U. S. FOREST SERVICE RESEARCH NOTE NE-82
1968

N
FOREST SERVICE, U. S. DEPT. OF AGRICULTURE, 6816 MARKET STREET, UPPER DARBY, PA.
E

AN ECONOMIC EVALUATION OF CULL-TREE REMOVAL IN MIXED HARDWOOD STANDS

Abstract. A comparison of inventories of six mixed hardwood compartments on the Kaskaskia Experimental Forest – made 12 years apart – shows that the three that received a cull-removal treatment as well as group-selection harvests were moving toward achieving sustained yields of medium to large sawtimber more rapidly than the three that had received only the group-selection harvests. Cull removal created value differences great enough to pay for the treatment two times out of three.

Before woodland owners invest their time and money in timber-stand-improvement (TSI) work, they want to know how TSI will affect their forest inventory and income. Our studies show that benefits can be derived from one kind of TSI work – cull removal. Our evaluation is based on data collected over 12 years on each of six comparable mixed hardwood compartments on the Kaskaskia Experimental Forest in southern Illinois.[1]

Three compartments were under extensive management – merchantable sawtimber trees were cut on an improvement and group-selection basis. Three compartments were under intensive management – merchantable sawtimber trees were cut on an improvement and group-selection basis, *and* cull trees were killed or removed. The objective on each compartment was to produce medium to large high-quality sawlogs from trees 18 to 24 inches d.b.h. Rotation is 80 to 100 years, and cutting cycle is 4 years. The six compartments reported are comparable and have the longest period of management.

[1]This report is based on a study of hardwood timber management practices conducted at the North Central Forest Experiment Station, Carbondale, Ill.

The authors acknowledge the contributions made to this publication by Leon S. Minckler, project leader of the forest-management research project located at Carbondale, who provided the field data. His patient counsel and careful reviews made this publication possible.

Inventory Changes

Cull removal favorably affected inventory. The three compartments that received a cull-removal treatment as well as group-selection cuts were moving toward sustained yields of medium to large sawtimber more rapidly than the three that had received only the group-selection cuts.

A comparison of physical data at the beginning of management with that after the last cut (table 1) shows the change in inventory over the 12 years. Some of these changes are:

- The proportion of total basal area in commercially sound trees increased on all three intensively managed compartments, while it decreased on two of the three extensively managed compartments.
- More effective regeneration area was generally provided by intensive management than by extensive management.
- The proportion of merchantable volume in high-value species (black walnut, white oak, and yellow-poplar) increased on all the intensive compartments, but decreased on two of the three extensive compartments.
- The proportion of merchantable volume in trees 18 inches d.b.h. and over increased on one intensive compartment, decreased on one, and remained constant on the third; while it decreased on all three extensive compartments.

Economic Evaluation

In addition to the favorable changes in inventory, the average value of standing timber increased on all the intensive compartments. But the average value decreased on two out of three of the extensive compartments. Average value was determined by applying a stumpage price to the merchantable volume in each species and by placing a premium on the merchantable timber in trees 18 inches and larger (see table 1, footnote 4). The values determined by this method were independently checked by other stumpage-appraisal relationships *(Worley 1962)* and found to be sound.

All possible comparisons of the change in average value for the intensive compartments and the extensive compartments show that the difference in stumpage value between paired compartments ranges from 0 to $2.50 per thousand board feet in favor of the intensive compartments (table 2). Per-acre value differences range from 0 to

Table 1. – Summary of selected data for extensively and intensively managed mixed hardwood compartments

Items for comparison	Units	Extensively managed			Intensively managed		
		A	B	C	A	B	C
At beginning of management:							
Average diameter breast high [1]	Inches	9.1	10.3	10.5	9.4	9.8	11.6
Basal area per acre, 5 inches and larger	Square feet	68	77	82	76	84	82
Proportion in commercially sound trees	Percent	92	76	80	85	86	86
Merchantable volume per acre	Feet board measure	4,600	4,600	6,400	3,700	5,500	7,600
Proportion in trees 18 inches and larger	Percent	42	41	51	26	46	57
Proportion in high-value species [2]	Percent	33	32	36	19	27	43
Average stumpage value [3]	Dollars per M feet board measure	17.60	18.80	19.60	16.30	17.40	20.70
Periodic cuts:							
Number of cuts	Number	4	4	4	4	4	3
Average volume removed per acre, per cut	Feet board measure	590	680	1,220	540	800	860
Diameter inches treated per acre, first cut	Diameter-inches	--	--	--	310	335	275
Average diameter inches treated per acre, other cuts	Diameter-inches	--	--	--	75	130	45
After last cut:							
Average diameter breast high	Inches	9.5	10.6	10.2	11.2	11.1	13.7
Basal area per acre, 5 inches and larger	Square feet	70	70	62	48	48	51
Proportion in commercially sound trees	Percent	71	75	81	100	100	100
Merchantable volume per acre	Feet board measure	4,500	4,800	4,900	3,700	4,600	6,700
Proportion in trees 18 inches and larger	Percent	28	34	39	29	38	57
Proportion in high-value species	Percent	46	30	28	20	42	52
Effective regeneration area per square foot of commercially sound trees harvested [4]	Milacres	13	4	6	8	13	18
Average stumpage value	Dollars per M feet board measure	18.50	17.80	18.20	17.20	18.60	21.80

[1] Live trees 5 inches and larger.

