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Sawtimber by Prescription— The Sudden Sawlog Story Through Age 33

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INTRODUCTION

Even-aged loblolly pine stands on good sites can grow sawtimber to a dbh of 17 to 18 inches in 33 years, with a standing volume of 13.1 M bm International ¼-inch rule to an 8-inch top d.i.b. The requirements for achieving this are ample growing space and green pruning for selected high-value individual trees, followed by understory control. The landowner must sacrifice some of the small-diameter roundwood that could be harvested in intermediate cuttings. Stumpage value of small-diameter roundwood today is low, and this sacrifice may not be painful. This paper reports yield, standing volume, and stand structure through age 33, obtained in a continuing study near Crossett, Arkansas.

METHODS

Plot Establishment

An old-field loblolly pine plantation was selected for the study. The stand had been bar-planted at a spacing of 6 × 6 feet, rows following contours. In February 1954 the stand was 9 years old (10 years from seed germination) and contained 1,100 pine trees/acre. Basal area in pines at least 1.0 inch dbh was 71 ft^2/acre. Dominant and codominant trees averaged 22 feet in height and 4 inches dbh. Nearly all trees were in the 1- through 5-inch dbh classes. There was very little understory vegetation. The 50-year site index for the loblolly pine plantation was determined to be between 90 and 100 feet.

Twelve 0.25-acre square plots, each with a 0.5-chain-wide isolation zone, were established and organized into 3 blocks on the twin bases of basal area and suspected differences in site quality. Researchers selected and tagged 100 crop trees/acre (25/plot) that were well spaced, vigorous, and well formed. Four treatments were assigned randomly within each block. Two treatments began immediately and two began at age 12, when the average tree had attained merchantable pulpwood size (at least 4.6 inches dbh, containing at least two 63-inch bolts to a 3-inch top d.i.b.). The four treatments were:

Sawtimber-only.—All but the crop trees were cut at age 9, which reduced basal area to 10 ft^2/acre (table 1, fig. 1). Stands were thinned to 76 trees/acre at age 19, 64 trees/acre at age 24, 48 trees/acre at age 27, and 41 trees/acre at age 30.

Sawtimber-pulpwood.—Thinnings at ages 9 and 12 removed noncrop trees whose crowns were within 5 feet of crop tree crowns. The last noncrop trees were removed at age 15. Further thinning left 80 trees/acre at age 19, 63 trees/acre at age 27, and 52 trees/acre at age 30.

Delayed-sawtimber—All but the 100 crop trees/acre were removed at age 12. The 0.25-acre plots were thinned to 80 trees/acre at age 24, 53 trees/acre at age 27, and 45 trees/acre at age 30.

Control.—Plots were thinned, mainly from below, to a basal area of 85 ft^2/acre at age 12 and every 3 years afterward through age 30. The thinnings reduced stand density to 712 stems/acre at 12 years, 468 at 15 years, 333 at 18 years, 251 at 21 years, 193 at 24 years, 148 at 27 years, and 116 at 30 years.

Thinnings at age 9 were precommercial. Thinnings at age 12 were largely commercial. After all noncrop trees were removed from the intensive treatment plots (sawtimber-only, sawtimber-pulpwood, and delayed-sawtimber), the prescriptions for thinning specified the stand to be retained in terms of trees/acre through age 24 and in basal area from age 27 onward. The timing and severity of thinnings were based on periodic dbh growth. The intent was to keep trees in the intensive treatments growing markedly and consistently faster than crop trees in control plots and to keep sawtimber-only trees growing distinctly faster than sawtimber-pulpwood and delayed-sawtimber trees.

Crop trees in the intensive treatments were pruned to about half their total height after the first thinning in the treatment and every 3 years afterward through

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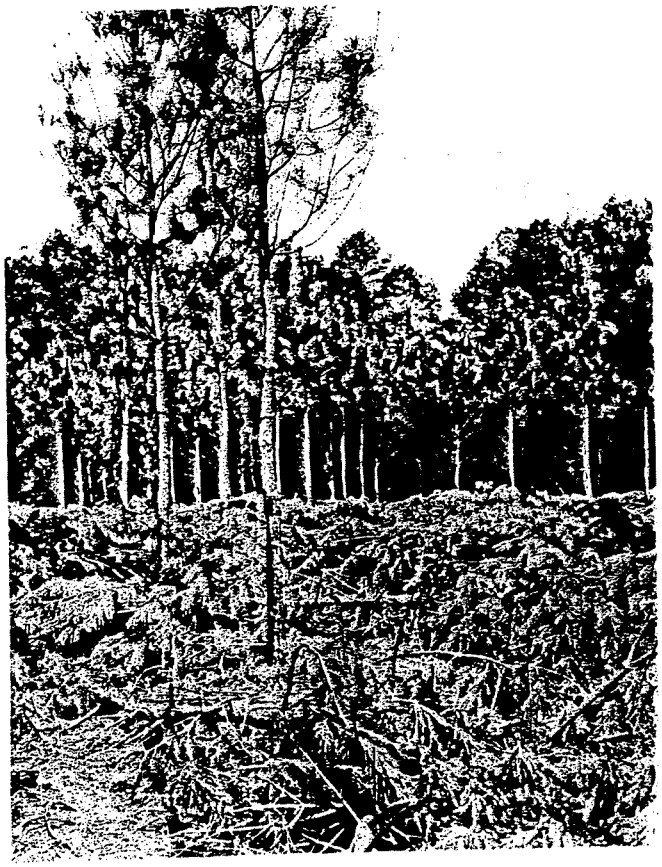

