1998

Impacts of Three Timber Stand Improvement Thinning Options on Low Quality Southern Mixed-Hardwood Stands

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IMPACTS OF THREE TIMBER STAND IMPROVEMENT THINNING OPTIONS ON LOW-QUALITY SOUTHERN MIXED-HARDWOOD STANDS

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Abstract—The impact of three thinning options (strip, single-tree selection, and strip with selection between strips) on low-quality southern mixed-hardwood stands was evaluated in northern Alabama. Although stand level comparisons showed no significant differences between options, individual dominant trees benefitted from the thinning treatments, exhibiting increased basal area growth during the period of the study. Intermediate treatments such as these thinning options may provide landowners with sufficient growth of selected high-quality trees to warrant the more intensive management activities on similar sites as utilized in this study.

INTRODUCTION

In general, hardwood stands in the Eastern United States have developed with little or no silvicultural or management activities. Since European settlement, these stands have been subjected to repeated cuttings (often diameter-limit cuts), insects, disease, and fire. Many of these stands are composed of mixed stands of residual individuals from past activities and a variety of shade-tolerant species (McGee 1980).

There are about 90 million acres of pure hardwood forestland in the Eastern United States. The bottom-land hardwood resource has been severely reduced in area over the last 60 years, much of it the result of conversion to agricultural uses. Although the rate of area decrease has slowed in the last 15 years (McWilliams and Faulkner 1991), the 40 million acres of bottom-land hardwoods found in 1952 has been reduced to about 29.8 million acres. Most of these forests are in private holdings (90 percent in 1988), with private nonindustrial landowners owning about 66 percent of the land (Saucier and Cost 1988).

The current hardwood stand condition in the South ranges from high-quality stands of pure or mixed even-aged timber to low-quality stands that are understocked and composed of often less than desirable species (McGee 1982). Many of these stands are continuing to deteriorate in quality as diameter-limit and individual-tree selection cuttings remove the few remaining high-quality (based on genetic quality or market factors) trees and leaving a residual stand of less-desirable species of low growth potential or low market quality.

The demand for hardwood products is increasing (McWilliams 1988, Hair 1980). It is projected that by the year 2030, the demand for hardwoods will triple, rising from the present 3.0 billion cubic feet to 9.6 billion cubic feet. Hardwood management has not kept pace with the intensive research and management strategies utilized in southern pine forests. The best management practices for these forests have not been determined. Thinning of low-quality stands is usually not practiced since the basal area of marketable trees and acceptable growing stock is low and control costs of non-desirable species high (McGee 1982). Increasing demands for fuelwood and other hardwood products have made more intensive management of these low-quality stands possible and profitable (Koch 1980, McGee 1982, Reynolds and Gatchell 1979, Reynolds and Schroeder 1978). Intermediate thinnings may reverse the decrease in quality of these stands by removing undesirable species and trees of poor quality. The objective of this study was to quantify the silvicultural impacts of three timber stand improvement thinnings on low-quality southern mixed-hardwood bottom-land stands.

METHODS

Four square, 1-acre study plots were established on each of two research sites: the Wheeler Wildlife Refuge (WWR) southeast of Decatur, AL; and the U.S. Army Redstone Arsenal (RSA) in Huntsville, AL. Both locations represented moderately productive bottom-land mixed-hardwood stands with white oak (*Quercus alba L.),*water oak (*Q. nigra* L.), southern red oak (*Q. falcata* Michx.), black oak (*Q. velutina* Lam.) and willow oak (*Q. phellos* L.) as well as sweetgum (*Liquidambar styraciflua* L.), hickories (*Carya* Nutt. spp.), red maple (*Acer rubrum* L.) and elms (*Ulmus* L. spp.) in addition to other minor species in the overstory and understory. Soils on both sites were Melvin silty clay loams.

