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PINE REGENERATION FOLLOWING FUEL CHIP UTILIZATION OF MIXED HARDWOOD-PINE

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INTRODUCTION

Much of the forest acreage in the Georgia Piedmont is commercially unproductive due to the low-value species mix or poor quality of existing stands. On many tracts the expected return on investment is too low to justify the cost of converting to more valuable species by conventional methods such as root raking, piling, burning, and planting. The problem is not one of poor sites, but in the cost of eliminating existing low-value stands. The advent of whole-tree-chipping systems and the expansion of fuel chip markets constitute a potential economic mechanism for converting this forest land to a more productive condition. Commercially productive pine forests first developed throughout the Piedmont by natural succession on abandoned cropland (Boyce and McClure 1975). Continued natural succession in conjunction with disproportionate harvesting of pines has resulted in the predominance of poor-quality upland hardwood stands with a minor component of pine. In contrast to conventional clearcutting, which leaves a residual stand of small trees and poor-quality large trees, whole-tree harvesting for fuel chips can effect complete clearing that approaches the abandoned agricultural condition. This paper reports initial results of a study to determine if intensive whole-tree harvesting alone can be used to achieve a degree of conversion back to loblolly (*Pinus taeda* L.) and shortleaf (*P. echinata* Mill.) pines.

METHODS

The study site is located NNE of Atlanta in the Upper Piedmont of Georgia on the Dawson Forest, Dawson County, which is managed by the Georgia Forestry Commission. The site--with soils of Fannin fine sandy loam and Tallapoosa fine sandy loam--had been farmed, abandoned early in the century, and allowed to revert to forest. Prior to the Commission's management program, the timber stands had been high-graded for pine and hardwood leaving either no merchantable timber or a merchantable volume too low for conventional logging (Figure 1). The most prevalent hardwoods were chestnut oak (*Quercus prinus* L.), northern red oak (*Q. rubra* L.), post oak (*Q. stellata* Wangenh.), scarlet oak (*Q. coccinea* Muenchh.), southern red oak (*Q. falcata* Michx.), and hickory (*Carya* spp.). The mean basal area was approximately 100 square feet per acre, of which about 65 percent was hard hardwood, 10 percent soft hardwood, and 25 percent pine. The ranges in diameter at breast height were 1 to 20 inches for hard hardwoods, 1 to 16 inches for soft hardwoods, and 1 to 14 inches for pines. Among all species combined, there were approximately 980 stems per acre, of which 60 percent ranged from 0.5 to 2.4 inches d.b.h., but these 588 small stems accounted for only about 8 percent of the total basal area per acre (McMinn and Nutter 1981).

The chip-harvesting treatments consisted of two cutting intensities in both winter and summer. The most intensive harvesting removed all woody biomass down to and including stems of approximately 1 inch d.b.h. (Figure 2). The less intensive treatment removed all stems 4 inches d.b.h. or larger (Figure 3); the 4-inch diameter is an approximate lower limit for economically feasible fuelwood harvesting. The lowest harvest intensity removed more material than a typical commercial clearcut. The 1-acre logging plots were harvested by Commission personnel with a small feller-buncher, grapple-skidders, and an 18-inch whole-tree chipper. Each combination of harvest intensity and season, as well as an undisturbed control treatment, was replicated three times. Detailed sampling and observations were confined to the interior half acre of each acre plot.

Observations were made of (1) mineral soil exposure, (2) light intensity under residual stands, and (3) initial pine seedling establishment. Mineral soil exposure, which is important for pine regeneration (Pomeroy 1949, McMinn 1981), was estimated on the basis of a 180-point sys-

Figure 1. --Mixed poor-quality, upland hardwood-pine stand before whole-tree harvest.