Figure 1.—*This sawtimber-only plot was photographed in March 1954, after thinning to 100 crop trees per acre and pruning to an average height of 11 feet at age 9.*

age 24; pruned bole length then equaled two 16-foot logs plus trimming allowance (fig. 2). Initial pruning went to a minimum height of 9 feet; pruned length on some trees was 10 or 12 feet because of internode length, and height to base of live crown before pruning at age 9 was 5 to 7 feet. Pruning at age 9 removed about 35 percent live crown length from the average dominant-stand tree and left a crown 13 feet long.

Beginning at age 19, the woody understory (hardwood sprouts, vines and shrubs) in intensive-culture plots was controlled by mowing at 2-year intervals. The aim of heavy thinning and understory control was to reduce competition for soil moisture and thus to accelerate the growth of crop trees.

Except for frequency of thinnings, the control treatment simulated conventional industrial silviculture as was in practice when the study began, with no pruning at all and no understory control before age 27.

Measurements and Analysis

The dbh of all trees was measured every 3 years, beginning at age 9. Total and merchantable heights were measured from age 12. Upper-stem measurements were made, beginning at age 21, which permitted more accurate estimates of stem form and volume. Cubic-foot volume to a 3-inch d.i.b. was obtained from a standard volume table entered by dbh and total height (U.S. Dep. of Agric. For. Serv. 1976) from age 12 to age 18. Beginning with age 21, cubic-foot and board-foot volumes were calculated by the STX Program (Grosenbaugh 1967).

Pulpwood volumes in this paper are in cunits. One cunit = 100 ft^3 of peeled wood.

Board-foot volumes, Int. ¼-inch rule and Doyle rule, were reckoned for two utilization thresholds: (1) stems at least 9.6 inches dbh containing one or more 16-foot logs to an 8-inch top d.i.b., and (2) stems at least 7.6 inches dbh containing one or more 16-foot logs to a 6-inch top d.i.b. Differences between estimates to these two thresholds represented material in small sawlogs suitable for conversion by a chipping headrig, but not merchantable as conventional sawlogs or veneer bolts.

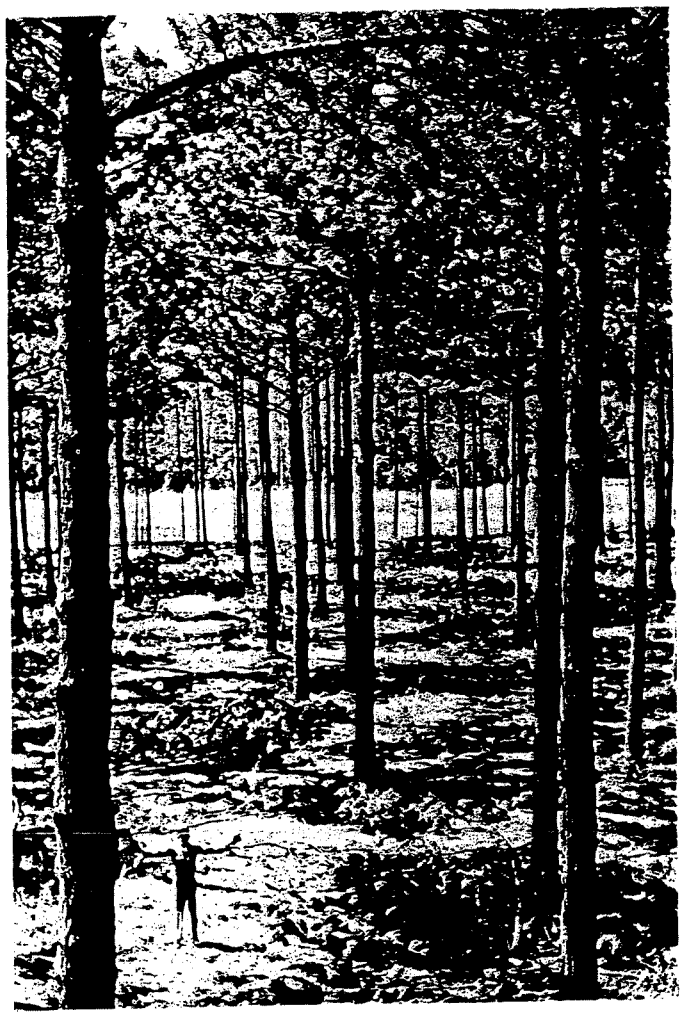

Figure 2.—*This sawtimber-pulpwood plot had just had its final pruning to an average height of 2 logs (32 feet) when the photograph was taken in March 1969. Pruned branches were left to decompose where they fell. The open area in the background is a utility right-of-way.*

