Profitability of Precommercially Thinning Oak Stump Sprouts

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ABSTRACT. *Thinning oak stump sprouts to a single stem at an early age will increase diameter growth of the released stem. However, precommercial thinning represents a substantial investment which must be carried for many years before any returns are realized. We estimated the incremental gains in yield and the present net worth for five crop-tree release treatments of 5-yr-old coppice sprouts in the southeastern Missouri Ozarks and compared them to the results from unthinned control plots. The treatments involved thinning 100, 150, 200, 250, and all clumps of sprouts on the plots to a single stem. All thinning treatments increased diameter growth and yield compared to the control, but at a 5% rate of return, the control treatment produced the largest present net worth. We have concluded that based on the growth response and timber price situations within the Ozark Region, precommercial thinning of oak stump sprouts is not an economical management practice. North. J. Appl. For. 10(4):179–183.*

Regeneration of upland oak after a timber harvest is primarily from stump sprouts and advance reproduction. Stump sprouts which grow in clumps represent the fastest growing component of reproduction (Sander et al. 1984). Precommercial thinning of oak clumps to a single stem has been found to maximize diameter growth (Johnson and Godman 1983, Lamson 1983, Johnson and Rogers 1980), and increase the future value of residual trees (Allen and Marquis 1970).

However, the economic gains from thinning young stands must be weighed against the costs of carrying thinning investments over virtually the entire length of the rotation. Costs of precommercial thinning depend on residual stand density and method of thinning (i.e., areawide versus crop tree). In this study, the areawide thin refers to the thinning of each and every clump of sprouts to a single stem over an entire acre. On the other hand, the crop-tree release involved thinning just 100, 150, 200, and 250 clumps per acre to release a single crop-tree sprout per clump while leaving the remaining clumps unthinned.

The objective of this study was to evaluate the economic returns for several thinning strategies applied to a 5-yr-old oak stand.

Description and History of Study Area

Located in southeastern Missouri in Butler County on the 7,000-ac University State Forest, the study site was classified by Fletcher and McDermott (1957) as a "flatwoods" that forms a transition zone between two larger physiographic provinces, the Ozark Plateau and the Mississippi Lowlands. The soil is a typic fragiudalf which contains a fragipan (28 to 33 in.) overlain by a loessal cap. Site index was estimated by Dwyer (1988) to be 69 ft (base age 50 yr) for scarlet oak.

Timber was harvested in the 1930s and 1940s. Harvest took place over several years leaving a stand composed of a few large nonmerchantable trees and small clumps of stump sprouts. Later, fire and grazing created even-aged stands of primarily oak species. In the summer of 1953, the trees were 28- to 30-yr-old, and the stand was comprised principally of scarlet oak and black oak in the overstory and white oak, post oak, hickory and southern red oak in the understory.

These species comprise the oak-hickory type, which encompasses over 39% of the forested acreage in the Midwest (Merz 1979).

Study Design

Three 1-ac plots were clearcut during July of 1953. Each plot was divided into four 0.25-ac subplots for a total of 12. A thinning and control (no-thin) treatment were randomly assigned to two of the subplots in each plot for a total of six. Within each thinned subplot, 0.156 ac was treated. Surrounding the treated area was a 21.8-ft isolation strip. The remaining two subplots in each plot were initially designed for other treatments but subsequently were not used. In 1958, 5 yr after clearcutting, a dominant sprout in each clump was selected for repeated measurements. Each and every clump was thinned to a single stem on the thinned subplots which corresponded to the areawide treatment. The control subplot received no treatment. At stand age 5, species, diameter of the parent stump, number of sprouts in the clump, and height of the dominant sprout were recorded. Diameter at breast height (dbh) of the study trees was measured to the nearest tenth-inch at ages 12-, 16-, 21-, 30-, and 38 yr. In 1991, at age 38, in addition to diameter, the total height of each tree was measured to the nearest foot, and cull percent was estimated using a sounding hammer and visual inspection. Growth and development of these coppice-regenerated oak stands have been reported by Mitchell et al. (1985) and Lowell et al. (1989). Data from this long-term study were used to evaluate the profitability of thinning in young oak stands.

