

The Timber Resources of DELAWARE

*A Report
on the Forest Survey
made by the
U.S. Forest Service*



NORTHEASTERN FOREST EXPERIMENT STATION

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RALPH W. MARQUIS, DIRECTOR

PREFACE

THIS is a report on the findings of the first comprehensive survey of the timber resources of Delaware. It describes, as of 1957, the area and condition of the forest land, the volume of standing timber, the annual growth and mortality of the forest growing stock, and the extent of timber cutting. The survey made by the Forest Service, U.S. Department of Agriculture, is a part of a nationwide survey of timber resources.

Previous estimates of Delaware's forest area and timber volume have been made, but because of changing definitions, standards, and procedures, comparisons of earlier estimates with the data in this report do not necessarily indicate trends.

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by Roland H. Ferguson

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Delaware's Forests... Yesterday

DELAWARE'S forests have made a unique contribution to the American tradition. For it was in what is now Delaware that Swedish colonists felled trees to make a type of dwelling that has become symbolic of the American pioneer --the log cabin. The idea of the Swedish log cabin, so well suited to life in a forest land, was soon adopted by other colonists; and wherever the ax stroke rang out in our westward expansion, there would soon rise the log house, close kin to those first seen in Delaware.

This State--by land area next to the smallest in the Nation--lies on a portion of the fertile Del-Mar-Va Peninsula between two great bays of the Atlantic Ocean. It is situated midway between the north and south zones of eastern forest growth so that its woodlands contain species representative of both climates. The demarkation line between the two forest types is, to the trained eye, quite easily noted where it crosses the State south of Dover.

Early explorers and colonists were attracted by the rich resource of Delaware timber. In 1616, a Dutch sea captain wrote that the area was "... full of trees, to wit: Oaks, hickory, and pines." Another colonial traveler stated that Delaware has "the finest oaks for height and thickness that one could ever see." Others reported that from the soils of Delaware sprang mighty oaks rising 60 to 80 feet to the first branch. Yellow-poplar trees were equally tall and clear. Huge beech, chestnut, walnut, hickory, maple, gum, sycamore, and ash trees competed for growing space. Pines--straight, slim, and smooth--stood close together, and cypress and white-cedar grew thick in swamps.

Delaware's original forests were one of the key factors in the early economic development of the State. Besides fuel, each farmer's woodlot provided him with cash when planted crops produced insufficient income. Many timber tracts containing black oak were cut solely for the bark, then in great demand for tanning and dyeing. Also, large volumes of white oak were logged for local shipbuilding, or for export to Holland, Sweden, and England. For a hundred years, 1750 to 1850, many stout wooden ships were built in Delaware.

...And Today

DELAWARE'S people still require a great deal of wood. Over a period of 7 years the average Delaware family uses enough wood to build a comfortable home--including a garage for the family car. For the State this amounts to an annual consumption of 20 million cubic feet of wood in the form of lumber, furniture, paper, firewood, and other useful products. Delaware's population is growing and will require even more wood in the future.

Careful management of the timber resource is particularly important in Delaware, where there is intense competition for the use of almost every acre of land. Only one-third of the State's land area now supports tree growth. As small as this area is, it is still potentially very productive. And management can make these forests play an important role in meeting the future woods needs of Delaware's people.

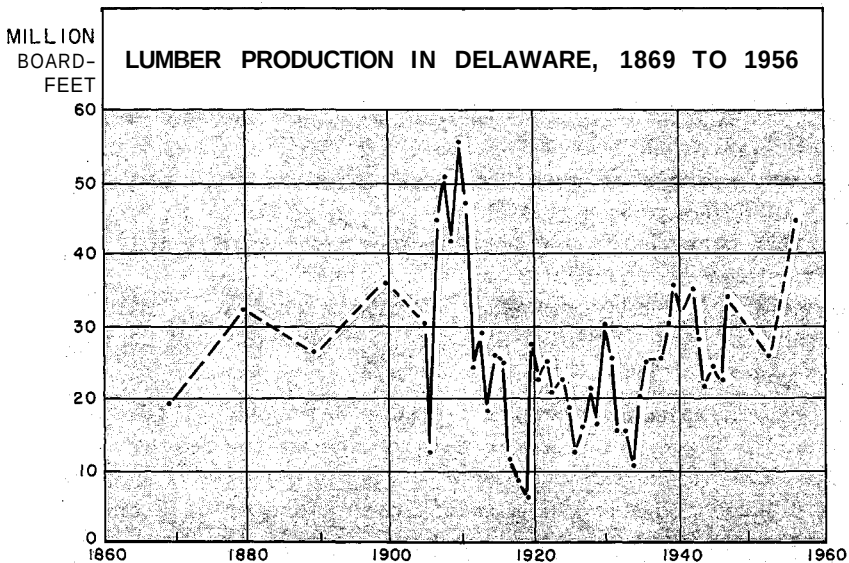


Figure 1.--Delaware's annual output of lumber reached its peak in 1909, declined rapidly until 1918, and over the intervening years has made a gradual climb back towards its former high of 55 million board feet.