Table 1.—*Basal area before and after thinning, ages 9–33*

Age	Stand condition	Treatment			
		Sawtimber-only	Sawtimber-pulpwood	Delayed-sawtimber	Control
yrs.		*square feet/acre*			
9	Before cut	71	70	69	74
	After cut	10	31	[1]	[1]
12	Before cut	25	65	118	124
	After cut	[1]	29	15	85
15	Before cut	47	56	33	119
	After cut	[1]	37	[1]	84
18	Before cut	69	57	55	113
	After cut	[1]	[1]	[1]	85
19	Before cut	75	63	61	90
	After cut	60	52	[1]	[1]
21	Before cut	69	63	73	103
	After cut	[1]	[1]	[1]	85
24	Before cut	82	78	88	103
	After cut	70	75	75	85
27	Before cut	84	89	89	104
	After cut	65	76	63	85
30	Before cut	76	88	74	101
	After cut	65	75	65	82
33	Before cut	70	81	73	97
	After cut	[1]	[1]	[1]	[1]

[1]Plots in this treatment were not thinned at this time.

Standing volume is defined as cubic-foot or board-foot volume of stemwood per acre in living trees before thinning, at any specified age. Yield to any age consists of standing volume plus volume in all previous merchantable thinnings plus any volume in natural mortality occuring in merchantable trees after age 12.

Two measures of stem form were calculated, Girard form class and absolute form quotient (AFQ). The latter is obtained (Husch et al. 1972) as:

$$AFQ = \frac{\text{(bole d.o.b. midway between breast height and apex)}}{\text{dbh}}$$

Differences in some of the tree and stand attributes due to treatment were evaluated by analysis of variance and Duncan's Multiple Range Test. Significance was preset at the 0.05 level.

RESULTS

Growth in Dbh

At age 33, mean dbh was 17.1 to 18.0 inches (by treatment means) in the intensive treatments and 12.3 inches in the control. These diameters reflect both differences in growth rate due to treatment and changes in mean stand diameter associated with thinning. For crop trees remaining at age 33, mean dbh growth after initial thinning averaged 0.57 inch/year in sawtimber-only, 0.54 inch/year in sawtimber-pulpwood, 0.56 inch/year in delayed-sawtimber, and 0.34 inch/year in control. Periodic growth rates for crop trees in each treatment were:

Stand age	Treatment			
	Sawtimber-only	Sawtimber-pulpwood	Delayed-sawtimber	Control
years	*inch/year*			
9–12	0.87	0.60	.....	.....
12–15	0.90	0.80	0.93	0.37
15–18	0.70	0.73	0.80	0.37
18–21	0.47	0.57	0.57	0.30
21–24	0.43	0.50	0.43	0.30
24–27	0.43	0.43	0.43	0.40
27–30	0.40	0.37	0.43	0.27
30–33	0.33	0.30	0.33	0.33

In other loblolly pine thinning studies, researchers found very little difference in mean dbh of the 50 largest trees/acre between thinned and unthinned plots for ages 25 to 60 (Andrulot and Williston 1974), or between levels of thinning for ages 20 to 45 (Feduccia and Mosier 1977). In this study, however, between-treatment differences in growth of larger trees developed early and persisted through age 33 (fig. 3). Comparisons were based on the largest 48 trees/acre from age 15 through 30; after age 30 the basis was 36

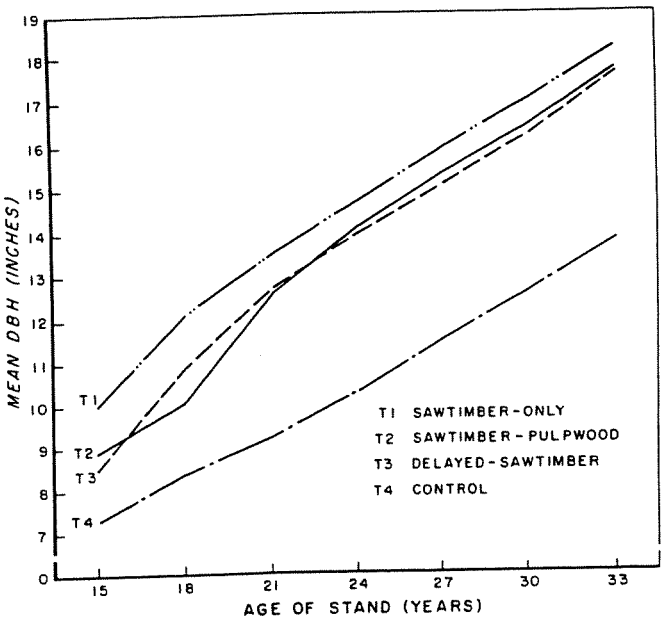

Figure 3.—*Quadratic mean dbh by treatment and age of the 48 largest trees per acre (36 trees at age 33).*