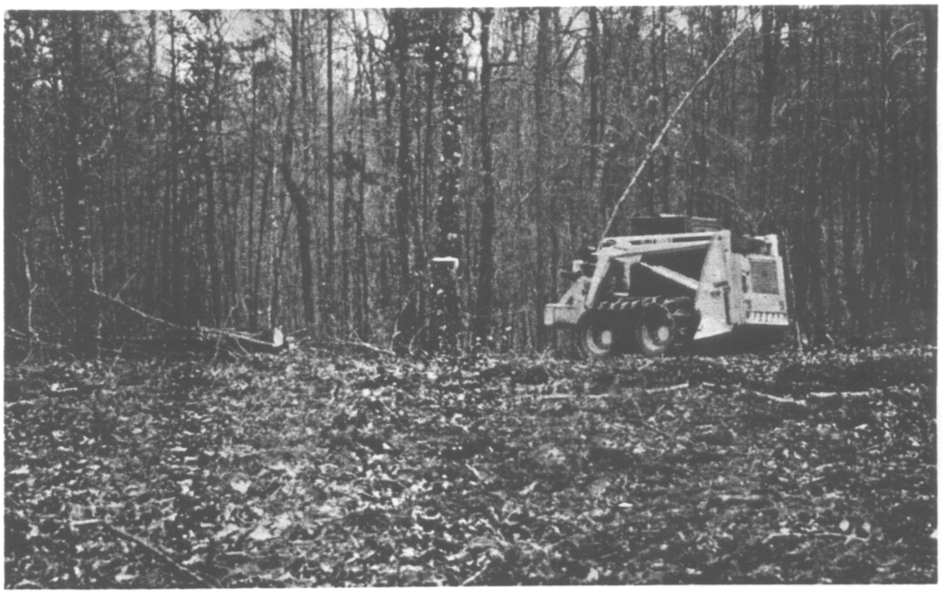

Figure 2. --One-inch limit plot after harvest.

Figure 3. --Four-inch limit plot after harvest.

tematic grid within each plot. Light intensity in the photosynthetically active range of the solar spectrum was measured to estimate differences in competition resulting from the two harvest intensities. (The measuring device was a Lambda Instruments Corporation LI-185A Quantum/Radiometer/Photometer equipped with an LI-190S Quantum Sensor.) The readings were taken on cloudless, late-summer days within 1 hour of solar noon at 40 groundline sample points traversing the plot diagonals. Initial pine seedling establishment was estimated approximately 1 year after logging from milacre inventories along the same systematic grids used to estimate soil exposure. Pine seedling density and stocking were used as measures of establishment. Density is an estimate of the total number of seedlings per acre without regard to their spatial distribution. Stocking provides an estimate of how completely an area is occupied by seedlings, or how well they are distributed spatially.

RESULTS AND DISCUSSION

There were significant differences ($P=0.05$) in density and stocking of natural pine seedlings both by season and intensity of harvest:

	Trees/acre	% stocking
Winter		
4-inch limit	1,658	62
1-inch limit	7,376	94
Summer		
4-inch limit	34	12
1-inch limit	0	0

Few seedlings became established after summer logging, but acceptable establishment followed winter logging even at the lowest harvest intensity. For the winter harvest, removal of all woody biomass down to 1 inch d.b.h. resulted in half again as many stocked milacres as the 4-inch limit cut. The 94 percent stocking is as high as could reasonably be expected even after planting (Cover photo).

The drastic seasonal differences suggest that successful establishment depends on viable seed on the ground at the time of harvest. The winter harvest was similar to the "seeds-in-place" regeneration technique conceived by Lotti (1961) and evaluated by Langdon (1981) as an effective natural regeneration method. In our situation the seed came from the pine component of the harvested material and the logging provided site preparation for seeds that were already on the ground. These seeds would not have become established seedlings without logging because the layer of litter prevented contact with mineral soil. Seed predators and fungi likely destroy a substantial proportion of a seed crop by early summer; Trousdell (1954) found that populations of seed-eating mammals build up very rapidly in cleared areas. Therefore, the seed crop immediately before harvest is crucial to regeneration success with this method.

