The TIMBER-SUPPLY POTENTIAL of INTENSIVE MANAGEMENT in Upland Oak Forests of Ohio

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ABSTRACT

Two alternative programs of intensive timber management were defined for Ohio's oak-hickory forests. Their potentials were evaluated by comparing the expected yields and yield values of each program with those expected from a continuation of current management practices. Neither program would produce large increases in timber yield. But the expected gains in yield value would be substantial.

Figure 1.—The Hill Country of Ohio, where the study was made.

THE USDA Forest Service is conducting a timber review designed to reassess the outlook for timber supplies in the United States. One objective of this review is to estimate the potential effect of a program of intensive timber management on timber yields for the next 50 years. Yields and yield values from an intensive program will be compared with those resulting from a continuation of current management practices.

Pilot studies to develop procedures for this task were conducted for various forest types in selected regions of the Nation. This is a report on results from one of those studies.

This investigation was concerned with intensification of timber-producing practices in oak-hickory forests of the Ohio Hill Country (fig. 1). The oak-hickory forest type is a major contributor to timber-based economic activity in the eastern United States. Meaningful information on yield response to treatment is available for this timber type. The Ohio Hill Country was selected for study because it has an extensive acreage of oak-hick-

ory forest for which recent and detailed information about timber-stand characteristics is available.

PROCEDURE

Seven basic procedural steps were followed in the analysis.

Management Opportunity Classes Were Identified

The Ohio Hill Country's 2.3 million acres of oak-hickory forest exhibits virtually every stage of stand condition and development. Our first task was to disaggregate this variable resource into well-defined areas that were relevant for selecting, analyzing, and evaluating timber-management practices. Thirty-six opportunity classes were identified by site index, total basal area, average d.b.h., and level of stocking in growing-stock trees (table 1), (*Gansner et al. 1973*). They represent 1.8 million acres or four-fifths of the oak-hickory forest in the Hill Country.

Representative Stand Profiles Were Derived

The choice of specific management strategies and evaluation of their yield potentials required detailed information about the structure of forest stands in each management-opportunity class. Stand profile tables, depicting the representative (average) forest acre in each opportunity class, were developed from forest-inventory plot records. These tables provided data on the number of trees in each stand by species, d.b.h., and quality class.

Management Strategies Were Selected

A management strategy was prescribed for each forest stand representing a management-opportunity class. These strategies were designed to grow the most high-quality sawtimber the site could produce in the shortest possible time. Specific treatments varied according to the age and condition of each representative stand, but this general guide was followed:

- Stands in the $< C$ level stocking class (table 1) are not fully utilizing their sites and cannot be expected to do so for several years. Therefore they should be regenerated as soon as possible. The resulting new stands should then be cleaned and periodically thinned so as to maximize yields and promote the rapid growth of timber to a mature stage of development.
- Stands in the C to B stocking class are adequately stocked with acceptable trees. Decisions about treating them can normally be deferred for at least 10 years.
- Stands in the B+ stocking class are fully stocked with acceptable trees. Improvement cuttings down to B-level stocking, followed by thinnings designed to promote the rapid growth and maturity of timber, should be undertaken.

Average d.b.h. was used to gage the maturity of managed stands. Maturity standards varied according to site index as follows:

Site index	*Stand mature when average d.b.h. is (inches)*
50-59	12
60-69	15
70-79	18
80+	21

Stand Development Was Projected

Eventually, we wanted to compare the yields of intensive management strategies with those resulting from a continuation of current management practices. Thus projections of stand development, accounting for the response to these two actions, were made for each representative stand. Growth models developed by the Northeastern Forest Experiment Station's Timber Management work unit at Columbus, Ohio, were used for the projections. Current annual cutting rates provided by the Northeast Station's Forest Survey work unit were used to estimate the yields associated with current management practices.