In 1957, the U.S. Forest Service, in cooperation with the Delaware Forestry Department, made a survey of Delaware's forests. The purpose of the survey was to find out how much timber there is in Delaware, how fast it is growing, and how much is being cut. This is information that public agencies need for planning forestry policies and programs, and that private forest industries use in their search for raw materials and in their plans for future operations. In summarizing the findings of this cooperative survey, this report describes the State's forest resources in terms of the timber products her people can obtain from it today and those they can expect it to produce for them tomorrow.

Nearly 400,000 forested acres are found within the State. Of Delaware's three counties, Sussex contains two-thirds of the State's timber volume. As the most southerly region, its soils are level and sandy and its forests--mostly southern yellow pines--occupy 42 percent of the county. But in the more densely populated northern counties of New Castle and Kent, forests cover only 21 percent of the land.

County	Forest area (<i>Thousand acres</i>)	Saw- timber (<i>Million bd.-ft.</i>)	Growing stock (<i>Million cu.ft.</i>)
Kent	78	241	104
New Castle	61	117	43
Sussex	252	777	336
Total	391	1,135	483

Farmers own more than half of the forest land. Woodlots still are an important integral part of the average Delaware farm.

Uses of the Timber Resource

LUMBERING in Delaware is not a large industry, but it can boast of continuous production since Colonial days. From 1869 on, lumber production has averaged 25 million board-feet per year (fig. 1). Output has been increasing since the 1930's, and in 1956 it was greater than in any year since 1909.



Figure 2.--Large dimension hardwood timber is sawed at this mill in Milford, Delaware.

Timber products taken from the forests of Delaware in 1956 amounted to 13.6 million cubic feet of sawlogs, pulpwood, fuelwood, veneer bolts, piling, and other wood. Sixty percent of this total was used to produce lumber--the State's most important forest product.

Seventy percent of the lumber produced in Delaware during 1956 was softwood--almost all of it pine. The remainder was hardwood, principally oak.

Sawmills are found throughout the State (fig. 2). Stationary mills, mainly cutting hardwood lumber, are common in the north. In southern Delaware, many of the mills are portable, moving frequently from one location to another.

Pulpwood ranks second to sawlogs¹ in volume of timber products output, making up 13 percent of the total. Because Delaware has no pulpmills, the 22,500 cords of pulpwood cut in 1956 was shipped out of the State; most of it went to mills in tidewater Virginia and western Maryland, but some reached Pennsylvania and New Jersey. All the pulpwood volume came from the southern yellow pines.

Wooden piling--long straight poles used in constructing docks, foundations, and the like--ranks third among timber

¹Terms are defined in the Appendix.



Figure 3.--Here piling is being removed from a stand before sawlogs are cut.