Development of Alternatives

The investment analysis involved estimating the potential economic gain from releasing all, versus only selected crop trees within the stand, and comparing the results to the returns from the unthinned control. The crop-tree release treatments were not actually applied in the field. Rather, data from the long-term study were used to simulate the survival, growth, and yield under these treatments. In the control treatment, a residual sprout was identified for future observation, but competing stems in the clump were not removed. However, all stems in the control treatment were included in subsequent yield calculations. The areawide thinning, which consisted of removing all but one stem on each and every stump across the area, resulted in 1,211 residual sprouts per acre.

Four residual crop-tree densities were believed to represent a reasonable range of management treatments: 100, 150, 200, and 250 trees/ac. Data from the unthinned plots were used for thinning simulation. At each of the four levels, a sprout was selected for release based on its height at age 5 yr, and the number of sprouts and diameter of the stump. Then, all smaller sprouts on the stump were "removed" in a simulated thinning.

Stand Development Models

The Central States TWIGS (Belcher 1982) growth and yield simulator was used to project stand development for all treatments from stand age 21 to the end of rotation (60 and 70 yr). TWIGS cannot predict stand development during the first 20 yr. Therefore, early stand development was simulated by predicting the survival and growth of individual trees using regeneration models developed for the Missouri Ozarks by Dey (1991). These models produce diameter distributions of both thinned and unthinned species-specific stands of stump sprouts from stand age 5 to 21.

The growth simulations from the regeneration model were used to generate a tree "list" at stand age 21 for each of the respective crop-tree thinning levels. While actual data were available for the no-thin and areawide thinning treatments to age 38 yr, no data were available on survival and growth of the crop-tree release treatments. As a result, the data set for the areawide thinning treatment was used to construct the species-specific survival and growth models for these treatments. This list was then used as input for the TWIGS projection to final harvest at age 60 or 70.

Individual species were assigned species-specific site indices, which were computed (Carmean et al. 1989) for both the control and thinned plots using height data recorded at age 38 yr. Gross volumes were adjusted to account for the estimated amount of cull present in the trees.

Economic Analysis

The present net worth of each alternative was calculated using only those costs and revenues attributable to the alternative. Land and annual costs were excluded in order to examine thinning as a separate investment.

Six management regimes were compared: (1) no thin (control); (2) areawide thin; and (3) the four crop-tree residual stand densities of 100, 150, 200, and 250 stems/ac. Final harvest was examined at age 60 and 70 yr for each of the alternatives.

Stumpage prices used were the mean and high average prices (weighted by region) for 1991 and taken from *Missouri Timber Price Trends* quarterly market report. The high prices reflect a higher quality tree, indicated in parentheses below. The mean sawtimber stumpage prices used in this analysis were \$91.35 (\$140.13) per mbf for white oak; \$87.86 (\$133.54) per mbf for southern red oak, black and scarlet oak; \$64.02 (\$104.50) per mbf for post oak; and \$43.32 (\$74.33) for hickory. The prices for blocking (\$6.50/cord) and charcoalwood (\$1.58/cord) were estimated from an informal telephone survey of forestry consultants working in the Ozark region. Real stumpage prices were assumed to remain constant over time. Thinning costs (Table 1) were based on actual thinning production records (276 stems cut/hr) for the thinned plots. The average thinning cost per sprout was \$0.0421 (1991 value). This cost includes labor, chainsaw maintenance and supplies, and travel to the plots (unpubl. data, J.P. Dwyer, Univ. Mo.-Columbia). Labor was valued at the current wage rate for University forest workers of \$10.25/hr, which included fringe benefits.