Table 1.—Acreage of oak-hickory forest in the Ohio Hill Country, by management-opportunity classes

Total basal area (sq. ft.)	Average d.b.h. of acceptable trees (inches)[a]	Site index				
		<50	50-59	60-69	70-79	80+
		ACCEPTABLE TREE STOCKING LEVEL <C[b]				
<40	<11.0	84,100	(60,500) ①	(104,200) ②	(40,300) ③	(26,900) ④
	11.0+	3,400	3,400	3,400	—	—
40-59	<11.0	13,400	(47,100) ⑤	(74,000) ⑥	(23,500) ⑦	(30,300) ⑧
	11.0+	3,400	—	—	—	—
60-79	<11.0	6,700	6,700	(16,800) ⑨	10,100	3,400
	11.0+	—	3,400	3,400	—	—
80-99	<11.0	—	—	—	6,700	3,400
	11.0+	—	—	6,700	—	—
100-119	<11.0	—	—	—	3,400	—
	11.0+	—	—	—	—	3,400
120+	<11.0	—	—	—	—	—
	11.0+	—	—	—	—	—
		ACCEPTABLE TREE STOCKING LEVEL C TO B[b]				
<40	<11.0	3,400	10,100	(16,800) ⑩	13,400	6,700
	11.0+	—	—	—	—	—
40-59	<11.0	40,300	(47,100) ⑪	(40,300) ⑫	(50,400) ⑬	(26,900) ⑭
	11.0+	—	—	—	—	—
60-79	<11.0	50,400	(67,200) ⑮	(90,800) ⑯	(50,400) ⑰	(43,700) ⑱
	11.0+	—	—	—	—	—
80-99	<11.0	13,400	(30,300) ⑲	(40,300) ⑳	(30,300) ㉑	(16,800) ㉒
	11.0+	—	—	—	3,400	—
100-119	<11.0	3,400	—	13,400	—	3,400
	11.0+	—	—	—	—	—
120+	<11.0	—	—	3,400	—	—
	11.0+	—	—	—	—	—
		ACCEPTABLE TREE STOCKING LEVEL B+[b]				
<40	<11.0	—	—	—	—	—
	11.0+	—	—	—	—	—
40-59	<11.0	—	6,700	6,700	—	3,400
	11.0+	—	—	—	—	—
60-79	<11.0	10,100	(37,000) ㉓	(43,700) ㉔	(16,800) ㉕	10,100
	11.0+	—	3,400	—	—	—
80-99	<11.0	53,800	(107,600) ㉖	(121,000) ㉗	(87,400) ㉘	(63,900) ㉙
	11.0+	—	—	—	13,400	
100-119	<11.0	26,900	(53,800) ㉚	(74,000) ㉛	(67,200) ㉜	(63,900) ㉝
	11.0+	—	—	3,400	—	—
120+	<11.0	6,700	13,400	(26,900) ㉞	(37,000) ㉟	(26,900) ㊱
	11.0+	—	—	—	—	—

[a]Acceptable trees are trees that fit the standard forest survey definition of growing stock.

[b]For definitions of B and C stocking levels, see (Roach, Benjamin A., and Samuel F. Gingrich) Timber management guide for upland central hardwoods; U.S. Forest Serv. Cent. States Forest Exp. Sta., 33 p., illus. 1962.

①Circled numbers identify the 36 opportunity classes.

The Economic Potential of Each Management Strategy Was Evaluated

Each management strategy was evaluated in terms of its economic desirability. This required meaningful estimates of costs and returns.

Costs.—Two basic kinds of cost were considered and accounted for: (1) direct costs of intensive management practices, and (2) opportunity costs (value forgone) relative to a continuation of current management practices.

The *direct costs* of intensive actions were simply those expenditures required to remove unmerchantable trees in regeneration and improvement cuttings and cleanings. Equations reflecting the difficulty of the tree-removal job (in number and size of trees removed) were used to calculate the costs of regeneration and improvement cuttings. The costs of cleanings were based on current estimates of the average time and manpower required to complete this kind of work on local experimental forests. Any cut yielding less than 5 cords of net volume per acre was presumed inoperable and therefore was considered strictly a cost operation.

The *opportunity costs* were estimates of the value that would be produced by a timber stand if current management practices continue. Current annual cutting rates were used to calculate the tree removals associated with current management practices. The value of these removals and the value of the residual stand at the end of the investment period were calculated, using the yield evaluation procedure outlined below. These values represented the opportunity costs of management.

Returns.—Returns to each management strategy were appraised in terms of the dollar value of projected timber yields. Tree conversion values developed by the Northeastern Station's Economics work unit at Columbus, Ohio, were used to derive values reflecting the net worth of standing trees. These tree values accounted for variations in tree size, species, tree quality, management intensity, and site productivity. Application of these tree values to stand-table projections provided estimates of the value of management strategy yields.