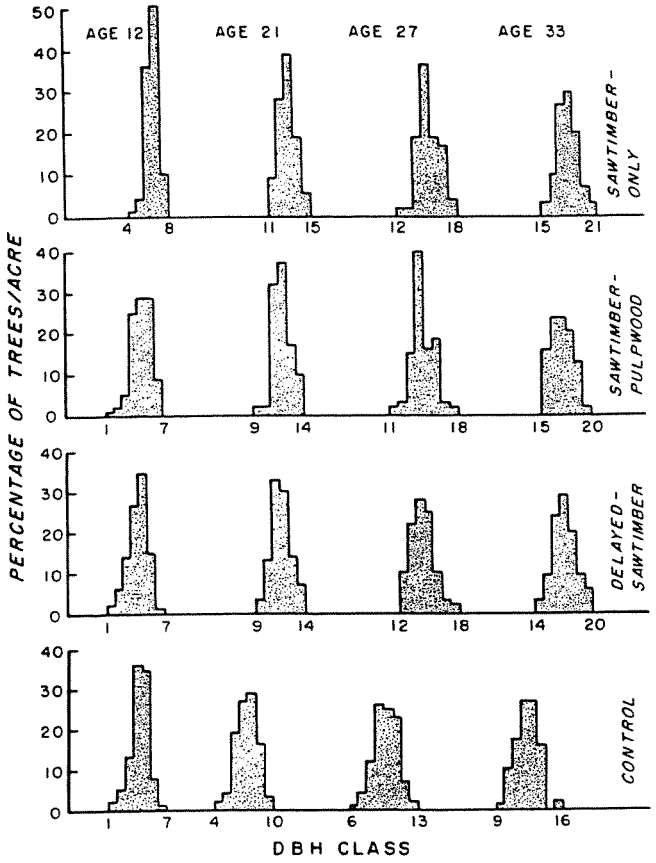

Figure 4.—*Stand structure by treatment before thinning at ages 12, 21, 27, and 33.*

trees/acre because one plot had been reduced to that level. At age 15, all four treatment means were significantly different. From age 18 through age 21 the sawtimber-pulpwood and delayed-sawtimber means were not different, but they were significantly smaller than sawtimber-only and significantly greater than the control. From age 24 through age 33, mean dbh was not significantly different among the intensive treatments, but it was significantly greater than in the control. Thinning levels in these intensive treatments differed more from the control than in the other studies cited.

Diameter Distribution

Following initial thinning at age 9, 99 percent of the sawtimber-only trees were in the 3-inch, 4-inch, and 5-inch dbh classes. The first thinning left 452 stems/acre in the sawtimber-pulpwood plots, with 16 percent of them in the 1-inch and 2-inch classes. At age 12, before thinning, 95 percent of the sawtimber-only trees were in the 6-inch class and larger (fig. 4), compared to 39 percent of the control trees.

At age 21, before thinning, all of the sawtimber-only trees, 98 percent of the sawtimber-pulpwood, 97 percent of the delayed-sawtimber trees, and 4 percent of the control trees were in the 10-inch class and larger.

Before thinning at age 27, 98 percent of the sawtimber-only trees were in the 13-inch dbh class or larger. Ninety-five percent of the sawtimber-pulpwood, 90 percent of the delayed-sawtimber, and 2 percent of the control trees were in the 13-inch class and up. Forty-three percent of the control trees were less than 10 inches in dbh.

At age 33, all the sawtimber-only trees, all the sawtimber-pulpwood trees, and 97 percent of the delayed-sawtimber trees were 15 inches or more in dbh. In the control plots, 99 percent of the trees were in the 10-inch or larger classes, but only 2 percent were as large as 15 inches.

Cunit Volumes, Standing and Harvested

Standing stemwood volume to a 3-inch top was always significantly greater in control plots than intensive culture plots, except at age 12, when delayed-sawtimber plots had the greatest volume (table 2). Neither delayed-sawtimber nor control plots had yet been thinned; the difference at age 12 was a random consequence of pretreatment stand density, not a result of treatment. Sawtimber-only plots, having been drastically thinned at age 9, contained very little volume. At age 18, they supported 12.35 cunits/acre. At age 27, the plots in the three intensive treatments averaged 22 cunits/acre and control plots 26. Because of periodic thinnings, standing volumes at ages 30 and

Table 2—*Standing pulpwood volumes before thinning and volumes removed in commercial thinnings plus natural mortality: merchantable stemwood in cunits to a 3-inch top d.i.b.*[1]

