a gross oversimplification, the potential benefit of prescribed burning is shown.

Table 1 values for production increase in cords per acre required to justify the more intensive and expensive mechanical seedbed preparation techniques were inputs to Figure 3. The lowest site index at which mechanical site preparation techniques can be economically justified is found by using the key associated with Figure 3. These site indexes were then plotted against year for the four date years—1967, 1972, 1974, and 2000—in Figure 4. The curves represent the breakeven point by year at which one site preparation technique is economically preferred over the other. They show that the site index at which mechanical preparation is justified over burning has been rising between 1967 and 1974. Prescribed fire is the more economically justifiable seedbed preparation technique for site indexes lower than 60 for stocking levels that will produce 200 trees per acre at harvest. If initial stocking will result in 400 or more trees per acre at the end of the rotation, prescribed fire should be used on all but the very highest site indexes. Furthermore, the difference in success between the two methods is likely to decrease as more is learned about the application of prescribed fire.

From this analysis, it is seen that forest management options are heavily dependent on both the current economic picture as well as the projected outlook. It is not necessarily true that intensified forest management through advanced mechanical technology will continue to offer the best economic return.

1 Yield differences due to stocking from Bennett, 1963.

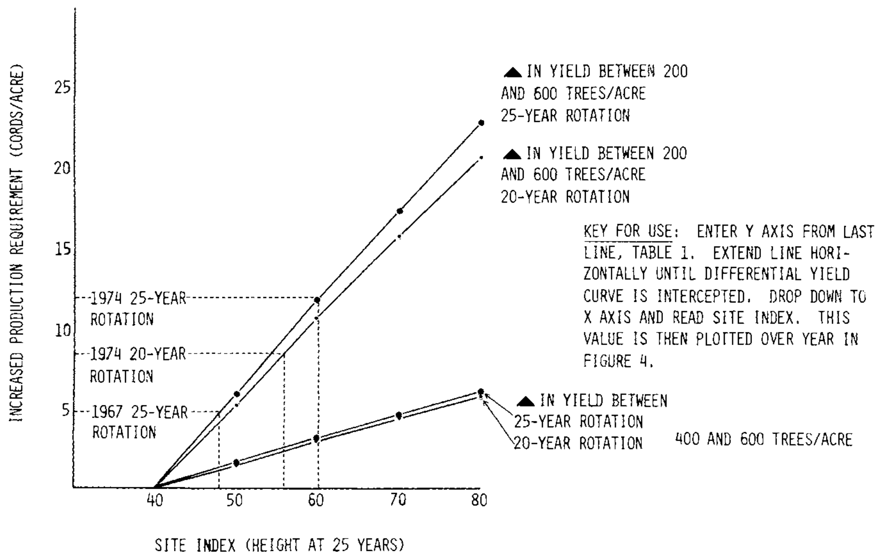

Fig. 3. Site index breakeven points necessary to economically justify the use of mechanical site preparation methods over prescribed fire at two levels of stocking and two rotation lengths given various time-dependent costs.

There are, however, many situations where mechanical methods such as bedding, furrowing, or harrowing should be used to upgrade the potential of a given site—the results of which may last for several rotations. Other reasons for using mechanical techniques—perhaps more subjective, but no less real—include the lack of skilled burning personnel, the fear of fire escape, and the inability or lack of desire to take advantage of adequate burning conditions.

Nonetheless, alternate low energy-using techniques will gain wider acceptance. Prescribed fire and natural regeneration techniques could virtually replace the current practice of mechanically preparing a site and planting tomorrow's timber resource. Many of the difficulties associated with direct seeding have been overcome. Genetically improved seed is readily available. An aerial row seeder that can control spacing between and among rows is approaching operational reality (Mann et al., 1974).

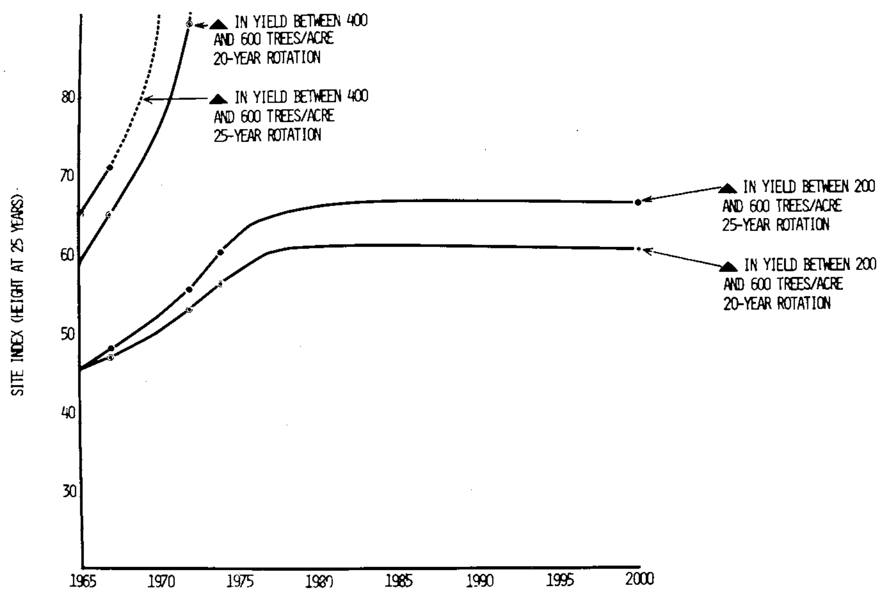

Fig. 4. Breakeven points plotted over time for two levels of stocking and two rotation lengths based on costs projected through the year 2000. Sites falling below the curve can more profitably be prepared using prescribed fire.

The extent of the increased use of prescription burning will depend upon us, both as individuals and as land managers. As custodians of America's great renewable resource, we have both a challenge and a responsibility to accelerate production of our forest resource to keep pace with the demands placed upon it. At the same time, we must conserve those resources which are not renewable.

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