Economic Potential.—Present net worth values were calculated, using a discount rate of 5 percent, for each management strategy from schedules of the amount and timing of costs and returns (See table 2 for example of one schedule.) Two assumptions about projected changes in the relative value of timber and treatment costs were considered; timber val-

Table 2.—Schedule of costs and returns[a] for management-opportunity class No. 6, in dollars per acre

Year	Action		Opportunity costs (value forgone)	Direct costs	Returns
1-70	Current management continued		$1.90 per year		
0	Regeneration cutting		—	$12.70	$75.80
10	Cleaning		—	21.50	—
30	Commercial thinning		—	—	12.50
42	Commercial thinning		—	—	12.50
52	Commercial thinning		—	—	24.70
62	Commercial thinning		—	—	53.00
70	Value of residual stand	Intensive management	—	—	673.70
		Current management continued	206.50	—	—

[a]Assuming no change in the relative value of timber or treatment costs over time.

Table 3.—Economic potential of intensive management strategies

Management opportunity class					Management strategy	Present net worth per acre if timber values and treatment costs—	
		Description					
No.	Area (acres)	Total basal area (sq. ft.)	Acceptable tree stocking level	Site index class		Remain constant	Increase at compound rate of 2%
1	60,500	<40	<C	50-59		(—)	(—)
2	104,200	<40	<C	60-69		(—)	$ 58.50
3	40,300	<40	<C	70-79		(—)	91.90
4	26,900	<40	<C	80+	Regenerate, clean,	$29.30	198.40
5	47,100	40-59	<C	50-59	periodically thin, and	4.70	20.50
6	74,000	40-59	<C	60-69	harvest	37.50	76.80
7	23,500	40-59	<C	70-79		35.00	133.10
8	30,300	40-59	<C	80+		74.40	195.80
9	16,800	60-79	<C	60-69		35.80	26.40
10 thru 22	551,300		C to B		None		
23	37,000	60-79	B+	50-59		(—)	8.60
24	43,700	60-79	B+	60-69		(—)	19.00
25	16,800	60-79	B+	70-79		14.70	91.90
26	107,600	80-99	B+	50-59		(—)	(—)
27	121,000	80-99	B+	60-69		(—)	(—)
28	87,400	80-99	B+	70-79	Improvement cut,	12.00	89.30
29	63,900	80-99	B+	80+	periodically thin,	12.70	176.30
30	53,800	100-119	B+	50-59	and harvest	(—)	10.20
31	74,000	100-119	B+	60-69		(—)	(—)
32	67,200	100-119	B+	70-79		(—)	37.70
33	63,900	100-119	B+	80+		(—)	118.10
34	26,900	120+	B+	60-69		(—)	(—)
35	37,000	120+	B+	70-79		(—)	25.90
36	26,900	120+	B+	80+		(—)	14.10

ues and treatment costs (1) remaining constant over time, and (2) increasing at a compound rate of 2 percent. A perfectly elastic demand for the products of each strategy was also assumed. In other words, all yields were presumed saleable at given prices. The resulting present net worth values provided a basis for gaging the economic potential of each strategy under the two value-cost assumptions (table 3).

Two Alternative Programs for Intensive Management Were Defined

All management strategies yielding a positive present net worth (at a 5-percent discount rate) were considered worthy components of a program of intensive timber management. Since two assumptions about projected changes in timber value and treatment costs were considered, two alternative programs for intensive management were defined:

Program	*Timber values and treatment costs*	*Area receiving intensive management*
A	Remain constant	386,700 acres in 9 management opportunity classes (No. 4-9, 25, 28, and 29)
B	Increase @ compound rate of 2 percent	860,700 acres in 18 management opportunity classes (No. 2-9, 23-25, 28-30, 32, 33, 35, and 36)

The Potential of Each Program Was Assessed

The expected yields and yield values produced over the next 50 years by programs A and B were summarized by decade (tables 4 and 5). Results of a continuation of current management practices on all oak-hickory forests in the Hill Country were also estimated for the same time period (table 6). Yields and yield values produced by each program were compared with those resulting from a continuation of current management practices. This comparison provided the measure of program potential.

