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THE NORTHERN HARDWOOD FORESTS OF THE ANTHRACITE REGION

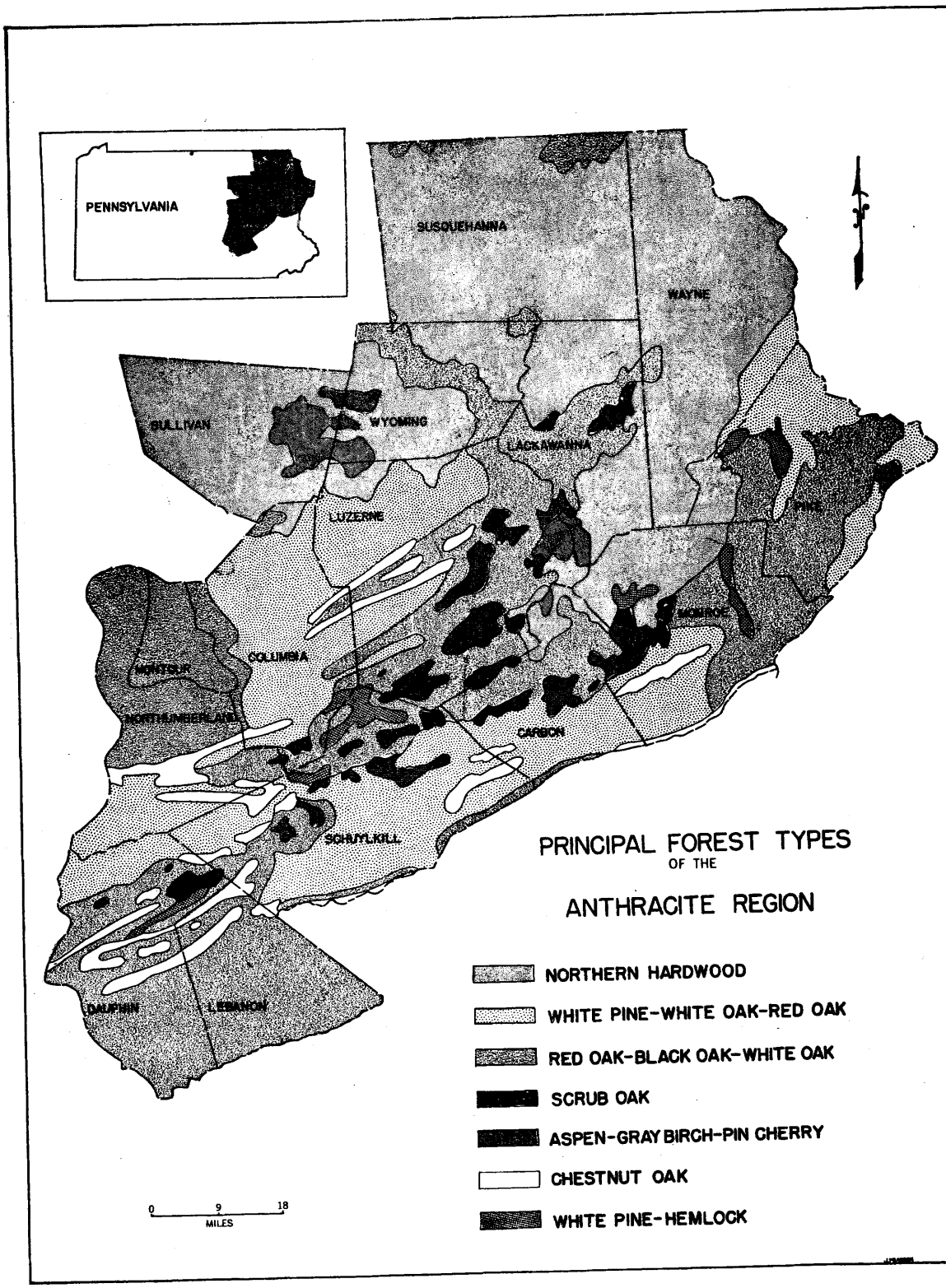
by C.F. Burnham
M.J. Ferree
F.E. Cunningham

U.S. Department of Agriculture
Forest Service

Northeastern Forest Experiment Station
Bankers Securities Building
Philadelphia 7, Pa.

V.I. Harper, Director

CONTENTS


PENNSYLVANIA
SUSQUEHANNA
WAYNE
SULLIVAN
WYOMING
LACKAWANNA
LUZERNE
PIKE
MONROE
COLUMBIA
MONTOUR
NORTHUMBERLAND
CARBON
SCHUYLKILL
DAUPHIN
LEBANON
PRINCIPAL FOREST TYPES
OF THE
ANTHRACITE REGION
NORTHERN HARDWOOD
WHITE PINE-WHITE OAK-RED OAK
RED OAK-BLACK OAK-WHITE OAK
SCRUB OAK
ASPEN-GRAY BIRCH-PIN CHERRY
CHESTNUT OAK
WHITE PINE-HEMLOCK
0
9
18
MILES

THE NORTHERN HARDWOOD FORESTS OF THE ANTHRACITE REGION

Their Present Condition and Possible Treatment

by C. F. Burnham
M. J. Ferree
F. E. Cunningham

INTRODUCTION

The northern hardwood type forest is found only in the northern counties of the Anthracite Region. It dominates the highlands from Sullivan County on the west to Monroe County on the east. The early lumbermen back in the 1860's, according to Illick and Frontz(6)1/, "found (some) valleys, hillsides and mountains covered with a dense growth of enormous white pine and hemlock, among which were splendid specimens of hardwoods". White pine and hemlock were about the only trees cut prior to 1900, but since then the hardwoods have increased in value so that now even the poorest species are in demand. As the softwoods were removed they were replaced by beech, birch, maple, cherry, ash, and basswood--trees commonly associated with the northern hardwood type.

By 1928 Illick and Frontz found that merchantable stands of this hardwood type had almost disappeared. By 1946, 18 years later, the situation had not improved. The practice of clear-cutting for mine timbers and small-dimension stock has kept the northern hardwood forests from growing the quantity of sawlog material it is capable of producing.

In spite of this past heavy cutting the northern hardwood forests are still more important to the Anthracite Region than any other type. They occupy 28.9 percent--922,700 acres--of the region's total forest acreage of 3,198,400 acres. They contain 46.6 percent of the region's saw-timber2/ acreage and about 45 percent of the total saw-timber volume is to be found on this same acreage. These high percentage figures actually represent only 82,700 acres and 375 million board feet of timber (table 1). This brings out the generally impoverished condition of the region's forest land as a whole.

1/ Figures in parentheses refer to Literature Cited, p. 16.
2/ For definitions see appendix.

This paper sets forth the present condition of these stands in terms of species composition, quality, stocking, growth, cull, vigor, and mortality. Several silvicultural treatments are suggested, which should result in greater production and more revenue within a relatively short time. These treatments, while based on the best information available at present, are subject to revision and refinement as further research brings out additional factors and makes more definite conclusions possible.

Table 1.—Acreage and volume distribution in the northern hardwood type, by stand-size classes[1/]

Item	Saw timber	Pole timber	Unmerchantable[2/] (Seedling & sapling)	All stands
Acres	82,700	315,300	524,700	922,700
Percent	9.0	34.1	56.9	100.0
Sawlog material:				
1,000 bd. ft...	375,000	182,700	309,500	867,200
Percent..	43.2	21.1	35.7	100.0
1,000 bd. ft. per acre..	4.50	0.58	0.59	0.94
Other material:				
Tons..	2,247,100	5,432,100	4,589,300	12,268,500
Percent..	18.3	44.3	37.4	100.0
Tons per acre..	28.2	17.2	8.7	13.3
All material:				
1,000 cu. ft...	132,990	228,070	211,870	572,930
Percent..	23.2	39.8	37.0	100.0
1,000 cu. ft. per acre...	1.6	.72	.40	.62

1/ Ineson, F. A., Ferree, M. J., and Robinson, D. F. The Anthracite Region—A Problem Area. 1946 (In process of publication by U. S. Dept. Agr.) Table data are for the entire 15-county area. The percentages and volume-per-acre figures should not be confused or compared with the actual plot figures.

2/ "Unmerchantable" as used in this table includes tracts of saw timber and pole timber less than 10 acres in size. The term "seedling and sapling" used elsewhere in this paper does not include these tracts.