All trees greater than 2 inches in diameter at breast height (d.b.h.) within each plot were measured and mapped in the summer of 1986. Measurements made included species, location in plot, height, and d.b.h. The location of each tree was determined through the placement of a 16-square grid superimposed on each 1-acre plot, with the distances from each tree to two designated grid corners recorded.

Treatments utilized at each site were: control (no tree removal); selection cut (removal of all trees except identified crop trees to 75 square feet BA); strip cut (removal of all trees within six 12-foot-wide strips spaced 36 feet apart, leaving approximately 75 square feet BA); and strip-selection cut (removal of all trees within four 12-foot wide strips and any except desired crop trees between

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strips to leave approximately 75 square feet BA). All removals were performed with chainsaws in 1987. The sites were revisited at the end of the 1993 growing season and the heights and d.b.h. of all residual trees recorded.

The basal area per plot was determined for both measurement periods (BA1 and BA2), as was per-plot basal area growth (BAG) and diameter growth (Growth). Statistical analysis (ANOVA and Tukey's range test) on this RCB experimental design was performed using a SAS (SAS Institute, 1991) statistical package on the mainframe computer at Alabama A&M University.

RESULTS AND DISCUSSION

The mean basal areas (square feet per acre) by plot for each of the four thinning treatments on the two sites are shown in table 1. There was no significant difference between sites for any of the treatments. Basal area for the control plots was significantly (p>0.05) greater than for any of the treatments. This was expected, since each of the thinning treatments reduced basal area to approximately 75 square feet, while the control plots were left at their original density.

Table 1—Mean basal area (square feet per acre) for two sites and four thinning treatments

Site	Plot	BA1	BA2	BAG	Growth
Redstone	Control	101.8[a]	115.4[a]	13.6	119.9
	Selection	75.1	90.1	15.0	140.8
	Strip	70.0	84.7	14.8	159.2
	St/Sel	53.5	72.7	19.2	142.7
Wheeler	Control	108.3[a]	131.0[a]	24.3	209.4
	Selection	74.0	69.2	4.9	42.4
	Strip	61.4	80.1	18.7	183.7
	St/Sel	64.2	73.7	9.5	148.1

BA1 = BA/plot 1987; BA2 = BA/plot 1993; BAG = (BA2-BA1)
[a] = Significantly different within same column.

No significant differences were found between treatments for basal area growth (BAG) when both sites were combined and only treatment effects analyzed. The negative BAG of the selection thinning treatment on the Wheeler site was the result of mortality of large trees that died between the two measurement dates. We believe the lack of significant differences in response to the thinning treatments may be accounted for by not having removed enough BA initially. If the residual basal area had been reduced to between 30 and 50 square feet, we believe we would have observed greater BAG, but residual basal areas of this level are associated with a shelterwood system, not an intermediate thinning treatment.

There were significant differences between mean tree basal area (table 2) and specific species' response to thinning treatment (table 3). After treatments were applied, trees within the strip/selection plots had consistently greater BA2, BAG, and Growth than trees within other treatments, and significantly greater BAG and Growth on those plots than trees that had been selection thinned. There were insignificant differences in BAG and Growth between the control and the strip and selection treatments (table 2).

Red Oak, willow oak, black oak, water oak, and white oak (*Q. alba*) had the greatest BA in both 1987 and 1993, with red oak significantly greater in basal area (BA) than all species except the other oaks (table 3). The hickories (*Carya* spp.), green ash (*Fraxinus pennsylvanica*), sweetgum, and red maple were grouped together in BA both years, with the remaining species a third group. These

Table 2—Mean per-tree basal area for each thinning treatment

	Treatment							
Treatment	Strip		Strip selection		Selection		Control	
plot	No.	Mean	No.	Mean	No.	Mean	No.	Mean
	- -Square feet- - - - - - - - - - - - - - - - - - - -							
BA1	360	0.36 BC	230	0.51 AB	259	0.57 A	686	0.31 C
BA2	343	0.48 BC	172	0.84 A	250	0.64 B	632	0.39 C
BAG	343	0.11 AB	172	0.21 A	250	0.06 B	632	0.07 AB
Gr	343	0.10 B	172	1.69 A	250	0.39 B	632	0.65 AB

No. = Number of trees within treatment plots; BA1 = BA/plot in 1987; BA2 = BA/plot in 1993; BAG = (BA2-BA1); Gr = Diameter Growth.
Within-row means not followed by same letter are significantly different (p<0.05).

