Identifying REGIONAL OPPORTUNITIES for Accelerated Timber Management

by David A. Gansner
Joseph E. Barnard
Samuel F. Gingrich

U.S.D.A. FOREST SERVICE RESEARCH PAPER NE-251
1973

NORTHEASTERN FOREST EXPERIMENT STATION, UPPER DARBY, PA.
FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE
WARREN T. DOOLITTLE, DIRECTOR

The Authors

DAVID A. GANSNER is leader of the Northeastern Forest Experiment Station's production economics research work unit at Upper Darby, Pennsylvania. He received his degree in forestry from the University of Missouri in 1958, a master's degree in agriculture economics from Ohio State University in 1968, and a master's degree in regional science from the University of Pennsylvania in 1970. He has been with the USDA Forest Service since 1958.

JOSEPH E. BARNARD, research forester, earned his bachelor's degree in forestry at The Pennsylvania State University in 1960. He joined the Northeastern Forest Experiment Station as a field crew member of the Forest Survey in 1960. He returned to The Pennsylvania State University in 1962 and received his master's degree in forest ecology in 1963. After serving in the U. S. Army and completing some additional course work in statistics and ecology at The Pennsylvania State University, he returned to the Experiment Station in 1965 and has been stationed since that time at Upper Darby, Pa. He is currently responsible for forest-survey data-processing and for survey-techniques research.

SAMUEL F. GINGRICH, principal mensurationist, is leader of the Northeastern Forest Experiment Station's timber management research work unit at Columbus, Ohio. He received his bachelor and master of science degrees at The Pennsylvania State University in 1950 and 1954, and was an instructor at The Pennsylvania State University from 1951 to 1957. He joined the Central States Forest Experiment Station in 1957 as a staff mensurationist. Since 1964 he has been a project leader for the Northeastern Forest Experiment Station, conducting research in the growth and yield of upland oak forests.

MANUSCRIPT SUBMITTED FOR PUBLICATION 18 JULY 1972.

Identifying REGIONAL OPPORTUNITIES for Accelerated Timber Management

Abstract

Describes a procedure for identifying regional opportunities for accelerated timber management and demonstrates its application. Results provide a basis for rational choices among alternative management strategies and permit meaningful micro- and macro-evaluations of treatment response.

MUCH ATTENTION has focused recently on the question of future supplies of timber in the United States. Many leading forest policy makers agree that foreseeable demands for timber can be met at current price levels, but only if large investments are made in forest management. This concern has stimulated proposals to increase the amount of public funds and technical assistance available for promoting accelerated timber-management practices.

But, few guidelines exist for making optimal use of these funds and services at the local level. Sound strategies for program orientation cannot be developed until regional oportunities for accelerated management have been clearly defined. What are the opportunities for timber management in a particular region? This paper outlines an objective procedure for answering this question and demonstrates its application to a typical problem.

THE APPROACH

The woodlands of any region exhibit virtually every stage of stand condition and development. There is a practical method for disaggregating this variable resource into well-defined units of area that are relevant for the selection, analysis, and evaluation of timber-management practices. It involves three basic steps:

1. Select stand criteria that are necessary for treatment decision-making.
2. Use forest-inventory plot records to differentiate regional management-opportunity

classes that are homogeneous in terms of the criteria selected in step 1.

3. Derive stand profiles representing the structure of forest stands in each management-opportunity class.

Results provide a framework for making rational choices among alternative management strategies and permit meaningful micro- and macro-evaluations of treatment response.

AN APPLICATION

The procedure for identifying regional opportunities for accelerated timber management was applied to oak-hickory stands of the Ohio Hill Country (fig. 1).

Decision-Making Criteria Were Selected

Information about four key criteria of stand condition are necessary for decisions regarding the silvicultural treatment of oak-hickory stands:

1. *The basal area of all live trees* provides a general measure of total stand stocking.

Figure 1.—The procedure was applied in the Hill Country of Ohio.

2. *The level of stocking with acceptable trees* provides a measure of stand area occupied by trees that are worth managing.[1] The formula for calculating this level of stocking is:[2]

$$S = -0.00507N + 0.01698\Sigma D + 0.00127\Sigma D^2$$

in which S = level of stocking with acceptable trees; N = number of acceptable trees, and D = diameters of acceptable trees.

3. *The average diameter of acceptable trees* indicates the timber size class of the manageable stand.

4. *Site index* provides a measure of the stand's productive potential and in conjunction with criterion 3 provides an indirect estimate of stand age.