METHODS USED IN THE STUDY

The northern hardwood areas studied were classified into three sites and, within each site, three stand-size classes. Five representative sample plots were then measured in each category of Sites I and II and detailed information was collected on each plot. No samples were taken on Site III as it occupies a very limited acreage in the northern hardwood type.

Thirty sample plots were selected in the counties of Luzerne, Wyoming, Sullivan, and Lackawanna. In the saw-timber and pole-timber stands sample plots were varied in size from 1/4 to 1/2 acre in order to include a minimum of 75 living trees 3.6 inches d.b.h. and larger on each plot. In the seedling-and-sapling stands each sample plot was 0.1 acre in size.

For each plot these data were recorded: exact location of the plot; ownership; forest type; forest site; stand-size class; age of stand; herbaceous material on the forest floor; amount and kind of trees 0.1-inch to 3.5-inch d.b.h.; estimate of reproduction; history of tract as to grazing, fire, and past cutting; general soil type; and an estimate of the amount of natural mortality in the past 10 years. For each live tree 3.6 inches d.b.h. and over, the species, d.b.h. (outside bark), vigor class, estimated percentage of cull, origin (seedling or sprout), tree form (good or poor), and the past 10-year radial growth as determined from an increment core, were recorded. Also, each plot was marked for cutting in accordance with what was considered the most practical silvicultural treatment.

In order to simplify analyses for sites and stand-size classes the sample-plot data were summarized on a plot basis and an average summary was made for the five plots in each category. In this manner it was possible to make an appraisal of the present condition for each plot and also for the average of each five-plot unit. In addition, annual growth rates for each site were correlated with volume-per-acre of growing stock. The volumes-per-acre (table 2) do not necessarily reflect the average volume-per-acre figures for the region (table 1). In selecting the plots in the field an attempt was made to get a range in volume in each stand-size class from the lowest to the highest so that in making growth determinations this range in volume-per-acre classes would be represented.

PRESENT CONDITION

The stands of northern hardwood studied on site I are similar in one respect to those on site II. They are both relatively young and even-aged due to heavy sawlog cutting during the latter part of the nineteenth and in the early part of the twentieth centuries. In most other respects they differ considerably (table 2).

The species composition of the two sites (tables 6-17) is quite different. Two-thirds of the volume contained in the site I stands of saw-timber size is in black cherry, hemlock, basswood, and white ash. The understory, however, is composed entirely of red and sugar maple, beech, and yellow birch. This indicates that the present overstory is temporary and may eventually be replaced by more tolerant species. In contrast to this, 80 percent of the volume in saw-timber stands on site II is in sugar maple, beech, red maple, and red oak. Except for red oak, these same species constitute the understory, indicating that under natural conditions these stands will probably remain predominately sugar maple, beech, and red maple.

Volumes (1) are considerably higher on site I. This is not due entirely to the better site qualities. Some of the difference must be attributed to the heavy cutting and subsequent fires that have swept over many of the site II stands.

Stocking of both the larger and smaller stems is only fair. While in some cases the number of stems seems to be ample the percentage of noncommercial species runs as high as 25 percent in the seedling-and-sapling class on site II (table 16). This, too, may be attributed to past misuse.

The percentage of volume in poorly-formed stems (stems that will never make sawlogs) is high on both sites. Between 1/3 and 2/3 of all trees on site II are of poor form.

Trees of sprout origin make up a greater portion of the volume on site II than on site I although in the seedling-and-sapling class more than 50 percent of the volume on both sites is in trees of this category. This also is a result of past and present heavy cutting practices.

Wider spacing and relative freedom from competition between dominants (trees greater than 3.5 inches d.b.h.) makes the seedling-and-sapling stands appear to be more vigorous than either of the other two classes.

Cull volume is particularly high in stands of saw-timber size on site II. Most of this is in old decadent beech, sugar maple, red maple, and basswood trees left standing after earlier cutting operations.

Mortality in the older stands is not high. In the seedling-and-sapling stands on site II, however, it amounts to 50 percent of the

Table 2.—Summary of conditions in northern hardwood stands, by stand-size class and site

Item	Saw timber		Pole timber		Seedling and sapling	
	Site I	Site II	Site I	Site II	Site I	Site II
Volume per acre .....Cubic feet..	3,175	2,140	1,625	985	380	330
Tons..	91	61	46	28	11	9
Board feet..	8,374	6,000	680	597	-	-
Average age ..... Years..	70	80	50	55	30	37
Trees per acre Pole size (3.6" d.b.h.) and larger ..... Number..	360	289	400	412	252	342
Seedling & sapling ... Number.. (0.6-3.5" d.b.h.)	426	559	658	964	3,124*	1,298*
Reproduction ..... Degree.. (Under 4.5" high)	Sparse	Ample	Fair	Sparse	Good	Sparse
Quality ..... Percent of total cu.ft. volume in poorly formed trees..	21	34	40	54	46	66
Origin ..... Percent of total cu.ft. volume in sprout-origin trees..	15	25	33	48	54	51
Vigor ..... Percent of total cu.ft. volume in vigor class 1..	5	11	3	8	10	15
vigor class 2..	23	26	21	16	25	19
vigor class 3..	47	50	53	58	42	55
vigor class 4..	25	13	23	18	23	11
Cull ..... Percent of total cu.ft. volume..	5.0	11.3	5.0	5.5	5.0	4.0
of total bd.ft. volume..	6.3	19.5	-	-	-	-
Annual mortality .... Cubic feet per acre..	4.6	4.0	7.1	3.3	6.3	12.0
Percent of total growth..	5.0	6.0	10.0	7.5	22.0	50.0
Annual growth[1]/..... Cubic feet.. per acre Tons..	86	57	70	40	28	24
	2.5	1.6	2.0	1.1	0.8	0.7
Board feet..	370	235	175	140	-	-
Ingrowth ..... Percent of annual cu.ft. increase..	2	2	4	9	39	52
of annual bd.ft. increase..	50	33	-	-	-	-

1/ Mortality deducted.
* Includes trees down to 0.1-inch d.b.h.

annual growth. Eighty percent of the casualties occur in the 1-3 inch diameter classes, and the dense sprout clumps of beech and red maple furnish most of the victims.

The growth rate of all site II stands is considerably lower than those on site I. Judicious improvement cuttings on both sites will allow salvage of the volume now being lost through cull and mortality, and will also stimulate the growth rate. It is generally known that the amount of annual increase depends on the volume of growing stock. Table 3 shows the amount of annual growth that may be expected for stands of various volumes after deducting for mortality.

Table 3.—Growth data for northern hardwood forests[1/]

Growing stock per acre	Annual growth per acre		Growing stock per acre[2/]	Annual growth per acre		Growing stock per acre	Annual growth per acre	
	Site I	Site II		Site I	Site II		Site I	Site II
Cubic feet	Cubic feet	Cubic feet	Tons	Tons	Tons	Board feet	Board feet	Board feet
200	22	20	5.7	0.6	0.6	1,000	84	68
400	30	27	11.4	0.8	0.8	2,000	145	110
600	38	32	17.1	1.1	0.9	3,000	195	148
800	46	37	22.8	1.3	1.1	4,000	240	178
1,000	53	41	28.6	1.5	1.2	5,000	280	205
1,200	60	45	34.3	1.7	1.3	6,000	315	236
1,400	66	48	40.0	1.9	1.4	7,000	345	245
1,600	70	51	45.7	2.0	1.5	8,000	370	260
1,800	74	53	51.4	2.1	1.5	9,000	395	270
2,000	77	55	57.1	2.2	1.6	10,000	410	280
2,200	79	57	62.8	2.3	1.6	11,000	430	290
2,400	81	58	68.6	2.3	1.7	12,000	450	294
2,600	83	59	74.3	2.4	1.7	13,000	465	298
2,800	85	60	80.0	2.4	1.7	14,000	480	301
3,000	86	61	85.7	2.5	1.7	15,000	490	304
3,200	86	62	91.4	2.5	1.8			
3,400	86	62	97.1	2.5	1.8			

1/ Mortality deducted.
2/ Converting factor: 33 cubic feet = 1 ton.