RESULTS

Two programs of intensive timber management were defined for oak-hickory forests in the Hill Country of Ohio. Each reflects different assumptions about projected changes in the relative value of timber and treatment costs. Program A is based on the assumption that timber values and treatment costs will not change. Program B is based on the assumption that values and costs will increase at

Table 4.—Projected results of implementing program A in oak-hickory forests of the Ohio Hill Country, by decade to 2020[a]

Decade	Inventory, beginning of decade	Removals during decade	Value of inventory, beginning of decade[b]	Value of removals during decade[b]
	Thousand cords		*Thousand dollars*	
1970-1979	31,203	7,810	268,728	68,757
1980-1989	34,588	6,648	295,169	59,056
1990-1999	41,821	7,144	349,389	63,538
2000-2009	48,205	6,964	412,530	59,402
2010-2019	51,953	10,643	482,787	140,340
2020	51,861		488,323	—

[a]386,700 acres in 9 opportunity classes (No. 4-9, 25, 28, and 29) receive intensive management. Current management practices continue on the remaining forest land.

[b]Assuming no change in the relative value of timber.

Table 5.—Projected results of implementing program B in oak-hickory forests of the Ohio Hill Country, by decade to 2020[a]

Decade	Inventory, beginning of decade	Removals during decade	Value of inventory, beginning of decade[b]	Value of removals during decade[b]
	Thousand cords		*Thousand dollars*	
1970-1979	31,203	7,702	268,728	56,865
1980-1989	33,727	6,419	386,617	64,367
1990-1999	41,824	6,819	597,239	93,337
2000-2009	49,557	9,689	912,457	193,022
2010-2019	50,775	14,590	1,255,102	547,635
2020	46,236	—	1,371,368	—

[a]860,700 acres in 18 opportunity classes (No. 2-9, 23-25, 28-30, 32, 33, 35, and 36) receive intensive management. Current management practices continue on the remaining forest land.

[b]Assuming that timber values increase at compound rate of 2 percent.

Table 6.—Projected results of continuation of current management practices in oak-hickory forests of the Ohio Hill Country, by decade to 2020[a]

Decade	Inventory, beginning of decade	Removals during decade	Value of Inventory, beginning of decade	Value of removals during decade
	Thousand cords		*Thousand dollars*	
1970-1979	31,203	7,109	268,728[b] 268,728[c]	65,353[b] 71,568[c]
1980-1989	34,419	7,109	278,451 339,425	65,353 87,252
1990-1999	40,863	7,109	316,700 470,590	65,353 106,354
2000-2009	46,137	7,109	342,337 620,100	65,353 129,629
2010-2019	53,796	7,109	356,417 786,992	65,353 158,018
2020	54,209	—	365,199 982,960	— —

[a]No acreage receives intensive management; current management practices continue on all forest land.

[b]Assuming no change in the relative value of timber.

[c]Assuming that timber values increase at compound rate of 2 percent.

Table 7.—Potential effect of programs A and B in oak-hickory forests of the Ohio Hill Country, 1970-2020[a]

Program	Area treated	Treatment costs	Increase in yield		Increase in yield value	
	Thousand acres	*Million dollars*	*Million cords*	*Percent*	*Million dollars*	*Percent*
A	386.7	10.7	1.3	2.3	187.5	44.3
B	860.7	24.9	1.7	2.9	790.8	62.4

[a]Relative timber value and treatment costs remain unchanged in program A and increase at a compound rate of 2 percent in program B.

a compound rate of 2 percent. A number of potential management opportunities were identified, but only those capable of yielding a positive present net worth at a 5-percent discount rate were considered worthy of program inclusion.

The potentials of programs A and B were evaluated by comparing the expected yields and yield values of each program with those resulting from a continuation of current management practices.

Program A would apply intensive management practices to 386,700 acres of oak-hickory forest in the Ohio Hill Country (table 7). The cost of treating these acres would be about $10.7 million. Timber yields over the next 50 years would be increased about 1.3 million cords; a net gain of 2.3 percent over the yields expected from a continuation of current management practices. The net gain in yield value would be approximately $187.5 million or 44.3 percent. This, of course, presumes perfect markets for added yields at given timber values.

For program B, intensive management practices would be carried out on 860,700 acres. Treatment costs would be $24.9 million. Timber yields would increase 1.7 million cords; a

net gain of 2.9 percent. And the net gain in yield value would be $790.8 million or 62.4 percent.

Neither program A or B would produce large increases in timber yield. But the expected gains in yield value are impressive. Gains in timber yield values would average $18 and $32 per management dollar spent in programs A and B, respectively. These results demonstrate the extent to which sound silviculture could improve timber quality and yield values in oak-hickory forests.

REFERENCE

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1973. IDENTIFYING REGIONAL OPPORTUNITIES FOR ACCELERATED TIMBER MANAGEMENT. USDA Forest Serv. Res. Pap. NE-251. 6 p.

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