Table 3—Mean basal area and diameter growth for each species (+2 occurrence) found within four treatment plots[a]

Species	BA1	BA2	BAG	Growth
	- - - - - - - - - -	*Square feet*	- - - - - - - - -	*Inches*
Quercus falcata	0.73 A	0.98 A	0.22 AB	1.56 B
Q. phellos	0.64 AB	0.78 AB	0.13 ABC	0.91 BC
Q. velutina	0.59 AB	0.78 AB	0.16 ABC	1.14 BC
Q. nigra	0.51 AB	0.64 ABC	0.10 ABC	0.88 BC
Q. alba	0.40 BC	0.49 BCD	0.08 BC	0.73 BC
Carya spp.	0.22 CD	0.27 DE	0.04 C	0.44 BC
Fraxinus pennsylvanica	0.19 CD	0.29 DE	0.06 C	0.70 BC
Liquidambar styraciflua	0.15 CD	0.20 DE	0.04 C	0.58 BC
Acer rubrum	0.12 D	0.20 DE	0.06 BC	0.93 BC
Ulmus americana/rubra	0.06 D	0.09 E	0.03 C	0.56 BC
Nyssa sylvatica	0.05 D	0.08 E	0.03 C	0.61 BC
Cercis canadensis	0.03 D	0.30 CDE	0.27 A	3.06 A
Carpinus caroliniana	0.03 D	0.04 E	0.01 C	0.35 C

BA1 = Basal area/plot in 1987; BA2 = Basal area/plot in 1993; BAG = Basal area growth (BA2- BA1); Growth = Diameter growth.
[a]Within-column means not followed by same letter are significantly different (p<0.05).

groups match the results of a study performed on upland hardwood sites throughout northern Alabama (Zhang and others 1994).

The greatest BAG was by redbud (*Cercis canadensis*) (0.268 square feet), but not significantly more than the oaks. The other species had no significant differences in BAG between species. Significantly greater growth was also produced by redbud than any of the other species, where little significant variation was observed. Individual redbud appeared to have taken advantage of the increase in available resources that resulted in these thinning operations, but their low numbers (6) and small basal area (table 3) made little impact at the stand level, and would have little impact on the market value of these stands.

CONCLUSIONS

Even though growth of individual trees was stimulated by thinning, this increase was not sufficient to offset the reduction in growing stock with thinning. Therefore, stand level growth was not increased by thinning. Depending on the management objective, thinning may be a suitable intermediate treatment for hardwoods, concentrating growth of overstory trees in the stand on a few large individuals. Any of these regimes should provide additional growth response in the higher quality species if the residual BA is decreased, and undesired species removed in the thinning activity. Strip thinning appears to accomplish this objective as well as single-tree selection. As management and silvicultural options are considered for low-quality, mixed-hardwood forests of the Southern United States, intermediate operations may play a large role in the successful management of individual trees within these forests but will not affect stand level productivity. Care must be taken that whatever option is chosen, the newly available resources do not go to the undesirable understory species such as redbud, rather than to the more valuable overstory oak species.

ACKNOWLEDGMENT

This project was made possible by USDA Forest Service Cooperative Agreement 23-91-03. Our sincere appreciation to Dr. George Brown and Dr. Basil Pinker at Alabama A&M University for the initial plot establishment, and to the USDA Forest Service Research Station Unit in Houghton, MI, for funding and technical assistance.

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