SILVICULTURAL TREATMENTS

Building up the growing stock of the northern hardwood forests so that high-quality timber can be removed periodically on a sustained basis is a major problem. To accomplish the desired result, stands in all stages of development must be properly treated. Inferior species, trees of poor form, and trees containing defect should be removed by one or more improvement cuttings. Practically all of the present northern hardwood stands, because of poor cutting practices, are in need of this improvement work. The present demand for all wood products offers an excellent opportunity to timberland owners to put their stands in better shape.

An individual tree-selection system of cutting is very well adapted to the northern hardwood forests. Illick and Frontz(6), as a result of their study of this forest type in Pennsylvania, say "It is the natural method and is especially adapted to producing a large volume of desirable kinds of wood." Hough and Taylor(5), working in this type at the Kane Experimental Forest, and Eyre and Neetzel(3), through their studies of several methods of cutting in Marquette County, Michigan, show that judicious cutting increases the growth rate and materially improves the quality and composition of the growing stock.

SAW-TIMBER STANDS

To illustrate the application of this system of cutting in the Anthracite Region the average saw-timber stands (tables 6-7 and 12-13) are used as examples. All saw-timber plots studied were marked for cutting in the field and in most cases the trees marked were of inferior species, poor form, or contained defect. If these trees are not removed the percentage of cull will increase and the quality of the stands will not improve.

Tables 2 and 3 show the present condition and growth rates of these stands growing under natural conditions. Tables 4 and 5 show the expected yields for several degrees of selectively cutting these composite saw-timber stands. Growth figures obtained by Hough and Taylor(5) in partially-cut stands were used in constructing these tables. They were slightly modified before applying them to the site II table.

The 20-25-year cycle.--Cutting these saw-timber stands at 20-year intervals on site I or 25 years on site II is probably the most desirable in the extensive forest areas where logging costs are apt to be high and a substantial cut is needed to meet them. The trees marked for removal on both sites consisted mainly of red maple, beech, sugar maple, and black cherry, all of which were of poor form, low vigor or had some defect. The volume of this material to be removed amounted to 1,200 cubic feet or 4,000 board feet per acre on site I

Table 4.—Northern hardwoods, Site I : Periodic removals and yields under different systems of management[1/]

(80-year rotation)

Year	Volume	Clear-cut[2/]		20-year cycle		15-year cycle		10-year cycle		5-year cycle	
		Board feet	Cubic feet	Board feet	Cubic feet	Board feet	Cubic feet	Board feet	Cubic feet	Board feet	Cubic feet
	Present volume	8,000	3,200	8,000	3,200	8,000	3,200	8,000	3,200	8,000	3,200
1946	Removal	8,000	3,200	4,000	1,200	3,000	800	2,000	600	1,000	300
	Residual	0	0	4,000	2,000	5,000	2,400	6,000	2,600	7,000	2,900
	Expected volume	—	—	—	—	—	—	—	—	9,500	3,400
1951	Removal	—	—	—	—	—	—	—	—	1,000	300
	Residual	—	—	—	—	—	—	—	—	8,500	3,100
	Expected	—	—	—	—	—	—	11,000	3,600	11,500	3,600
1956	Removal	—	—	—	—	—	—	4,000	800	1,000	400
	Residual	—	—	—	—	—	—	7,000	2,800	10,500	3,200
	Expected	—	—	—	—	11,000	3,700	—	—	13,500	3,900
1961	Removal	—	—	—	—	5,000	1,100	—	—	1,500	400
	Residual	—	—	—	—	6,000	2,600	—	—	12,000	3,500
	Expected	—	—	12,000	3,800	—	—	12,000	3,800	15,000	4,000
1966	Removal	—	—	7,000	1,300	—	—	4,000	900	3,000	500
	Residual	—	—	5,000	2,500	—	—	8,000	2,900	12,000	3,500
	Expected	—	—	—	—	—	—	—	—	15,000	4,000
1971	Removal	—	—	—	—	—	—	—	—	3,000	500
	Residual	—	—	—	—	—	—	—	—	12,000	3,500
	Expected	—	—	—	—	13,500	3,900	13,500	3,900	15,000	4,000
1976	Removal	—	—	—	—	6,000	1,200	4,500	900	3,000	500
	Residual	—	—	—	—	7,500	2,700	9,000	3,000	12,000	3,500
	Expected	—	—	—	—	—	—	—	—	15,000	4,000
1981	Removal	—	—	—	—	—	—	—	—	3,000	500
	Residual	—	—	—	—	—	—	—	—	12,000	3,500
	Expected	—	—	15,000	4,000	—	—	15,000	4,000	15,000	4,000
1986	Removal	—	—	10,000	1,500	—	—	6,000	1,000	3,000	500
	Residual	—	—	5,000	2,500	—	—	9,000	3,000	12,000	3,500
	Expected	—	—	15,000	4,000	15,000	4,000	15,000	4,000	15,000	4,000
1991	Removal	—	—	10,000	1,500	7,500	1,300	6,000	1,000	3,000	500
	Residual	—	—	5,000	2,500	7,500	2,700	9,000	3,000	12,000	3,500
		—	—	(3/)	(3/)	(3/)	(3/)	(3/)	(3/)	(3/)	(3/)
2026	Expected volume	13,000	4,000	15,000	4,000	10,000	3,100	15,000	4,000	15,000	4,000
Total volume removed		8,000	3,200	31,000	5,500	36,500	7,000	38,500	7,200	40,500	7,400

1/ Expected growth after cutting was based on the work of Hough and Taylor(5) at the Kane Experimental Forest.

2/ Removes all stems to 2-inch d.b.h.

3/ Yield sustained at the above volumes.

To convert cubic feet to tons use factor: 35 cubic feet = 1 ton.

Table 5.—Northern hardwoods, Site II: Periodic removals and yields under different systems of management[1/]

(100-year rotation)

Year	Volume	Clear-cut[2/]		25-year cycle		15-year cycle		5-year cycle	
		Board feet	Cubic feet	Board feet	Cubic feet	Board feet	Cubic feet	Board feet	Cubic feet
	Present volume	6,000	2,200	6,000	2,200	6,000	2,200	6,000	2,200
1946	Removal	6,000	2,200	3,000	800	2,000	500	500	150
	Residual	0	0	3,000	1,400	4,000	1,700	5,500	2,050
	Expected volume	—	—	—	—	—	—	6,800	2,350
1951	Removal	—	—	—	—	—	—	500	150
	Residual	—	—	—	—	—	—	6,300	2,200
	Expected	—	—	—	—	—	—	7,700	2,500
1956	Removal	—	—	—	—	—	—	600	150
	Residual	—	—	—	—	—	—	7,100	2,350
	Expected	—	—	—	—	8,000	2,500	8,600	2,700
1961	Removal	—	—	—	—	2,500	600	600	150
	Residual	—	—	—	—	5,500	1,900	8,000	2,550
	Expected	—	—	—	—	—	—	9,500	2,900
1966	Removal	—	—	—	—	—	—	1,000	200
	Residual	—	—	—	—	—	—	8,500	2,700
	Expected	—	—	8,500	2,800	—	—	10,000	3,000
1971	Removal	—	—	4,000	900	—	—	1,000	200
	Residual	—	—	4,500	1,900	—	—	9,000	2,800
	Expected	—	—	—	—	9,500	2,900	10,500	3,200
1976	Removal	—	—	—	—	3,000	650	1,000	200
	Residual	—	—	—	—	6,500	2,250	9,500	3,000
	Expected	—	—	—	—	—	—	11,000	3,300
1981	Removal	—	—	—	—	—	—	1,200	200
	Residual	—	—	—	—	—	—	9,800	3,100
	Expected	—	—	—	—	—	—	11,500	3,500
1986	Removal	—	—	—	—	—	—	1,500	250
	Residual	—	—	—	—	—	—	10,000	3,250
	Expected	—	—	—	—	11,500	3,400	12,000	3,600
1991	Removal	—	—	—	—	4,000	800	2,000	350
	Residual	—	—	—	—	7,500	2,600	10,000	3,250
	Expected	—	—	11,500	3,300	—	—	12,000	3,600
1996	Removal	—	—	6,500	1,100	—	—	2,000	350
	Residual	—	—	5,000	2,200	—	—	10,000	3,250
	Expected	—	—	—	—	12,000	3,600	12,000	3,600
2006	Removal	—	—	—	—	4,500	1,000	2,000	350
	Residual	—	—	—	—	7,500	2,600	10,000	3,250
	Expected	—	—	12,000	3,600	12,000	3,600	12,000	3,600
2021	Removal	—	—	7,000	1,400	4,500	1,000	2,000	350
	Residual	—	—	5,000	2,200	7,500	2,600	10,000	3,250
		—	—	(3/)	(3/)	(3/)	(3/)	(3/)	(3/)
2046	Expected volume	12,000	3,600	12,000	3,600	10,500	3,500	12,000	3,600
Total volume removed		6,000	2,200	20,500	4,200	25,000	4,550	29,900	5,500

1/ Expected growth after cutting was based on the work of Hough and Taylor(5) at the Kane Experimental Forest.