The difference between harvest intensities in number of established seedlings may be due partly to mechanical disturbance and partly to competition by residual woody vegetation. Harvest to a 4-inch limit exposed half as much soil area as harvest to a 1-inch limit:

Diameter limit	Exposed mineral soil	
	Winter	Summer
1-inch	71%	61%
4-inch	35%	30%

However, the 4-inch limit had only 22 percent as many established seedlings as the 1-inch limit; hence, residual stems had an apparent influence on establishment. Figure 4 gives an indication of relative competition from residuals by harvest intensity. Plots with no residual woody stems had almost 60 percent more groundline points receiving a high intensity of insolation as plots with small-diameter residuals. Conversely, plots with small residual stems had three times as many points receiving low intensity insolation as plots with no residuals. Although these light readings provide an index to residual competition, root competition, especially for moisture, may have had a greater impact at this stage than shade, per se.

CONCLUSIONS

The results suggest that, under conditions similar to those described for this study, intensive whole-tree fuel chip production can be employed to achieve an acceptable level of pine seedling establishment--a crucial step in the partial conversion of mixed hardwood-pine to a higher level of pine stocking. The harvesting must be carried out in winter or early spring with a reliable seed crop and, for best results, residual stems should be removed.

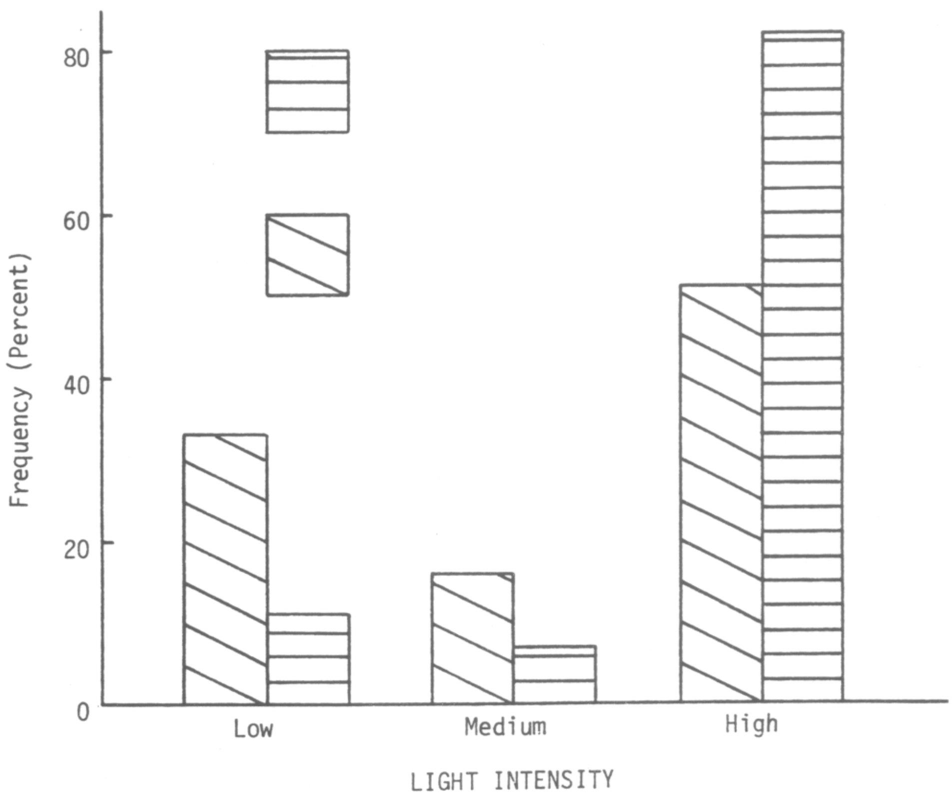

Figure 4. --Frequency distribution of light intensity readings by whole-tree harvest limits (Low, Medium, and High correspond to 0-700, 701-1400, and 1401-2100 microeinsteins per square meter per second, respectively).

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