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Thinning and Harvesting Regimes for Yellow-Poplar[1]

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ABSTRACT. Grade 1 yellow-poplar logs were recently selling for $150/mbf, three times the price for grade 2 logs in North Carolina. A computerized stand development model was used to examine the profitability of thinning and holding yellow-poplar stands for increased diameter and grade. Analyses were done over wide ranges in stand age, site quality, and stocking, at 5% and 10% discount rates. At a 5% discount rate, the maximum net present stumpage value was obtained by thinning in most regimes. Lower stand age, higher initial stocking, and higher site indices favored thin-clearcut regimes over regimes with no initial thinning. At a 10% discount rate, thinning was optimal only at initial age 30 on the highest quality sites at the highest initial stockings. All other combinations of variables favored clearcutting immediately or with a 10-year delay. Thinning options with net values within 50% of maximum were numerous at a 5% discount rate in younger stands but decreased rapidly as initial age increased. Only a few such options were available at the 10% discount rate.

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Yellow-poplar (*Liriodendron tulipifera* L.) is an important eastern hardwood that regenerates readily from seeds and sprouts, grows rapidly, and responds well to intermediate thinnings. Increasing demand for yellow-poplar in highly valued wood products such as face veneer has increased prices for higher grade logs. An economic consequence of this relative price increase may be to increase the attractiveness of thinning and holding growing stock to allow it to reach larger diameters.

OBJECTIVE

The objective of this study was to determine thin-harvest regimes that maximized net present value of stumpage to owners of yellow-poplar stands for wide ranges of specified initial stand age, site quality, and stocking.

METHODS

Thinning rather than clearcutting represented an investment of liquidity foregone by harvesting poorer timber to allow the better timber to increase in diameter and grade. Net present value of stumpage was estimated using two discount rates under alternative thin-clear cut regimes over ranges of initial ages from 30 to 60 years, site indices from 90 to 130 feet (base age 50), and basal areas from 100 to 200 ft^2.

We modified a version of the program developed by Knoebel, Burkhart, and Beck (1985) for calculating growth and yields under different thin-harvest regimes. This program produced estimates of number of trees, basal area, and cubic foot volume per acre for each regime. With the modifications we added, we projected number of logs per tree, log grades, and volumes. Future values were estimated as the product of yields in various grades times the appropriate price for that grade. All cash flows were discounted to present value and summed. Analyses were for a single thinning and final harvest in the current rotation.[2] Thinning objectives were to leave the fastest-growing, best-quality trees at about 80 ft^2 of basal area. Final harvests were simulated at ages of 30 to 90 years in 10-year increments.

A telephone survey was conducted with 15 veneer mills and 6 sawmills that processed yellow-poplar in North Carolina (Kronrad et al. 1984). Survey results indicated that stumpage prices (per mbf, Doyle rule) were: grade 1, $150; grade 2, $50; grade 3, $40; grade 4, $30; grade 5, $25; and pulpwood, $5/cord. Log grade was based on small-end diameter inside bark, and position in the tree. All 16-ft logs less than 10 in. and all top logs were graded as pulpwood. Butt and second logs 13+ in. were grade 1. Logs 11 to 13 in. were grade 2 or 3 and logs 10 to 11 in. were grade 3 or 4 depending on position in the tree.

Different thin-harvest regimes were compared using real (deflated) discount rates of 5% and 10%. Real log prices for different grades of yellow-poplar were assumed to remain constant over time for all regimes.

RESULTS

Maximum net present stumpage value at a 5% discount rate was obtained by thinning in most regimes (Tables 1, 2, 3) except at the oldest initial age of 60 years (Table 4). For example, at a

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[2] Infinite rotation analysis was considered but not used because infinite rotation regimes were beyond the scope of the growth and yield model.

Table 1. Thin-clearcut options that yielded the highest net present value of stumpage, with initial age 30, discount rate of 5%, and representative ranges of initial basal area and site quality (base age 50) (NT = no thinning).