These variables of stand condition formed the basis for stratifying the Hill Country's 2.3 million acres of oak-hickory forest into management-opportunity classes.

Inventory Plot Records Were Screened to Identify Management-Opportunity Classes

Some 680 oak-hickory ground plots, measured in the Hill Country of Ohio at the time of the last comprehensive forest inventory (1968), provided data for defining management-opportunity classes. Each plot, representing about 3,360 acres of commercial forest land, was screened and sorted on the criteria of stand condition listed above.[3] Six total-basal-area classes, three stocking-level classes, two average-diameter classes and five site-index classes were recognized.

---

[1]For this study we assumed that trees fitting the standard forest-survey definition of "growing stock" were acceptable. *(DeBald and McCay 1969).*

[2]See Gingrich *(1967)* for explanation of the development and use of this stocking formula.

[3]FINSYS—Forest Inventory System—a computer processing system, provided the vehicle for screening and sorting the ground-plot data. FINSYS was described in a series of research papers by R. W. Wilson and R. C. Peters in 1967: *The Northeastern Forest Inventory Data Processing System,* USDA Forest Serv. Res. Pap. NE-61 and NE-70 to 78.

The screening identified a gross set of 77 distinct opportunity classes (table 1). Several of these opportunity classes were immediately excluded from consideration. Those with less than 15 thousand acres were dropped because basic data on stand condition available for such small units of area are subject to large sampling error. Classes in the < 50 site-index category were also eliminated. Past research has shown that timber producing investments

Table 1.—*Acreage of oak-hickory forest in southeastern Ohio, by management-opportunity classes*

Total basal area (sq. ft.)	Average d.b.h. of acceptable trees (inches)	Site index				
		< 50	50-59	60-69	70-79	80 +
		ACCEPTABLE TREE STOCKING LEVEL <C[a]				
<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[a]				
<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+[a]				
<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]For definitions of B and C stocking levels, see Central States Forest Experiment Station and North Central Region 1962 Timber management guide for upland central hardwoods. USDA Forest Serv., Cent. States Forest Exp. Sta., 33 pp.

① Numbered items identify the 36 opportunity classes.

on these poorer sites generally yield very low returns. This left a net of 36 opportunity classes (numbered in table 1). They represent 1.8 million acres or four-fifths of the oak-hickory forest in the Hill Country.

Stand Profiles Were Derived

The choice of specific management strategies and evaluation of their impact potential requires more 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 the forest-inventory plot records. These tables provide data on the number of trees, by species, d.b.h., and quality class. An example of one of these stand profiles (the one for opportunity class 6) is shown in table 2.

Table 2.—*Stand profile for management-opportunity class 6*

Criteria of Stand Condition:

Total basal area	49
Stocking level	26.8
Average d.b.h.	5.9
Site index	65

D.b.h. (inches)	Species	Number of trees per acre		
		Acceptable	Cull	Total
2	A[a]	10.9	5.5	16.4
	B[b]	15.0	6.8	21.8
	C[c]	44.9	145.9	190.8
4	A	1.4	—	1.4
	B	5.4	1.4	6.8
	C	20.4	38.2	58.6
6	A	2.1	—	2.1
	B	.9	1.0	1.9
	C	11.8	18.7	30.5
8	A	.9	—	.9
	B	1.0	—	1.0
	C	9.1	4.1	13.2
10	A	.6	—	.6
	B	1.0	—	1.0
	C	7.1	4.0	11.1
12	A	.4	.2	.6
	B	—	—	—
	C	4.5	1.1	5.6
14	A	.3	—	.3
	B	.2	.3	.5
	C	1.7	1.2	2.9
16	A	.2	.1	.3
	B	.6	—	.6
	C	.5	.8	1.3
18	A	.1	—	.1
	B	.2	—	.2
	C	.6	.3	.9
20	A	.3	.1	.4
	B	.3	.2	.5
	C	.1	.1	.2
22	A	.1	—	.1
	B	.3	.3	.6
	C	.1	.1	.2
24-28	A	—	—	—
	B	.1	—	.1
	C	.2	.1	.3
30+	A	—	—	—
	B	—	—	—
	C	—	.1	.1
Total	A	17.3	5.9	23.2
	B	25.0	10.0	35.0
	C	101.0	214.7	315.7

[a]Yellow-poplar and black walnut.
[b]Red oak and ash.
[c]All other species.

CHOOSING MANAGEMENT STRATEGIES AND EVALUATING THEIR IMPACT

The 36 management-opportunity classes and their representative stand profiles give us a framework for selecting management strategies. This general guide can be followed:

- Stands in the *< C level* stocking class are not fully utilizing their sites and cannot be expected to do so for several years. They should therefore 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-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.