2/ Removes all stems to 2-inch d.b.h.

3/ Yield sustained at the above volumes.

To convert cubic feet to tons use converting factor of 35 cubic feet = 1 ton.

Figure 1.—Saw timber, site I.

and 800 cubic feet or 3,000 board feet on site II. Most of the material cut on both sites would be of mine-timber quality. High-quality species—black cherry, white ash, basswood, yellow poplar, and sugar maple—were favored for retention as crop trees.

Succeeding cuts at 20-year intervals on site I and 25 years on site II should be designed to remove considerably less volume than the growth for the periods until about 15,000 and 12,000 board feet of growing stock per acre are attained on sites I and II respectively. Then the periodic removal could more nearly approach the periodic growth so that sustained cutting of mature trees could continue indefinitely. Undesirable trees should be removed at the time of each cutting. The trees left after each cut should be evenly distributed so they will not suffer from windthrow and ice damage; and so that species such as black cherry, yellow birch, and beech will suffer no ill effects from overexposure.

Figure 2.—Saw timber, site II.

The 15-year cycle.—The present good market for all wood products makes the use of this interval quite desirable. It will allow removal of most of the poorer material now while prices are high and it will shorten the interval between cuts and consequent revenue. The first cut provides for removal of 3,000 board feet or 800 cubic feet per acre on site I and 2,000 board feet or 500 cubic feet on site II. The species and quality of material to be removed are the same as mentioned above. Succeeding cuts at 15-year intervals should be aimed at constantly improving the growing stock until 15,000 board feet per acre on site I and 12,000 board feet on site II is reached. Then about 7,500 and 5,000 board feet per acre on sites I and II respectively can be removed every 15 years.

The 10-year cycle.—Site I stands may allow cutting every 10 years because of the higher growth rates. The 10-year cycle would prevent complete removal of undesirable material during the present good market, but it would allow a greater intensity of management and more frequent financial returns. This cycle should prove to be of value on the larger farm woodlots.

The 5-year cycle.--Cutting every 5 years is suggested for use on farm woodlots or wherever the owner desires frequent small returns and is able to do most of the work himself. Silviculturally it is the best of all the cycles since the tract would be given almost constant attention. It also yields the highest volume over a long period of time. Using this cycle, a farmer owning a 10-acre woodlot, for example, could selectively cut 2 acres per year indefinitely. The present disadvantage would be the length of time required to remove all of the undesirable material. Some difficulty might be encountered during the third and fourth cuts in disposing of some of the low-quality material unless needed for fuel or other farm uses.

Clear-cutting.--This is the present practice: removing all stems down to 2 inches d.b.h. It is obviously undesirable, and has many disadvantages:

1. The timber yield over an 80-year rotation on site I and 100 years on site II (tables 4 and 5) is approximately one-third of what should be realized under good management. One-half of the yield would be in low-quality material.

2. The site is exposed so that drying out and erosion is severe.

3. The large amounts of slash left after logging increase the fire hazard.

4. Reproduction of sprouts or suckers is encouraged.

5. Establishment of intolerant noncommercial species--aspen, pin cherry, and gray birch--is favored.

6. In some cases dense fern growth or shrubby growth may occupy the clear-cut site and retard the establishment of good reproduction for many years.

POLE-TIMBER STANDS

The pole-timber stands (tables 8-9 and 14-15) were also marked for cutting and were found to be in need of improvement work. Five hundred cubic feet or 14 tons per acre were marked for removal on the site I stands. All of this volume was in red maple, beech, yellow birch, and American elm having low vigor, poor form, or defect. Three hundred cubic feet or 9 tons per acre were found to be in need of removal from the site II stands. Most of the trees to be removed on this site were from beech, sugar maple, and red maple sprout clumps plus deformed trees of all species. The volume to be removed from both sites would be sufficient to at least pay for the operation since most of it could be disposed of as mine timber.

Hough's (4) work at Kane, Pennsylvania, shows that improvement work of this kind done in the younger stands will increase their growth

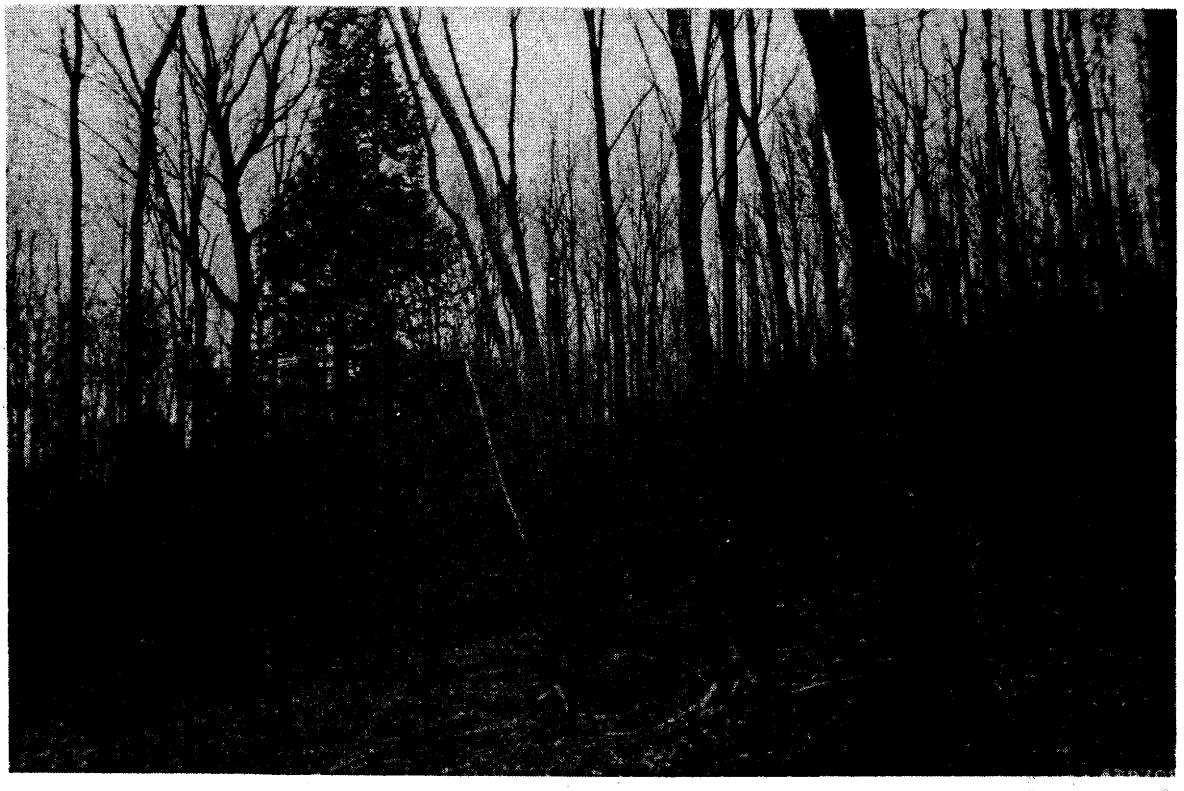


Figure 3.—Pole timber, site I.

rate; increase the proportion of straight, clean-boled, healthy trees; and improve the stand composition.

SEEDLING-AND-SAPLING STANDS

There is a tendency for these young stands to thin themselves through the natural dying of stems. However, this process can be hastened in some stands by artificial means. Jensen(7) found that "Due to the large proportion of undesirable trees which occur on most cutover areas in this type, a weeding operation is necessary to secure a desirable stand as this will increase the proportion of desirable species...stimulate the growth, and improve the quality..." Campbell and Spaulding(2) show that this type of work can best be done in stands 15 to 25 years old. While the returns from such an operation, if any, probably would not defray the immediate costs, the improvement work should speed up the process of getting the stand into desirable condition.