	Site Index									
	90		100		110		120		130	
Initial basal area	Thin	Cut	Thin	Cut	Thin	Cut	Thin	Cut	Thin	Cut
	(Age)									
100	NT	50	50	60	50	60	40	50	40	50
110	NT	50	50	60	40	50	40	50	40	50
120	NT	50	50	60	40	50	40	50	40	50
130	NT	50	40	50	40	50	40	50	40	50
140	40	50	40	50	40	50	40	50	30	50
150	40	50	40	50	40	50	40	50	40	50
160	40	50	40	50	40	50	40	50	40	50
170	40	50	40	50	40	50	40	50	30	40
180	40	50	40	50	40	50	30	50	30	40
190	40	50	40	50	40	50	30	40	30	40
200	40	50	40	50	40	50	30	40	30	40

Table 2. Thin-clearcut options that yielded the highest net present value of stumpage, with initial age 40, discount rate of 5%, and representative ranges of initial basal area and site quality (base age 50) (NT = no thinning).

	Site Index									
	90		100		110		120		130	
Initial basal area	Thin	Cut	Thin	Cut	Thin	Cut	Thin	Cut	Thin	Cut
	(Age)									
100	NT	50	NT	50	NT	50	50	60	50	60
110	NT	50	NT	50	50	60	50	60	50	60
120	NT	50	50	60	50	60	50	60	40	50
130	NT	50	50	60	50	60	40	50	40	50
140	NT	50	50	60	40	50	40	50	40	50
150	50	60	40	50	40	50	40	50	40	50
160	40	50	40	50	40	50	40	50	40	50
170	40	50	40	50	40	50	40	50	40	50
180	40	50	40	50	40	50	40	50	40	50
190	40	50	40	50	40	50	40	50	40	50
200	40	50	40	50	40	50	40	50	40	50

Table 3. Thin-clearcut options that yielded the highest net present value of stumpage, with initial age 50, discount rate of 5%, and representative ranges of initial basal area and site quality (base age 50) (NT = no thinning).

	Site Index									
	90		100		110		120		130	
Initial basal area	Thin	Cut	Thin	Cut	Thin	Cut	Thin	Cut	Thin	Cut
	(Age)									
100	NT	60	NT	60	NT	60	50	60	50	60
110	NT	60	NT	60	NT	60	50	60	50	60
120	NT	50	NT	50	NT	50	50	60	50	60
130	NT	50	NT	50	50	60	50	60	50	60
140	NT	50	50	60	50	60	50	60	50	60
150	50	60	50	60	50	60	50	60	50	60
160	50	60	50	60	50	60	50	60	50	60
170	50	60	50	60	50	60	50	60	50	60
180	50	60	50	60	50	60	50	60	50	60
190	50	60	50	60	50	60	NT	50	50	60
200	50	60	50	60	NT	50	NT	50	50	60

5% discount rate, the optimal plan for a 40-year-old stand with basal area of 150 and a site index of 100 was to thin at age 50 and clearcut at age 60 (Table 2). Lower initial ages, high initial stockings, and higher site indices favored thinning over clearcutting as general trends. At a 10% discount rate, thinning resulted in a maximum net present stumpage value only at initial age 30 and then only at the highest initial stockings and site indices. All other combinations of variables favored clear cutting immediately or with a 10-year delay (Table 5). At initial ages 40, 50, and 60 on all sites and initial stocking rates maximum net present stumpage value was obtained by immediate clear cutting. As a measure of the sensitivity of results to the ranges of variables tested, the number of options within $25/ac or 50% of the best option were tallied. There were very few options within $25/ac of the regime that yielded maximum net present stumpage value. There were many options within 50% of the regime that yielded maximum net present stumpage value with a 5% discount rate. As initial age increased, especially at the 10% discount rate, numbers of options decreased substantially (Table 6).

DISCUSSION

Increases in stumpage values resulting from thinning were shown to be sufficient to justify thinning and holding stands for 10 years beyond the initial treatment age in the majority of cases where a discount rate of 5% was applied with initial ages of 30 to 50 years. Despite the high premiums paid for grade 1 yellow-poplar logs, however, there were a large number of cases in which thinning was not a profitable alternative for a landowner interested in maximizing the net present value of stumpage from an existing stand of yellow-poplar. Landowners with relatively high discount rates, and older timber stands, were least likely to gain by thinning. At a discount rate of 10%, very few thinning options resulted in higher net present stumpage values than immediate clearcutting.