[2] Black walnut, white oak, yellow-poplar.

[3] Based on price ranges published in current Illinois and Ohio timber price reports. Assuming that larger timber produces higher-quality logs *(Trimble 1965b)* we applied the higher prices to volume in trees 18 inches and over, lower prices to trees 11 to 17 inches d.b.h.

[4] Area covered by enough free-growing desirable reproduction in openings of adequate size to produce a stand of desirable species.

Table 2. – All possible stumpage-value differences between extensive and intensive compartments in dollars per M board feet

Extensive compartments	12-year value change	Intensive compartments A (+ .90)	B (+1.20)	C (+1.10[1])
		Difference		
A	+ .90	$ 0.00	$+0.30	$+0.20
B	-1.00	+1.90	+2.20	+2.10
C	-1.40	+2.30	+2.60	+2.50

[1]The change in value over the 8-year management period is 75 cents per thousand board feet, or an annual change of around 9 cents. The 12-year change was obtained by multiplying 9 cents times 12.

$12.50, assuming an average volume per acre of 5 thousand board feet.

In most cases the increase in value was sufficient to pay for efficient cull removal. By dividing the per-acre value by the total amount of undesirable tree stems actually treated – 410 to 725 diameter-inches per acre – we find that in two out of three cases from 1 to 3 cents per diameter-inch could have been spent for this TSI work with a reasonable expectation of recovering this investment in the 12 years. Reasonable costs for efficient cull deadening (applying 2, 4, 5-T to ax frills) are estimated to be as low as 1 cent per diameter-inch *(Little and Mohr 1956, Plass 1956, Ryker and Minckler 1962,* and *Trimble and Wendel 1966).*

A Longer Look

A period longer than 10 to 15 years will find a much greater difference in the forest inventory on extensively and intensively managed properties. Over a longer time, the number of cull and other undesirable trees will increase on the extensively managed compartments, take up more and more growing space, and leave less and less space for desirable reproduction and growing stock. As a result, future inventory value on these extensive compartments will decrease. In addition to the constant increase in value differences between extensive and intensive compartments, the per-acre TSI cost on the intensive compartments will become lower as the number of undesirable trees to kill on these compartments steadily decreases (table 1) *(Trimble 1965a).*

If the woodland owner's objective is to grow high-value medium to large sawtimber using the group-selection management system, he will achieve that objective more quickly and more profitably by removing or killing cull trees in addition to making periodic commercial cuttings.

– DAVID P. WORLEY and HOYT A. WHEELAND[2]

---

[2]David P. Worley is research forester at the Northeastern Forest Experiment Station's research unit at Columbus, Ohio. Hoyt A. Wheeland, formerly research forester at the Station's research unit in Columbus, is now with the Department of the Interior at Arlington, Va.

Literature Cited

Little, S. and J. J. Mohr. 1956. CHEMICAL CONTROL OF HARDWOODS ON PINE SITES OF MARYLAND'S EASTERN SHORE. U. S. Forest Serv. NE. Forest Exp. Sta. Res. Note 64, 4 pp. Upper Darby, Pa.

Plass, William T. 1956. KILLING HARDWOODS WITH HERBICIDES IN SOUTHEASTERN OHIO. U. S. Forest Serv. C. S. Forest Exp. Sta. Res. Note 98, 2 pp. Columbus, Ohio.

Ryker, Russell A. and Leon S. Minckler. 1962. METHODS AND COSTS OF KILLING HARDWOOD CULLS. U. S. Forest Serv. C. S. Forest Exp. Sta. Tech. Paper 191, 9 pp. Columbus, Ohio.

Trimble, George R., Jr. 1965a. IMPROVEMENT IN BUTT-LOG GRADE WITH INCREASE IN TREE SIZE FOR SIX HARDWOOD SPECIES. U. S. Forest Serv. Res. Paper NE-31, 15 pp., illus. NE, Forest Exp. Sta., Upper Darby, Pa.

Trimble, George R., Jr. 1965b. REDUCING THE PROPORTION OF CULL MATERIAL IN HARDWOOD STANDS. N. Logger 14(2):26-27, illus.

Trimble, George R., Jr. and George W. Wendel. 1966. A COST FIGURE FOR A CHEMICAL RELEASE IN APPALACHIAN HARDWOODS. N. Logger 14(7):24, 42.

Worley, David P. 1962. PREDICTING HARDWOOD STUMPAGE PRICES FROM SALES DATA. J. Forestry 60: 181-183, illus.