Age (years)	Sawtimber-only	Sawtimber-pulpwood	Delayed sawtimber	Control
		cunits/acre		
Standing Volume				
12	2.15	4.75	7.65	6.83
15	6.30	7.30	4.21	13.94
18	12.35	9.82	9.11	18.78
21	13.40	12.16	13.48	18.97
24	18.97	17.85	19.64	22.54
27	20.87	22.51	22.54	26.24
30	20.23	23.45	20.29	25.68
33	21.04	24.04	21.92	28.05
Volumes cut and mortality				
12	0	.96	6.40	1.93
15	0	2.32	0	3.72
18	0	0	0	4.15
19	2.33	1.82	0	0
21	0	0	0	3.06[3]
24	2.68	.66[2]	2.88	3.92
27	4.51	3.39	6.28	4.33
30	2.74	3.27	2.68	4.42
30–33[2]	.63	.54	0	0
Total volumes cut	12.89	12.96	18.24	25.53

[1]One cunit = 100 ft^3 of peeled wood.
[2]Volume by mortality alone.
[3]Includes .13 cunit mortality.

Table 3.—*Standing volume per acre before thinning in different classes of product, ages 21 through 33*

Age	Product	Unit	Sawtimber-only	Sawtimber-pulpwood	Delayed-sawtimber	Control
21	Pulpwood	Cunit	.83	.82	1.05	12.71
	SS[1]	M bm Int. ¼	.95	1.17	1.92	2.74
	CS[2]	M bm Int. ¼	6.14	5.03	4.77	.06
	SS	M bm Doyle	.30	.36	.60	.65
	CS	M bm Doyle	3.19	2.45	2.32	.03
24	Pulpwood	Cunit	.86	.85	1.03	8.63
	SS	M bm Int. ¼	.84	.91	1.24	5.11
	CS	M bm Int. ¼	9.84	8.94	9.37	1.46
	SS	M bm Doyle	.28	.32	.38	1.32
	CS	M bm Doyle	5.60	4.88	5.00	.59
27	Pulpwood	Cunit	.75	.98	1.04	4.77
	SS	M bm Int. ¼	.51	.67	.75	5.35
	CS	M bm Int. ¼	11.71	12.19	11.94	5.31
	SS	M bm Doyle	.11	.14	.16	1.35
	CS	M bm Doyle	7.13	7.18	6.87	2.34
30	Pulpwood	Cunit	.44	.64	.54	2.95
	SS	M bm Int. ¼	.44	.58	.49	4.93
	CS	M bm Int. ¼	11.95	13.43	11.64	6.69
	SS	M bm Doyle	.09	.12	.10	1.32
	CS	M bm Doyle	7.81	8.42	7.30	3.11
33	Pulpwood	Cunit	.40	.53	.49	1.78
	SS	M bm Int. ¼	.38	.46	.44	2.60
	CS	M bm Int. ¼	12.89	14.39	13.13	11.76
	SS	M bm Doyle	.08	.10	.09	.61
	CS	M bm Doyle	8.87	9.56	8.78	5.99

[1]SS (small sawlogs): Trees between 7.6 and 9.5 inches dbh to a 6-inch top d.i.b., also between the 8-inch and 6-inch d.i.b. in upper stems of trees containing conventional sawlogs.
[2]CS (conventional sawlogs): Trees at least 9.6 inches dbh containing at least one 16-foot log to an 8-inch top d.i.b.

33 years were not much different from those at age 27; what was different was number and average size of trees.

Total volume of stemwood to a 3-inch top in commercial thinnings, from age 12 onward, averaged 12.93 cunits/acre in sawtimber-only and sawtimber-pulpwood, 18.24 cunits in delayed-sawtimber, and 25.53 cunits in the control (table 2); these totals were significantly different.

Natural mortality was slight. One tree was salvaged in a control plot at age 20, two trees in a sawtimber-pulpwood plot at age 24, and one tree each in a sawtimber-only and a sawtimber-pulpwood plot between ages 30 and 33.

Sawtimber Standing Volume

Sawtimber first appeared in standing volumes at age 21. Nearly every tree in the intensive treatments included a conventional sawlog in the butt and some pulpwood in the upper stem. Control plots contained only 12 trees/acre that were at least 10 inches dbh.

The pulpwood, small-sawlogs, and conventional-sawlogs volumes in table 3 from age 21 through 33 are additive. At age 21, for example, sawtimber-only plots contained 0.83 cunit/acre of pulpwood plus 6.14 M bm (Int. ¼) of conventional sawlogs plus 0.95 M bm in small sawlogs, or 0.83 cunit/acre plus (6.14 + 0.95) M bm to a 6-inch top. Board-foot volumes are also given in Doyle-rule equivalents; thus, sawtimber-only plots at age 21 contained (3.19 + 0.30) M bm (Doyle) to a 6-inch top plus 0.83 cunit/acre of pulpwood to a 3-inch top.