Profitability was evaluated in terms of present net worth (PNW) expressed in dollars per acre. An underlying assumption was that intermediate funds would be reinvested for the life of the project at the required rate of return. The analysis was conducted using real discount rates of 3% and 5%.

Table 1. Total thinning costs for five clump thinning alternatives.

Clumps thinned (no.)	Sprouts per clump (no.)	Sprouts cut per ac (no.)	Total thinning[a] cost per ac (\$)
100	9.1	913	38
150	8.4	1,254	53
200	7.2	1,450	61
250	6.9	1,714	72
1,211	4.4	5,301	223

[a] Based on a cost of \$0.042 per sprout cut.

Results and Discussion

Stand characteristics at age 60 and 70 yr are shown in Table 2 for all six management regimes. The areawide thinning treatment showed a 26.4% and 20.4% increase in board foot volume over the unthinned stand at 60 and 70 yr, respectively. Thinning stumps to a single sprout significantly increased the diameter of the largest 100, 150, 200, and 250 crop trees per acre at age 38. "Largest" in this case (Figure 1) refers to the dominant sprout dbh at age 60. Average sprout dbh is based only on the crop trees for the crop-tree release treatments. Analysis of variance was used to test for differences in diameter increase for trees in plots thinned to various crop-tree densities and control plots. At the $\alpha = 0.05$ level, diameter increase was significantly greater for the trees from all of the treated plots in comparison to the control plots.

Although stand volume at age 70 for the areawide thinning treatment was 20% higher than for the control, and stumpage income was 21% higher, the PNW was lower by $214/ac (Table 3). Benefits stemming from increased sawtimber yields attributable to thinning at age 5 are not sufficient to cover the areawide precommercial thinning cost plus an annual accrual of 5.0% interest.

Crop-tree release offers the opportunity to reduce the cost of thinning for a 60-yr-old stand. However, the 100-, 150-, 200-, and 250 crop-tree per acre alternatives did not yield a greater PNW than the unthinned treatment (Table 3). In addition, the 60-yr-old stand had greater PNW values than the 70-yr-old stand. This is due, in part, to the fact that the 60-yr-old stand provides opportunities to harvest standing volume that otherwise would be lost to natural mortality after age 60. Also, the 60-yr-old stand provides positive cash flows from the commercial harvest that occur earlier than the 70-yr-old stand, thus increasing PNW. In fact, none of the alternatives in the 70-yr management regime are as profitable as the unthinned alternative.

A sensitivity analysis was performed to evaluate the effect of two real discount rates (3% and 5%) and two alternative stumpage price scenarios on PNW. Results of this analysis

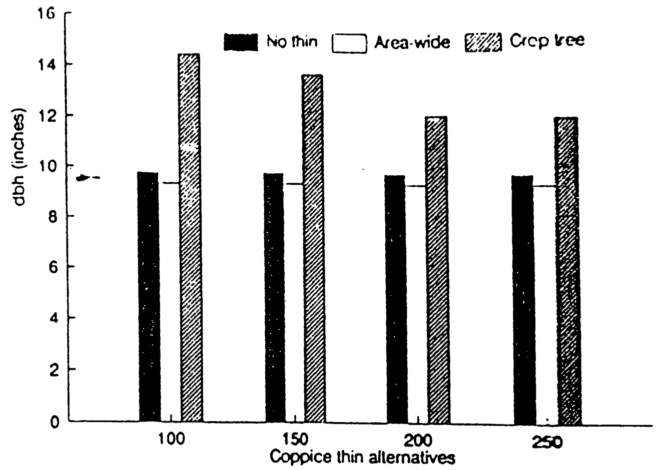

Figure 1. Average sprout dbh of no-thin, areawide, and crop-tree alternatives at age 60 yr.