Management objectives of many landowners may not include maximizing net present stumpage value. Yellow-poplar and other hardwoods also may be managed for esthetic, recreational, or other

Table 4. Thin-clearcut options that yielded the highest net present value of stumpage, with initial age 60, discount rate of 5%, and representative ranges of initial basal area and site quality (base age 50) (NT = no thinning).

Initial basal area	Site Index 90 Thin	90 Cut	100 Thin	100 Cut	110 Thin	110 Cut	120 Thin	120 Cut	130 Thin	130 Cut
	(Age)									
100	NT	60	NT	60	NT	60	NT	60	60	70
110	NT	60	NT	60	NT	60	60	70	60	70
120	NT	60	NT	60	NT	60	60	70	60	70
130	NT	60	NT	60	NT	60	60	70	60	70
140	NT	60	NT	60	60	70	60	70	60	70
150	NT	60	NT	60	60	70	60	70	60	70
160	NT	60	NT	60	NT	60	NT	60	60	70
170	NT	60	NT	60	NT	60	NT	60	60	70
180	NT	60	NT	60	NT	60	NT	60	60	70
190	NT	60	NT	60	NT	60	NT	60	60	70
200	NT	60	NT	60	NT	60	NT	60	NT	60

Table 5. Thin-clearcut options that yielded the highest net present value of stumpage, with initial age 30, discount rate of 10%, and representative ranges of initial basal area and site quality (base age 50) (NT = no thinning).[a]

Initial basal area	Site Index 90 Thin	90 Cut	100 Thin	100 Cut	110 Thin	110 Cut	120 Thin	120 Cut	130 Thin	130 Cut
	(Age)									
100	NT	30	NT	40	NT	40	NT	40	NT	40
110	NT	30	NT	40	NT	40	NT	40	NT	40
120	NT	30	NT	40	NT	40	NT	40	NT	40
130	NT	30	NT	30	NT	40	NT	40	NT	40
140	NT	30	NT	30	NT	40	NT	40	30	40
150	NT	30	NT	30	NT	40	30	40	30	40
160	NT	30	NT	30	30	40	30	40	30	40
170	NT	30	NT	30	30	40	30	40	30	40
180	NT	30	30	40	30	40	30	40	30	40
190	NT	30	30	40	30	40	30	40	30	40
200	NT	30	30	40	30	40	30	40	30	40

[a] Immediate clear cutting was indicated at all initial ages above 30 years under all other conditions, at a 10% discount rate.

Table 6. Ranges in numbers of optional alternative thin-harvest regimes that yielded within $25/ac or 50% of the maximum net present stumpage value for initial ages 30 to 60 years, at discount rates of 5 and 10% (ranges are for all combinations of sites 90 to 130 and initial basal areas of 100 to 200 ft²/ac.

Current age	Discount rate	Range of options within $25/ac	Range of options within 50%
(yr)	(%)	(No.)	
30	5	0–3	16–22
40	5	0–1	12–16
50	5	0–1	8–11
60	5	0–1	5–6
30	10	0–1	4–7
40	10	0	2–4
50	10	0	2–3
60	10	0	1–2

benefits. Although the value of such benefits is often difficult to measure directly, landowners are likely to have a subjective notion of the maximum amount of income they would be willing to forego to satisfy other objectives. To provide information on the availability and costs of other objectives, we chose $25/ac as representing a lower limit on absolute value, and 50% as representing an upper limit on the proportion of the maximum attainable present value a landowner might be willing to forego. The observation that there were very few options within $25/ac of the maximum net present stumpage value confirmed that amount as a valid lower limit (Table 6). A landowner willing to consider reductions in stumpage value of up to 50% of maximum value had many thinning options available at a 5% discount rate. A few options were also available at a 10% rate with younger stands. In terms of numbers of options available, the model was most sensitive to discount rate and initial age of the stand. The model was least sensitive to initial stocking and site index as indicated by the small range in number of options within a given age and discount rate (Table 6). □

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