Figure 4.—Pole timber, site II.

With approximately 60 percent of the total northern hardwood acreage in this seedling-and-sapling stage and most of it in poor condition some means of improving it should be worked out. Plans for future research include work in these young stands to determine whether the demand for small mine timbers can be filled from the thinnings and weedings necessary to put these stands into better condition. First of all, though, they must be protected from fire and grazing.

If any of the above systems of management are adopted by any landowner he should find his woodland becoming a source of greater revenue. If they are followed over the region as a whole the northern hardwood forests will very soon regain their former importance in the economy of the region. The present volume of growing stock can easily be increased 10 times with high-quality species predominating.

Figure 5.—Seedling-and-sapling stand, site I.

Figure 6.—Seedling-and-sapling stand, site II.

LITERATURE CITED

(1) Burnham, C. F., Ferree, M. J., and Cunningham, F. E.
1946. Site class volume tables for merchantable timber in the Anthracite Region of Pennsylvania. Northeast. Forest Expt. Sta. Forest Management Paper No. 3.

(2) Campbell, W. A., and Spaulding, P.
1942. Stand improvement of northern hardwoods in relation to diseases in the Northeast. Allegheny Forest Expt. Sta. Occasional Paper No. 5.

(3) Eyre, F. H., and Neetzel, J. R.
1937. Applicability of the selection method in northern hardwoods. Jour. Forestry 35 : 353-358.

(4) Hough, A. F.
1946. Improvement of second growth northern hardwoods by cordwood thinnings. Northeast. Forest Expt. Sta. Forest Management Note No. 1.

(5) ---------- and Taylor, R. F.
1946. Response of Allegheny northern hardwood species to partial cutting. Jour. Forestry 44 : 30-38.

(6) Illick, J. S., and Frontz, L.
1928. The beech-birch-maple forest type in Pennsylvania. Pa. Dept. Forests and Waters Bul. No. 46.

(7) Jensen, Victor S.
1935. Suggestions for weeding in northern hardwoods. Northeast. Forest Expt. Sta. Occasional Paper No. 3. New Haven.

APPENDIX

DEFINITIONS OF TERMS

Specific application of terms used in this paper is in accord with the definitions given below.

Forest Sites

Results obtained in this study emphasize the importance of site as a factor affecting growth, composition, and quality of the stand.

Site I.—This site is characterized by moist, well-drained, fairly deep soils frequently of alluvial origin. It usually is found in protected coves or along streams or bottom-lands that maintain moist, well-drained conditions throughout the year. On northern exposures it will ordinarily extend higher up the slope than on southern exposures because of more favorable soil moisture. Club moss, hydrangea, maidenhair fern, trillium, sphagnum moss, and fern-leaf moss are fairly good indicators.

White ash, black cherry, basswood, hemlock, yellow birch, and yellow poplar will in most cases occupy more of the area than the more tolerant sugar maple and beech.

In mature stands the dominant and co-dominant hardwood species will produce 3 or more 16-foot logs per tree. Conifer dominants and co-dominants will produce 3½ or more 16-foot logs.

Site II.—Site II areas are characterized by soils intermediate in moisture, depth, drainage, and fertility. They will dry out for short periods during the year. Usually they are slope types located between the ridges and the coves or bottom-lands. Poorly drained bottom-lands may also be of site II quality. Ordinarily the site will reach nearly to the ridge tops. It will reach higher on slopes with northern exposures than on slopes with southern exposures. Trailing arbutus, ground pine, aster, goldenrod, bracken fern, and sheep laurel usually indicate site II.

Sugar maple, red maple, and beech are the predominant species with white ash, black cherry, basswood, northern red oak, and black birch in association.

In mature stands the dominant and co-dominant hardwood species will produce from 2 to 2½ 16-foot logs per tree, while the conifers will yield 2½ to 3 16-foot logs.

Site III.—This site is characterized by shallow, rather dry, stony, or compact soils characteristic of ridges. It will produce hardwood trees having less than two 16-foot logs per tree at maturity. On southern exposures it may extend down a slope for a considerable distance, because of unfavorable soil moisture conditions. Dense mountain laurel ground cover or preponderance of lichens often indicate site III conditions.

Forest Stand-size Classes

Saw-timber stands.—Stands bearing a minimum volume of 2,000 board feet per acre. Saw-timber volume is measured in conifers in the 9-inch d.b.h. class and over, and in hardwoods in the 11-inch d.b.h. class and over.

Pole-timber stands.—Stands bearing a minimum volume of 5 standard cords per acre in trees in the 4-inch d.b.h. class and over, and less than 2,000 board feet of saw timber.

Seedling and sapling stands.—Young-growth areas of forest land which have less than 5 standard cords of wood per acre in trees in the 4-inch d.b.h. class and over.

Tree Vigor Classifications

In this study tree vigor is an expression of the present growth rate of a tree as conditioned by density, size, and position of the crown, plus the general health of the tree as determined from its age and the presence or absence of diseases or mechanical injuries. Four vigor classes are recognized. Trees in these classes meet the following conditions:

Vigor class 1.—These trees have large dense crowns, are usually dominant or co-dominant with at least one-half of their crowns exposed. They are free from diseases or mechanical breakage tending to reduce the crown surface (mall mechanical injuries on tree trunks do not affect the vigor classification.) They are free from old-age stagnation as evidenced by dead limbs in the crown, and have a general healthy and thrifty appearance.

Vigor class 2.—These trees have a fair-sized crown with moderate density or large crown of light density, are usually co-dominant with less than one-half the crown exposed, but with more than the tip in the open in well stocked uncut stands. They are free from diseases or mechanical breakage tending to reduce the crown surface, are free from old-age stagnation. This class may include trees that are dropped from vigor class 1 because of injury, disease, or old age.

Vigor class 3.—These trees have small, dense crowns with just the tips exposed and are free from diseases and mechanical injuries tending to reduce crown surface. They have not reached old-age stagnation. This class may include trees that are dropped from vigor classes 1 or 2 because of injury, disease, or old-age.

Vigor class 4.--These trees are growing under obvious handicaps, such as severe suppression, injury, disease, or old age.

Tree Origin

Seedling.--Any tree which at present shows no union with a stump or other tree and can be silviculturally treated as a single tree.

Sprout.--Any tree which is joined to a stump, other tree, or clump of trees.

Tree Form

Good form.--Any tree which at present has a clear, straight bole and is a potential saw-timber tree.

Poor form.--Any tree which at present is so deformed that its potential use would not exceed that of a mine prop.

Other Terms

Ingrowth.--Volume of small-sized trees that have grown into the merchantable classes during the past 10 years.

Mortality.--Number and/or volume of trees which have been lost through natural causes such as insects, disease, windfall, or suppression during the past 10 years.

Table 6.—Average stand data, site I, saw-timber class: number of stems per acre, by species and diameter

D.b.h. (Inches)	Hemlock	Sugar maple	Red maple	Beech	Yellow birch	White ash	Basswood	Yellow poplar	Black cherry	Misc. 1/	All species	
											Total	Percent
1	—	169	10	36	—	—	—	—	—	23	238	55.9
2	—	69	13	8	5	—	—	—	—	8	103	24.2
3	—	56	16	8	5	—	—	—	—	—	85	19.9
Total	—	294	39	52	10	—	—	—	—	31	426	100.0
Percent	—	69.1	9.1	12.2	2.3	—	—	—	—	7.3	100.0	
4	0.5	17.4	12.2	11.7	12.5	2.4	0.5	—	1.6	0.8	59.6	16.6
5	.5	11.9	10.8	6.4	10.6	1.6	.5	—	4.8	1.0	48.1	13.3
6	1.0	5.0	5.5	9.3	6.8	2.4	2.4	—	6.9	1.3	40.6	11.2
7	.8	10.9	8.9	4.2	12.0	2.9	2.9	0.5	8.5	.8	52.4	14.5
8	2.0	3.2	8.9	.8	5.3	1.6	2.4	.5	12.0	.8	37.5	10.3
9	.5	3.2	2.4	1.6	5.8	2.4	5.3	1.0	16.0	—	38.2	10.5
10	1.5	2.4	1.3	2.4	2.4	4.0	1.3	1.5	8.5	—	25.3	7.0
11	2.1	—	1.3	.8	.8	.8	4.8	1.0	10.1	.8	22.5	6.2
12	3.6	—	—	—	—	—	.5	—	4.0	—	8.1	2.2
13	1.6	.8	—	—	—	.8	—	1.0	3.9	—	8.1	2.2
14	2.5	—	—	.8	—	—	—	—	2.4	—	5.7	1.6
15	1.0	—	.8	—	—	2.4	.8	—	1.6	—	6.6	1.8
16	1.3	—	—	—	—	—	—	—	1.6	—	2.9	.8
17	1.0	—	—	—	—	—	—	—	.8	—	1.8	.5
18	1.5	—	.8	—	—	—	—	—	—	—	2.3	.6
19	1.0	—	—	—	—	—	—	—	—	—	1.0	.3
20	—	—	—	.5	—	—	.8	—	—	—	1.3	.4
Total	22.4	54.8	52.9	38.5	56.2	21.3	22.2	5.5	82.7	5.5	362.0	100.0
Percent	6.2	15.1	14.6	10.6	15.6	5.9	6.1	1.5	22.9	1.5	100.0	