Analysis of variance in board-foot standing volumes and yields, to the two thresholds of merchantability, was done only with Int. ¼ values. Sawtimber-only plots contained more volume than sawtimber-pulpwood and delayed sawtimber at age 21; control plots contained less at the same age (table 3). At age 30, volumes in intensive treatments were greater than those in control but not different from each other. At age 33, the only significant difference was between sawtimber-pulpwood and control.

In board feet to a 6-inch top (trees at least 7.6 inches dbh), standing volume at age 21 averaged 6.67 M bm (Int. ¼) in intensive treatments and differed significantly from the 2.80 M bm in control. At age 30, only the sawtimber-pulpwood plots had significantly greater standing volume than control. At age 33, there was no difference between treatments. The initial effect of drastic thinning on board-foot growth was dramatic, but it diminished rapidly.

Sawtimber Yield

Board-foot yield to ages 21 and 24 consisted entirely of standing volume. From age 24 onward, total yield in conventional sawlogs was nearly equal in all three intensive treatments (table 4). Conventional sawlog yield from intensive culture was 6 times that of control at age 24, 2.4 times at age 27, 2.3 times at age 30, and 1.5 times at age 33. In trees at least 7.6 inches dbh to a 6-inch top, total yield from intensive culture was 1.6 times that of control at age 24, 1.2 times control at ages 27 and 30, and 1.09 times control at age 33, using Int. ¼ values.

Sawtimber Volume in Thinnings

The first sawtimber thinnings removing at least 1 M bm were in the sawtimber-only and the delayed-sawtimber at age 24 (table 5). The sawtimber-pulpwood plots first produced sawlogs in thinnings at age 27, and the control plots never did produce as much as 1 M bm (Int. ¼) in conventional sawlogs in a thinning. No thinning was done at age 33.

Other Stand Attributes at Age 33

Girard form class averaged 81 percent at age 33. Differences between treatments were not significant at age 21 or any time since.

The AFQ was 71 percent at age 33 with no differences between treatments. Taper in the lower half of the bole apparently was not much affected by thinning intensity.

Mean height to an 8-inch d.i.b. was 52 feet in all three intensive treatments and 36 in the control. This difference was significant. Mean height to a 6-inch d.i.b. was 60 to 62 in intensive treatments and 51 in control. Mean height to a 3-inch d.i.b. was 70 feet in sawtimber-only and delayed-sawtimber, 69 feet in sawtimber-pulpwood, and 64 feet in control. Only the difference between 70 feet and 64 feet was significant.

Total height at 33 years averaged 77 feet in control and 79 to 80 feet in the intensive treatments; there were no significant differences.

Mean live crown percent at age 33 was 50 in the intensive treatments and 38 in control; the difference was significant.

DISCUSSION AND CONCLUSIONS

Which of the four treatments is best? The answer depends on the objective of management. The three intensive treatments were intended to grow sawtimber in a very short time, and they did. Intensive culture's advantage over control, in sawtimber yield to an 8-inch top, rapidly diminished after age 30.

If growing sawtimber to an 8- or 6-inch top in the shortest possible time is the landowner's objective, and production of small-diameter roundwood is not important, then precommercial thinning is called for, and

Table 4.—*Total yield per acre of merchantable stemwood in different classes of product, ages 21 through 33.*

Age	Product	Unit	Sawtimber-only	Sawtimber-pulpwood	Delayed-sawtimber	Control
21	Pulpwood	Cunit	3.16	5.92	7.45	22.64
	SS[1]	M bm Int. ¼	.95	1.17	1.92	2.74
	CS[2]	M bm Int. ¼	6.14	5.03	4.78	.06
	SS	M bm Doyle	.30	.36	.60	.64
	CS	M bm Doyle	3.19	2.45	2.32	.03
24	Pulpwood	Cunit	3.19	5.95	7.43	21.49
	SS	M bm Int. ¼	.84	.91	1.24	5.18
	CS	M bm Int. ¼	9.84	8.94	9.37	1.46
	SS	M bm Doyle	.28	.32	.38	1.33
	CS	M bm Doyle	5.60	4.88	5.00	.59
27	Pulpwood	Cunit	3.23	6.10	7.65	20.22
	SS	M bm Int. ¼	.67	.70	1.13	5.93
	CS	M bm Int. ¼	13.00	12.55	13.03	5.41
	SS	M bm Doyle	.16	.16	.28	1.48
	CS	M bm Doyle	7.82	7.40	7.44	2.38
30	Pulpwood	Cunit	3.12	5.92	7.53	20.17
	SS	M bm Int. ¼	.74	.74	1.16	6.54
	CS	M bm Int. ¼	15.65	15.48	15.81	6.94
	SS	M bm Doyle	.18	.16	.29	1.72
	CS	M bm Doyle	9.88	9.53	9.51	3.21
33	Pulpwood	Cunit	3.14	5.95	7.56	19.92
	SS	M bm Int. ¼	.75	.73	1.17	5.26
	CS	M bm Int. ¼	18.57	18.52	18.80	12.70
	SS	M bm Doyle	.18	.16	.29	1.28
	CS	M bm Doyle	12.22	11.89	11.88	6.41

[1]SS (small sawlogs): Trees between 7.6 and 9.5 inches dbh to a 6-inch top d.i.b., also between the 8-inch and 6-inch d.i.b. in upper stems of trees containing conventional sawlogs.
[2]CS (conventional sawlogs): Trees at least 9.6 inches dbh containing at least one 16-foot log to an 8-inch top d.i.b.