The choice of specific strategies will vary according to product objectives and the condition of each representative stand. Consider management-opportunity class 6, representing 74,000 acres of oak-hickory forest. Suppose our objective were to grow the most mature high-quality sawtimber this stand of timber could produce in the shortest possible time, using proved methods of sound silviculture. The general strategy outlined above for stands in the < C level stocking class would be followed.

The representative stand profile for opportunity-class 6 (table 2) provides an empirical foundation for scheduling specific treatments, calculating per-acre costs, and projecting and valuing potential per-acre yields. Results are summarized in table 3.

During the next 70 years approximately 59 cords of sound timber volume worth $852 would be removed from each acre of forest land in management-opportunity class 6. About $34 would be spent on each acre for regeneration cuttings and precommercial thin-

Table 3.—*Treatment schedule for representative stand of opportunity-class 6*

Year	Treatment	Treatment costs[a] per acre	Timber removals[b] per acre	Sawtimber included in timber removals per acre	Value of removals[c] per acre
		Dollars	*Cords*	*Board feet*	*Dollars*
0	Regeneration cut	12.70	8.6	1,600	75.80
10	Precommercial cleaning	21.50	—	—	—
30	Commercial thinning	—	5.0	0	12.50
42	Commercial thinning	—	5.0	0	12.50
52	Commercial thinning	—	5.1	900	24.70
62	Commercial thinning	—	5.8	1,800	53.00
70	Harvest[d]	—	29.9	12,000	673.70
Total		34.20	59.4	16,300	852.20

[a]Based on current estimates of the expenditures required for regeneration cuttings and precommercial thinnings in the Ohio Hill Country.
[b]Basis for projecting timber removals: yield tables in Gingrich, Samuel F., 1971, Management of young and intermediate stands of upland hardwoods, NE. Forest Exp. Sta., Upper Darby, Pa. 26 p., illus. (USDA Forest Serv. Res. Pap. NE-195).
[c]Based on current estimates of the net worth of standing timber in the Ohio Hill Country.
[d]Stand was considered mature when average d.b.h. reached 15.0 inches.

nings. The cost-and-return data shown in table 3 provide a basis for estimating the economic potential of this strategy (using present net values, benefit/cost ratios, internal rates of return and other appropriate yardsticks).

For example, at a discounting rate of 5 percent, the present net worth of this proposed action would be about $81 per acre. These per-acre values provide indices for approximating the impact of treating all or any part of the 74,000 acres of oak-hickory forest in opportunity-class 6. They also give us a basis for comparing the inputs, outputs, and economic potential of this particular strategy with those of other management alternatives.

REFERENCES

DeBald, Paul S., and Roger E. McCay.
1969. THE TIMBER RESOURCES OF THE OHIO HILL COUNTRY. USDA Forest Serv. Resource Bull. NE-14. 73 p. NE. Forest Exp. Sta., Upper Darby, Pa.

Gingrich, Samuel F.
1971. MANAGEMENT OF YOUNG AND INTERMEDIATE STANDS OF UPLAND HARDWOODS. USDA Forest Serv. Res. Pap. NE-195. 26 p. NE. Forest Exp. Sta., Upper Darby, Pa.

Gingrich, Samuel F.
1967. MEASURING AND EVALUATING STOCKING AND STAND DENSITY IN UPLAND FORESTS IN THE CENTRAL STATES. Forest Sci. 13:38-53.

Herrick, Owen W., and J. Edwin Morse.
1968. INVESTMENT ANALYSES OF STAND IMPROVEMENT AND REFORESTATION OPPORTUNITIES IN APPALACHIAN FORESTS. USDA Forest Serv. Res. Pap. NE-111, 43 p. NE. Forest Exp. Sta., Upper Darby, Pa.

Marty, Robert, Charles Rindt, and John Fedkiw.
1966. A GUIDE FOR EVALUATING REFORESTATION AND STAND IMPROVEMENT PROJECTS. USDA Agr. Handbook. 304, 24 p.

Roach, Benjamin A., and Samuel F. Gingrich.
1962. TIMBER MANAGEMENT GUIDE FOR UPLAND CENTRAL HARDWOODS. USDA Forest Serv. Central States Forest Exp. Sta., 33 pp., illus. Columbus, Ohio.

■

THE FOREST SERVICE of the U. S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — as directed by Congress — to provide increasingly greater service to a growing Nation.