(Table 4) show that the no-thin treatment generated the highest PNW regardless of which discount rate or stumpage price scenario was chosen. The PNWs of the crop-tree release treatments under the 3%/high price scenario were similar to the no-thin treatment. Profitability is improved for all crop-tree release treatments relative to the no-thin treatment when the high price scenario is considered. If, for example, the weighted mean sawtimber stumpage price were to rise to $140 and $181 per mbf for the 3% and 5% discount rates, respectively, then it would be a breakeven between the crop-tree 100 treatment and the no-thin treatment.

In reality, the PNWs would not be so similar because it would be reasonable to expect that the cost to release the crop trees would be higher because of the time to (1) select which stump to release, and (2) decide which sprout to leave on the

Table 2. Stand characteristics (on per-acre basis) of the six coppice regeneration management regimes at 60 and 70 years of age.

Crop-tree release treatment	Stocking (%)	Live trees (no.)	Basal area (ft^2)	Dbh (in.)	MAI (ft^3/yr)	Volume: Sawlog (mbf)[a]	Volume: Pulpwood (cords)	Volume: Residue (mft^3)
60 yr								
No thin	86	167	102	9.8	33.6	8.0	10.6	1.0
Areawide	112	227	131	9.3	44.0	10.1	14.8	1.3
100	118	256	134	8.9	43.9	8.7	17.3	1.3
150	116	248	135	9.1	44.4	9.5	16.2	1.4
200	116	248	136	9.1	44.6	9.7	16.0	1.6
250	116	247	136	9.1	44.4	9.8	15.7	1.4
70 yr								
No thin	93	144	113	11.1	34.0	10.6	10.6	1.2
Areawide	115	192	139	10.4	42.6	12.7	14.5	1.4
100	113	206	136	10.0	40.2	11.3	14.9	1.4
150	112	198	136	10.2	40.7	11.9	14.4	1.4
200	112	199	136	10.2	40.8	11.9	14.3	1.4
250	112	198	136	10.2	40.6	11.5	14.9	1.4

[a] Volume in International 1/4-in.

Table 3. Investment performance of the crop-tree release thinning levels for coppice-regenerated stands at a 5% real discount rate and stand ages 60 and 70.

Management alternative	Stumpage income	Present value		
		Cost	Revenue	PNW
		($/ac)		
		60 yr		
No thin	788	0	54	54
Areawide	1,004	223	69	-154
Crop-tree 100	900	38	61	23
Crop-tree 150	962	53	66	13
Crop-tree 200	979	61	67	6
Crop-tree 250	983	72	67	-5
		70 yr		
No thin	1,018	0	43	43
Areawide	1,236	223	52	-171
Crop-tree 100	1,115	38	47	9
Crop-tree 150	1,157	53	49	-4
Crop-tree 200	1,164	61	49	-12
Crop-tree 250	1,130	72	47	-25

Table 4. Sensitivity analysis for alternative thinning treatments for coppice regenerated 60-year-old oak stands.

Management alternative	3% discount rate		5% discount rate	
	Mean price	High price	Mean price	High price
		(PNW — $/ac)		
No-thin	155	227	54	79
Areawide	-26	65	-154	-123
Crop-tree 100	139	217	23	50
Crop-tree 150	136	222	13	43
Crop-tree 200	132	219	6	36
Crop-tree 250	121	209	-5	26

chosen stump. In addition, some efficiency may be lost if size of sprouts were an overriding criterion for retention instead of optimum spacing. These two factors must be taken into account jointly in order to optimize growing space and yield the highest future profitability for the released sprouts.

Conclusion

The cost of thinning young oak coppice sprouts cannot be overcome by selecting stems from clumps which exhibit dominant characteristics. Thinning the best 100, 150, 200, or 250 crop trees per acre was not found to be as profitable as the no-thin treatment on a 60-yr rotation. For the longer rotation, the cost of precommercial thinning exceeds the discounted increases in final harvest revenues. Evaluating the profitability of thinning oak sprouts at a 3% interest rate and under a high price scenario did not yield increases sufficiently high to warrant a crop-tree release treatment.

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