Table 5—*Volume per acre harvested in commercial thinnings plus volume in dead trees in different classes of product, ages 24 through 30*[1]

Age	Product	Unit	Sawtimber-only	Sawtimber-pulpwood	Delayed-sawtimber	Control
24	Pulpwood	Cunit	.15	.02	.21	2.59
	SS[2]	M bm Int. ¼	.16	.03	.38	.51
	CS[3]	M bm Int. ¼	1.29	.36	1.09	.10
	SS	M bm Doyle	.06	.01	.12	.12
	CS	M bm Doyle	.69	.21	.56	.03
27	Pulpwood	Cunit	.20	.16	.38	1.77
	SS	M bm Int. ¼	.14	.13	.28	1.03
	CS	M bm Int. ¼	2.40	1.68	3.08	.16
	SS	M bm Doyle	.03	.03	.06	.26
	CS	M bm Doyle	1.38	.90	1.65	.07
30	Pulpwood	Cunit	.06	.14	.08	.92
	SS	M bm Int. ¼	.07	.12	.07	1.05
	CS	M bm Int. ¼	1.99	2.08	1.50	.68
	SS	M bm Doyle	.02	.02	.02	.28
	CS	M bm Doyle	1.28	1.21	.89	.32
Total (Ages) 24–30	Pulpwood	Cunit	.41	.32	.67	5.28
	SS	M bm Int. ¼	.37	.28	.73	2.59
	CS	M bm Int. ¼	5.68	4.12	5.67	.94
	SS	M bm Doyle	.11	.06	.20	.66
	CS	M bm Doyle	3.35	2.32	3.10	.42

[1]No cutting was done at age 33.
[2]SS (small sawlogs): Trees between 7.6 and 9.5 inches dbh to a 6-inch top d.i.b., also between the 8-inch and 6-inch d.i.b. in upper stems of trees containing conventional sawlogs.
[3]CS (conventional sawlogs): Trees at least 9.6 inches dbh containing at least one 16-foot log to an 8-inch top d.i.b.

the sawtimber-only treatment is the best of the four treatments. It had the greatest dbh at every inventory, and the greatest sawtimber yield at age 21.

If the main objective is to grow sawtimber quickly, and a heavy early cut of merchantable pulpwood is an important secondary consideration, then delayed-sawtimber is the best of the four treatments. It produced the largest single pulpwood cut very early, its sawlog yield from age 24 onward was not significantly different from that of the sawtimber-only treatment, and it involved one less pruning.

The intensive treatments used in this study could be improved and their costs reduced. Results would not necessarily be identical to those actually attained; from a silvicultural standpoint, they might even be better.

If old fields or prepared sites are to be planted for fast growth of loblolly pine sawtimber, a spacing of 6×6 feet is too close, unless factors other than tree growth are considered. Loblolly pine spacing trials in Louisiana at Homer (Shepard 1974), Woodworth (Feduccia and Mosier 1977), and Merryville (Campbell and Mann 1974); and at Union, South Carolina (Balmer et al. 1975); showed that spacings of 10×10 or 12×12 feet produced sawtimber much earlier than did spacings of 6×6 or 8×8 feet. Excessively wide spacings also are undesirable. Planting only the number of crop trees desired, at a spacing of 21×21 feet, avoids precommercial thinning, but creates other problems. A landowner who plants at wide spacings will find that planting costs are less, larger trees will be grown in a shorter time, and percentage of juvenile corewood will be greater (Zobel et al. 1958). The limbs will be coarser, percentage of compression wood will be greater (Haught 1957), pruning will be needed earlier, and understory control will be needed earlier and more often. The impact of tipmoth infestation and fusiform rust stem infection probably will be greater than they were in this study.

Selection of the 100 crop trees/acre at age 9 in this study was difficult and time-consuming because many of the more vigorous trees were forked (as a result of tipmoth attack) or had stem galls. Many compromises had to be made. Incidence of fusiform rust is difficult to predict, but even minor occurrences can ruin a widely spaced sawtimber planting. A spacing of 8×8 or 7×9 feet will offer more trees from which to choose than a 10×10 foot spacing.

Mowing is not the only way to control woody understory. Fire or chemicals may be cheaper. In loblolly pine plantations, prescribed burning may be done as early as age 12 (Crow 1970).