1/ Noncommercial species: serviceberry and gray birch—1.6 trees 4 inches d.b.h. and over, 31 trees under 4 inches. Commercial species: red oak, white oak, hickory, black birch—3.9 trees.

Table 7.—Average stand data, site I, saw-timber class: volume per acre, by species and diameter(1)

Item	Cubic-foot volume				Board-foot volume			
	Poor form	Good form	Total	Percent	Poor form	Good form	Total	Percent
Species								
Hemlock	79.5	512.8	592.3	18.6	336	2,578	2,914	34.8
Red oak	13.2	—	13.2	.4	39	—	39	.4
White oak	—	1.5	1.5	.1	—	—	—	—
Hickory	—	5.6	5.6	.2	—	—	—	—
Sugar maple	40.3	161.8	202.1	6.4	—	79	79	.9
Red maple	180.7	87.6	268.3	8.5	420	—	420	5.0
Beech	148.5	27.3	175.8	5.6	366	—	366	4.4
Yellow birch	134.3	98.6	232.9	7.3	—	41	41	.5
Black birch	.4	.7	1.1	—	—	—	—	—
White ash	18.6	226.7	245.3	7.7	—	578	578	6.9
Basswood	60.1	238.3	298.4	9.4	66	864	930	11.1
Yellow poplar	16.6	74.6	91.2	2.8	—	183	183	2.2
Black cherry	294.4	746.7	1,041.1	32.8	398	2,426	2,824	33.8
Noncommercial	6.1	—	6.1	.2	—	—	—	—
Total	992.7	2,182.2	3,174.9	100.0	1,625	6,749	8,374	100.0
D.b.h. (Inches)								
4	20.9	8.6	29.5	1.0	—	—	—	—
5	41.9	24.3	66.2	2.1	—	—	—	—
6	70.5	47.7	118.2	3.7	—	—	—	—
7	139.9	117.1	257.0	8.1	—	—	—	—
8	133.6	139.0	272.6	8.6	—	—	—	—
9	158.6	227.0	385.6	12.1	—	16	16	.2
10	72.6	263.7	336.3	10.6	—	78	78	.9
11	138.8	249.3	388.1	12.2	514	1,044	1,558	18.6
12	62.8	114.0	176.8	5.6	279	516	795	9.5
13	—	217.4	217.4	6.8	—	1,003	1,003	12.0
14	24.5	157.7	182.2	5.8	118	779	897	10.7
15	25.4	219.2	244.6	7.7	122	1,089	1,211	14.6
16	—	128.2	128.2	4.0	—	678	678	8.1
17	—	91.2	91.2	2.9	—	500	500	6.0
18	69.4	58.6	128.0	4.0	389	338	727	8.6
19	—	66.1	66.1	2.1	—	389	389	4.6
20	33.8	53.1	86.9	2.7	203	319	522	6.2
Total	992.7	2,182.2	3,174.9	100.0	1,625	6,749	8,374	100.0
Percent	31.3	68.7	100.0		19.4	80.6	100.0	

Table 8.—Average stand data, site I, pole-timber class: number of stems per acre, by species and diameter

D.b.h. (Inches)	Sugar maple	Red maple	Beech	Yellow birch	Black birch	White ash	Bass-wood	Black cherry	Aspen	Elm	Misc. 1/	All species	
												Total	Percent
1	361	8	26	10	—	—	—	—	—	—	—	405	61.5
2	112	10	10	—	—	—	8	—	—	24	5	169	25.7
3	32	20	—	16	—	—	—	—	—	16	—	84	12.8
Total	505	38	36	26	—	—	8	—	—	40	5	658	100.0
Percent	76.8	5.8	5.5	3.9	—	—	1.2	—	—	6.1	0.7	100.0	
4	17.5	32.3	3.4	9.7	2.8	4.8	4.7	2.4	—	2.4	8.0	88.0	21.9
5	9.9	29.3	3.6	9.6	2.6	4.8	6.0	4.0	1.2	4.0	6.0	81.0	20.3
6	8.3	28.6	1.0	19.7	1.4	1.6	4.4	5.6	—	5.6	1.0	77.2	19.2
7	1.0	23.7	1.0	7.8	2.0	—	6.0	6.4	2.0	4.8	.8	55.5	13.8
8	2.6	9.7	6.3	7.8	2.7	5.2	—	6.6	1.2	4.8	.8	47.7	11.9
9	1.0	8.5	5.2	3.3	1.4	.8	1.6	2.4	—	1.6	1.0	26.8	6.7
10	—	4.1	1.8	3.8	2.0	1.2	—	2.4	.8	.8	.8	17.7	4.4
11	—	—	—	.7	—	.8	—	.8	—	—	—	2.3	.6
12	—	—	1.6	—	—	.7	—	1.0	—	—	—	3.3	.8
13	—	—	.8	—	—	—	—	—	—	—	—	.8	.2
14	—	—	—	—	—	—	—	1.0	—	—	—	1.0	.2
Total	40.3	136.2	24.7	62.4	14.9	19.9	22.7	32.6	5.2	24.0	18.4	401.3	100.0
Percent	10.0	34.0	6.1	15.5	3.7	5.0	5.7	8.1	1.3	6.0	4.6	100.0	

1/ Noncommercial species: butternut, hop-hornbeam, serviceberry—all stems 4 inches d.b.h. and over. Commercial species: red oak 5 stems under 4 inches d.b.h.—4.2 stems over 4 inches.

Table 9.—Average stand data, site I, Pole-timber class: volume per acre, by species and diameter(1)

Item	Cubic-foot volume				Board-foot volume			
	Poor form	Good form	Total	Percent	Poor form	Good form	Total	Percent
Species								
Red oak	—	25.3	25.3	1.6	—	—	—	—
Sugar maple	23.4	58.7	82.1	5.0	—	—	—	—
Red maple	167.1	295.7	462.8	28.5	—	—	—	—
Beech	108.5	63.6	172.1	10.6	128	90	218	31.7
Yellow birch	137.0	120.1	257.1	15.8	—	36	36	5.2
Black birch	42.8	33.0	75.8	4.6	—	—	—	—
White ash	4.2	103.0	107.2	6.6	—	125	125	18.2
Basswood	14.7	55.8	70.5	4.3	—	—	—	—
Black cherry	68.2	157.3	225.5	13.9	252	56	308	44.9
Aspen	26.0	6.4	32.4	2.0	—	—	—	—
Butternut	7.5	—	7.5	.5	—	—	—	—
Elm	48.5	46.4	94.9	5.9	—	—	—	—
Ironwood	6.2	2.7	8.9	.6	—	—	—	—
Shadbush	1.5	—	1.5	.1	—	—	—	—
Total	655.6	968.0	1,623.6	100.0	380	307	687	100.0
D.b.h. (Inches)								
4	27.4	16.0	43.4	2.7	—	—	—	—
5	68.8	42.8	111.6	6.9	—	—	—	—
6	83.7	145.7	229.4	14.1	—	—	—	—
7	95.8	176.0	271.8	16.7	—	—	—	—
8	132.2	200.0	332.2	20.4	—	—	—	—
9	74.6	178.2	252.8	15.6	—	—	—	—
10	86.6	134.7	221.3	13.6	—	—	—	—
11	—	38.9	38.9	2.4	—	153	153	22.3
12	54.4	15.5	69.9	4.4	224	64	288	41.9
13	—	20.2	20.2	1.2	—	90	90	13.1
14	32.1	—	32.1	2.0	156	—	156	22.7
Total	655.6	968.0	1,623.6	100.0	380	307	687	100.0
Percent	40.4	59.6	100.0		55.3	44.7	100.0	