Pruning can be very expensive, and some landowners may be inclined to omit it. But if the trees have undergone drastic thinning to as few as 100 trees/acre, pruning is necessary. Without it, fast-growing young trees at wide spacings form numerous large knots and much compression wood. With today's labor costs, pruning should be restricted to the butt log and done in one or two steps. It should leave a crown whose length is equal to 50 percent of the total height of the tree and be completed before d.o.b. at 17.3 feet is much greater than 4 inches. Table 1 of Mesavage and Girard (1946) indicates that 42 percent of the board-foot volume of a 3-log tree is in the first 16-foot log.

With understory control, green pruning, and ample growing space for selected crop trees, sawtimber can be grown in less than 30 years. Sudden sawlogs culture is recommended for land ranging from gently sloping to nearly level, where site index is 90 feet or more at 50 years, and where the risk of erosion is slight.

LITERATURE CITED

Andrulot, E. A. and H. L. Williston.
1974. Growth and yield of second-growth loblolly in central Louisiana. *In* Proc. Sympos. on Mgmt. of Young Pines, p. 116–120. U.S. Dep. Agric. For. Serv., Southeast. Area, State and Private For. and South. and Southeast. For. Exp. Stns., Alexandria, La. and Charleston, S.C.

Balmer, W. E., E. G. Owens, and J. R. Jorgensen.
1975. Effects of various spacings on loblolly pine growth 15 years after planting. U.S. Dep. Agric. For. Serv. Res. Note SE-211, 7 p. Southeast. For. Exp. Stn. Asheville, N.C.

Campbell, T. E. and W. F. Mann, Jr.
1974. Growth in a loblolly pine spacing study in southwest Louisiana. *In* Proc. Sympos. on Mgmt. of Young Pines, p. 108–115. U.S. Dep. Agric. For. Serv., Southeast. Area, State and Private For. and South. and Southeast. For. Exp. Stns. Alexandria, La. and Charleston, S.C.

Crow, A. B.
1970. Prescribed burning in Lousiana pinelands. La. State Univ. Coop. Ext. Pub. 1618. 17 p. Baton Rouge, La.

Feduccia, D. and J. Mosier.
1977. The Woodworth spacing and thinning study: an obituary. Forests & People 27(1):18–21.

Grosenbaugh, L. R.
1976. STX-FORTRAN-4 program for estimates of tree populations from 3P sample-tree measurements. U.S. Dep. Agric. For. Serv. Res. Pap. PSW-13, rev., 76 p. Pac. Southwest. For. and Range Exp. Stn. Berkeley, Ca.

Haught, E.
1957. Distribution and extent of compression wood in loblolly pine. *In* First Forest Tree Improvement Progress Report. 14 p. N.C. State College School of Forestry. Raleigh, N.C.

Husch, B., C. I. Miller, and T. W. Beers.
1972. Forest mensuration, 2nd ed. Ronald Press, New York, 410 p.

Mesavage, C. and J. W. Girard.
1946. Tables for estimating board-foot volume of timber. U.S. Dep. Agric., Washington, D.C. [Unnumbered Publ.] 94 p.

Shepard, R. F., Jr.
1974. An initial spacing study. *In* Proc. Sympos. on Mgmt. of Young Pines, p. 121-128. U.S. Dep. Agric. For. Serv., Southeast. Area, State and Private For. and South. and Southeast. For. Exp. Stns., Alexandria, La. and Charleston, S.C.

U.S. Dep. Agric. For. Serv.
1976. Volume, yield, and stand tables for second-growth southern pines. U.S. Dep. Agric. Misc. Pub. 50, rev., 202 p., Washington, D.C.

Zobel, Bruce J. and Robert L. McElwee.
1958. Natural variations in wood specific gravity of loblolly pine, and an analysis of contributing factors. Tappi 41(4):158–161.

Conversion to Metric Units

1 inch	=	2.54 centimeters
1 foot	=	0.3048 meter
1 acre	=	0.4047 hectare
1 tree/acre	=	2.47 trees/hectare
1 square foot/acre	=	0.2296 square meters/hectare
1 cubic foot/acre	=	0.06997 cubic meters/hectare
1 cubic foot	=	0.0283 cubic meter
1 cunit	=	2.83 cubic meters of peeled wood

BURTON, J. D.

1981. Sawtimber by prescription—the sudden sawlog story through age 33. U.S. Dep. Agric. For. Serv. Res. Pap. SO-179, 9 p. South. For. Exp. Stn., New Orleans, La.

Presents total and net yield, standing volume, volume harvested, and natural mortality, in cubic feet i.b. to a 3-inch top d.i.b., and in board feet Int. ¼ to an 8-inch and to a 6-inch top, together with dbh distribution at various ages.

Additional keywords: *Pinus taeda* L., stand structure, diameter distribution, stem form, stand density.

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