Table 10.—Average stand data, site I, seedling-and-sapling class: number of stems per acre, by species and diameter

D.b.h. (Inches)	Sugar maple	Red maple	Beech	Yellow birch	Black birch	Yellow poplar	Black cherry	Aspen	Misc. 1/	All species	
										Total	Percent
0.25	46	30	88	478	12	—	—	—	4	658	21.1
1	364	88	246	730	66	—	—	—	8	1,502	48.1
2	184	98	108	228	18	2	—	—	12	650	20.8
3	84	84	62	56	2	2	2	4	18	314	10.0
Total	678	300	504	1,492	98	4	2	4	42	3,124	100.0
Percent	21.7	9.6	16.1	47.8	3.1	0.1	0.1	0.1	1.4	100.0	
4	34	62	24	4	—	2	4	12	—	142	56.3
5	12	18	12	—	—	2	6	6	—	56	22.2
6	10	8	6	—	—	2	2	2	—	30	11.9
7	—	—	4	—	—	6	—	4	—	14	5.6
8	8	2	—	—	—	—	—	—	—	10	4.0
Total	64	90	46	4	—	12	12	24	—	252	100.0
Percent	25.4	35.7	18.2	1.6	—	4.8	4.8	9.5	—	100.0	

1/ Noncommercial species: serviceberry, fire cherry.

Table 11.—Average stand data, site I, seedling-and-sapling class: volume per acre, by species and diameter(1)

Item	Volume in poor form		Volume in good form		Total	
Species	Cubic feet	Percent	Cubic feet	Percent	Cubic feet	Percent
Sugar maple	29.8	7.5	94.0	23.7	123.8	31.2
Red maple	69.8	17.6	27.0	6.8	96.8	24.4
Beech	43.2	10.9	34.4	8.7	77.6	19.6
Yellow birch	2.0	.5	—	—	2.0	.5
Yellow poplar	10.8	2.7	32.0	8.0	42.8	10.7
Black cherry	1.0	.2	12.8	3.2	13.8	3.4
Aspen	26.6	6.7	14.0	3.5	40.6	10.2
Total	183.2	46.1	214.2	53.9	397.4	100.0
D.b.h. (Inches)						
4	33.0	8.3	38.0	9.6	71.0	17.9
5	25.2	6.3	50.2	12.6	75.4	18.9
6	62.2	15.7	36.4	9.2	98.6	24.9
7	33.8	8.5	44.6	11.2	78.4	19.7
8	29.0	7.3	45.0	11.3	74.0	18.6
Total	183.2	46.1	214.2	53.9	397.4	100.0

Table 12.—Average stand data, site II, saw-timber class: number of stems per acre, by species and diameter

D.b.h. (Inches)	Hemlock	Red Oak	Sugar maple	Red maple	Beech	Black birch	White ash	Basswood	Black cherry	Misc.1/	All species	
											Total	Percent
1	16	—	175	18	121	—	—	5	—	—	335	59.9
2	8	—	52	9	59	—	13	8	—	—	149	26.7
3	—	—	42	5	28	—	—	—	—	—	75	13.4
Total	24	—	269	32	208	—	13	13	—	—	559	100.0
Percent	4.3	—	48.2	5.7	37.2	—	2.3	2.3	—	—	100.0	
4	—	3.2	21.5	10.9	18.0	0.8	4.0	0.5	0.8	3.2	62.9	21.8
5	—	—	13.6	13.7	6.4	.8	4.1	4.7	.5	—	43.8	15.1
6	—	.8	9.3	7.6	8.0	1.5	1.7	1.8	.8	2.6	34.1	11.8
7	—	2.4	9.8	7.8	5.5	2.4	3.1	—	—	3.1	34.1	11.8
8	—	1.6	7.9	8.5	4.3	—	2.5	2.2	.8	—	27.8	9.6
9	—	.8	5.3	7.2	2.3	—	.5	1.3	.8	1.3	19.5	6.7
10	—	1.3	3.7	2.6	3.7	—	—	1.7	—	—	13.0	4.5
11	—	—	5.3	3.8	2.2	—	—	—	.8	—	12.1	4.2
12	—	.9	4.4	3.0	1.3	—	—	—	1.3	—	10.9	3.8
13	—	2.7	.5	2.1	3.1	—	—	—	.5	—	8.9	3.1
14	—	—	2.6	1.8	2.5	—	—	—	—	—	6.9	2.4
15	—	.9	1.3	—	1.8	—	—	.8	—	—	4.8	1.7
16	—	1.8	—	—	1.0	—	—	—	.5	—	3.3	1.1
17	—	—	—	.5	.5	—	—	—	—	—	1.0	.3
18	—	—	1.0	—	—	—	—	—	—	—	1.0	.3
19	—	.5	1.4	—	.5	—	—	—	—	—	2.4	.8
20	—	—	1.0	—	—	—	—	—	—	—	1.0	.3
22	—	—	.5	—	—	—	—	—	—	—	.5	.2
23	—	—	—	—	.5	—	—	—	—	—	.5	.2
25	—	—	—	—	—	—	—	.8	—	—	.8	.3
Total	—	16.9	89.1	69.5	61.6	5.5	15.9	13.8	6.8	10.2	289.3	100.0
Percent	—	5.8	30.9	24.0	21.3	1.9	5.5	4.8	2.3	3.5	100.0	

1/ Noncommercial species: sassafras, striped maple, fire cherry, butternut, hop-hornbeam—5.8 stems.
Commercial species: yellow poplar, yellow birch, aspen—4.4 stems.

Table 13.—Average stand data, site II, saw-timber class: volume per acre, by species and diameter(1)

Item	Cubic-foot volume				Board-foot volume			
	Poor form	Good form	Total	Percent	Poor form	Good form	Total	Percent
Species								
Red oak	32.5	203.3	235.8	11.0	142	636	778	13.0
Sugar maple	179.9	484.7	664.6	31.1	523	1,405	1,928	32.1
Red maple	112.7	272.0	384.7	18.0	195	621	816	13.5
Beech	249.4	255.5	504.9	23.6	895	791	1,686	28.0
Yellow birch	5.9	—	5.9	.3	—	—	—	—
Black birch	7.8	6.7	14.5	.7	—	—	—	—
White ash	13.5	32.9	46.4	2.1	—	—	—	—
Basswood	120.2	54.0	174.2	8.1	523	—	523	8.7
Yellow poplar	—	10.2	10.2	.5	—	—	—	—
Black cherry	—	82.9	82.9	3.9	—	283	283	4.7
Aspen	6.5	—	6.5	.3	—	—	—	—
Hop-hornbeam	1.9	—	1.9	.1	—	—	—	—
Buttermut	6.7	—	6.7	.3	—	—	—	—
Fire cherry	.4	—	.4	—	—	—	—	—
Striped maple	.4	—	.4	—	—	—	—	—
Sassafras	.4	—	.4	—	—	—	—	—
Total	738.2	1,402.2	2,140.4	100.0	2,278	3,736	6,014	100.0
D.b.h. (Inches)								
4	15.9	7.4	23.3	1.0	—	—	—	—
5	27.9	24.4	52.3	2.4	—	—	—	—
6	32.2	59.5	91.7	4.3	—	—	—	—
7	62.9	83.9	146.8	6.9	—	—	—	—
8	33.6	131.9	165.5	7.8	—	—	—	—
9	58.3	108.5	166.8	7.8	—	—	—	—
10	28.0	116.7	144.7	6.7	—	—	—	—
11	28.6	132.7	161.3	7.6	105	451	556	9.3
12	34.4	145.6	180.0	8.4	132	557	689	11.5
13	11.0	176.9	187.9	8.8	45	700	745	12.3
14	78.9	84.6	163.5	7.7	343	376	719	11.9
15	91.1	52.9	144.0	6.8	415	227	642	10.7
16	50.0	68.6	118.6	5.5	229	323	552	9.2
17	—	38.7	38.7	1.8	—	194	194	3.2
18	20.0	20.0	40.0	1.8	102	102	204	3.4
19	49.6	66.7	116.3	5.4	266	347	613	10.2
20	—	51.2	51.2	2.4	—	279	279	4.6
22	—	32.0	32.0	1.5	—	180	180	3.0
23	39.2	—	39.2	1.8	240	—	240	4.0
25	76.6	—	76.6	3.6	401	—	401	6.7
Total	738.2	1,402.2	2,140.4	100.0	2,278	3,736	6,014	100.0
Percent	34.5	65.5	100.0		37.9	62.1	100.0	

Table 14.—Average stand data, site II, pole-timber class: number of stems per acre, by species and diameter

D.b.h. (Inches)	Hemlock	Sugar maple	Red maple	Beech	Yellow birch	Black birch	Gray birch	White ash	Black cherry	Aspen	Misc. 1/	All species	
												Total	Percent
1	18	260	—	88	10	—	—	10	—	—	46	432	44.8
2	9	81	—	100	10	—	—	—	—	—	75	275	28.5
3	—	50	10	157	30	—	—	—	—	—	10	257	26.7
Total	27	391	10	345	50	—	—	10	—	—	131	964	100.0
Percent	2.8	40.6	1.0	35.8	5.2	—	—	1.0	—	—	13.6	100.0	
4	4.5	35.5	8.9	32.1	1.2	7.0	4.5	3.0	2.7	1.0	40.1	140.5	34.1
5	2.7	34.2	10.0	22.9	3.4	3.0	3.3	3.0	1.8	10.4	8.6	103.3	25.1
6	—	15.6	10.0	25.0	.9	7.0	8.2	3.0	3.1	5.2	2.0	80.0	19.4
7	—	10.2	9.0	8.2	2.2	4.0	1.0	1.0	3.1	1.0	1.9	41.6	10.1
8	—	3.1	4.0	6.1	—	1.0	—	—	2.0	3.0	—	19.2	4.7
9	—	1.0	2.0	3.8	—	1.0	1.0	—	—	—	1.0	9.8	2.4
10	—	1.0	1.0	2.0	—	—	—	1.0	—	2.0	1.0	8.0	1.9
11	—	2.2	—	.9	—	—	—	—	2.4	—	—	5.5	1.3
12	—	.9	—	.9	—	—	—	—	1.2	—	—	3.0	.7
13	—	—	—	—	—	—	—	—	1.2	—	—	1.2	.3
Total	7.2	103.7	44.9	101.9	7.7	23.0	18.0	11.0	17.5	22.6	54.6	412.1	100.0
Percent	1.7	25.2	10.9	24.7	1.9	5.6	4.4	2.7	4.2	5.5	13.2	100.0	

1/ Noncommercial species: serviceberry, striped maple, blue beech, fire cherry, hop-hornbeam—121 stems under 4 inches d.b.h.—44.6 stems over 4 inches d.b.h. Commercial species: basswood, yellow poplar—10 stems under 4 inches d.b.h.—10 stems over 4 inches d.b.h.

Table 15.—Average stand data, site II, pole-timber class: volume per acre, by species and diameter(1)

Item	Cubic-foot volume				Board-foot volume			
	Poor form	Good form	Total	Percent	Poor form	Good form	Total	Percent
Species								
Hemlock	0.9	0.8	1.7	0.2	—	—	—	—
Sugar maple	113.5	117.3	230.8	23.6	148	—	148	24.8
Red maple	64.6	67.7	132.3	13.5	—	—	—	—
Beech	145.7	86.7	232.4	23.7	111	—	111	18.6
Yellow birch	13.0	2.2	15.2	1.5	—	—	—	—
Black birch	36.5	16.5	53.0	5.4	—	—	—	—
Gray birch	36.7	1.0	37.7	3.8	—	—	—	—
White ash	8.2	21.2	29.4	2.9	—	—	—	—
Basswood	.8	6.2	7.0	.7	—	—	—	—
Yellow poplar	22.9	—	22.9	2.3	—	—	—	—
Black cherry	45.1	78.1	123.2	12.5	130	208	338	56.6
Aspen	24.5	47.0	71.5	7.3	—	—	—	—
Fire cherry	12.9	5.9	18.8	1.9	—	—	—	—
Hop-hornbeam	2.5	.8	3.3	.3	—	—	—	—
Noncommercial	4.3	—	4.3	.4	—	—	—	—
Total	532.1	451.4	983.5	100.0	389	208	597	100.0
D.b.h. (Inches)								
4	34.1	17.1	51.2	5.2	—	—	—	—
5	56.2	44.6	100.8	10.3	—	—	—	—
6	116.2	83.6	199.8	20.3	—	—	—	—
7	87.5	92.8	180.3	18.3	—	—	—	—
8	38.9	83.0	121.9	12.4	—	—	—	—
9	55.6	24.2	79.8	8.1	—	—	—	—
10	33.6	54.2	87.8	8.9	—	—	—	—
11	79.7	—	79.7	8.1	272	—	272	45.6
12	30.3	23.5	53.8	5.5	117	90	207	34.7
13	—	28.4	28.4	2.9	—	118	118	19.7
Total	532.1	451.4	983.5	100.0	389	208	597	100.0
Percent	54.1	45.9	100.0		65.2	34.8	100.0	

Table 16.—Average stand data, site II, seedling-and-sapling class: number of stems per acre, by species and diameter

D.b.h. (Inches)	Hemlock	Sugar maple	Red maple	Beech	Yellow birch	Black birch	Black cherry	Aspen	Misc.1/	All species	
										Total	Percent
0.25	—	70	6	62	10	—	2	—	100	250	19.3
1	4	152	30	122	64	—	20	—	146	538	41.4
2	—	76	60	54	52	—	14	—	68	324	25.0
3	4	44	52	36	22	—	14	—	14	186	14.3
Total	8	342	148	274	148	—	50	—	328	1,298	100.0
Percent	0.6	26.3	11.4	21.1	11.4	—	3.8	—	25.4	100.0	
4	—	32	68	36	12	6	30	—	4	188	55.0
5	—	22	44	22	8	4	12	—	8	120	35.1
6	—	4	10	2	2	—	—	—	—	18	5.3
7	—	—	2	4	2	—	—	—	—	8	2.3
8	—	—	2	2	—	—	—	2	—	6	1.7
9	—	—	—	—	2	—	—	—	—	2	0.6
Total	—	58	126	66	26	10	42	2	12	342	100.0
Percent	—	17.0	36.8	19.3	7.6	2.9	12.3	0.6	3.5	100.0	

1/ Noncommercial species: blue beech, sassafras, serviceberry, fire cherry, hop-hornbeam.

Table 17.--Average stand data, site II, seedling-and-sapling class: volume per acre, by species and diameter(1)

Item	Volume in poor form		Volume in good form		Total	
Species	Cubic feet	Percent	Cubic feet	Percent	Cubic feet	Percent
Sugar maple	13.4	4.1	35.2	10.6	48.6	14.7
Red maple	101.8	30.9	22.0	6.7	123.8	37.6
Beech	19.4	5.9	41.2	12.4	60.6	18.3
Yellow birch	42.0	12.7	2.2	.7	44.2	13.4
Black birch	6.8	2.1	—	—	6.8	2.1
Black cherry	12.0	3.6	10.8	3.3	22.8	6.9
Aspen	14.8	4.5	—	—	14.8	4.5
Fire cherry	4.4	1.3	—	—	4.4	1.3
Hop-hornbeam	1.6	.5	2.2	.7	3.8	1.2
Total	216.2	65.6	113.6	34.4	329.8	100.0
D.b.h. (Inches)						
4	46.2	14.0	25.2	7.6	71.4	21.6
5	77.0	23.4	44.0	13.3	121.0	36.7
6	31.4	9.5	16.6	5.0	48.0	14.5
7	16.8	5.1	16.0	4.9	32.8	10.0
8	27.2	8.3	11.8	3.6	39.0	11.9
9	17.6	5.3	—	—	17.6	5.3
Total	216.2	65.6	113.6	34.4	329.8	100.0