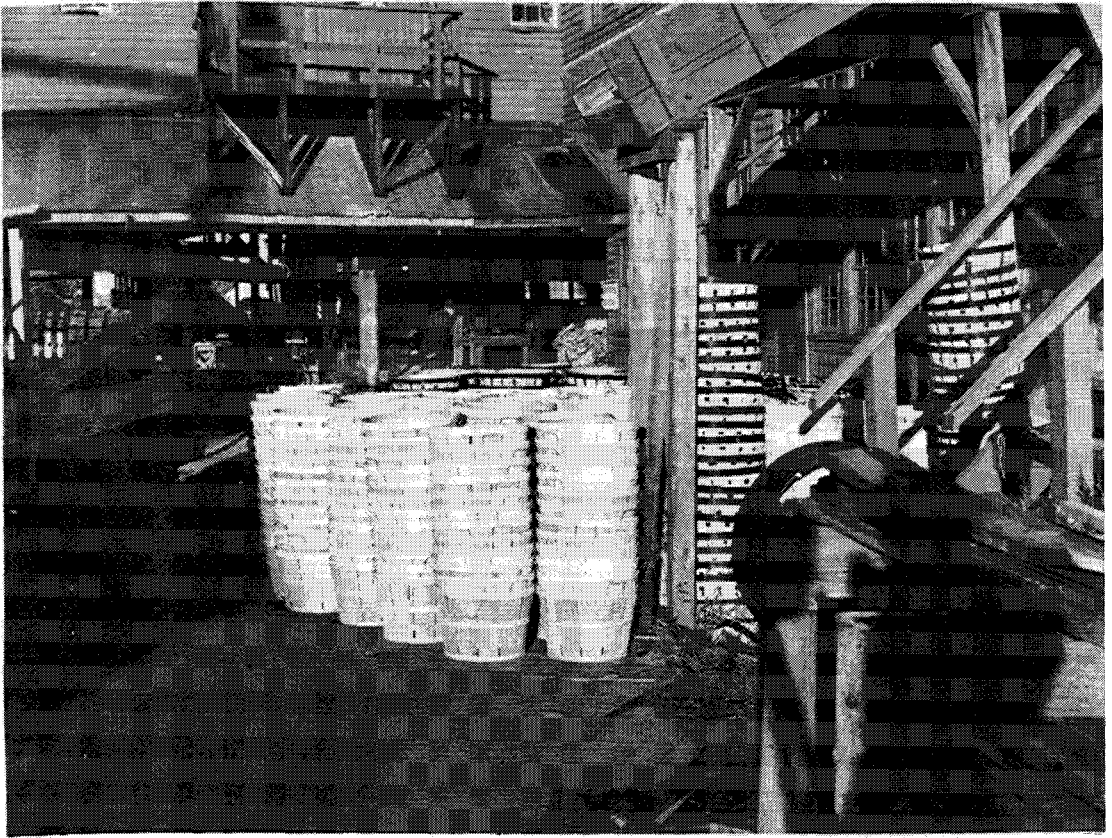


Figure 4.--Fruit and vegetable baskets are the principal products of veneer mills in southern Delaware.

products output, with 9 percent of the total volume. Sixty percent of the piling is pine, the rest hardwood (fig. 3).

Three basket-veneer mills operate in Delaware (fig. 4). Although one of the mills is large, providing work for more than 100 employees, this industry takes only a small quantity of logs (5 percent of the total), but the logs it does use are high in quality. Most of the sweetgum and yellow-poplar veneer logs cut in Delaware are shipped to mills in southern New Jersey. Also operating in Delaware is a plant that makes excelsior--fine wooden shavings used for packing.

The remainder of the State's timber products output --13 percent--is made up of fuelwood, fence posts, mine props, and so on.

The Timber Inventory

KEEPING in mind the uses made of timber, let's examine the raw material inventory present in Delaware's forests. Differences in timber quality must be recognized, so the volume of sound wood in live trees is divided into two classes: growing stock and other material. Volume meeting growing-stock specifications is further subdivided by tree size into two classes: sawtimber, trees considered suitable for conversion into sawlogs and lumber; and poletimber, trees too small for sawlogs (fig. 5).

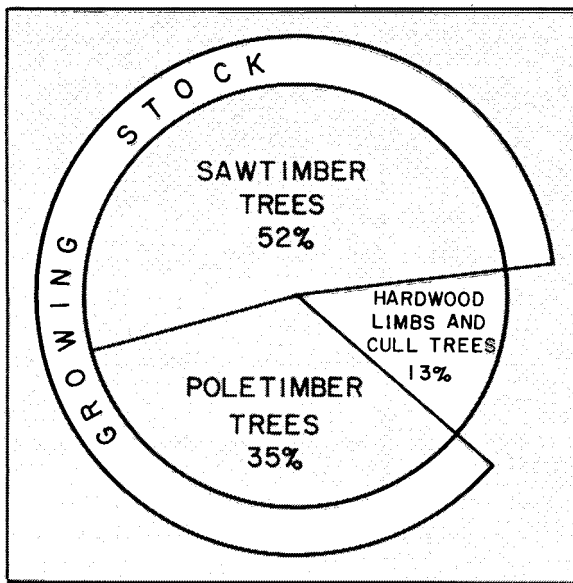


Figure 5.--Sawtimber trees account for a little more than half of the total volume of wood in Delaware.

The solid-wood content in all trees larger than 5 inches in diameter found growing on commercial forest land in Delaware adds up to more than one-half billion cubic feet. Growing-stock volume amounts to 483 million cubic feet. In bulk, this is a lot of wood. But this forest inventory is rather heavily weighted with small trees (fig. 6).

But lumber is produced primarily from larger trees, the sawtimber--softwoods over 9 inches in diameter and hardwoods over 11 inches. Delaware's sawtimber volume--that amount of timber from which lumber can be sawed--totals 1,135 million board-feet. Almost half of this is in the favored pines (fig. 7 and fig. 8). Also in sawtimber, there are more small trees than large: over half of the volume is

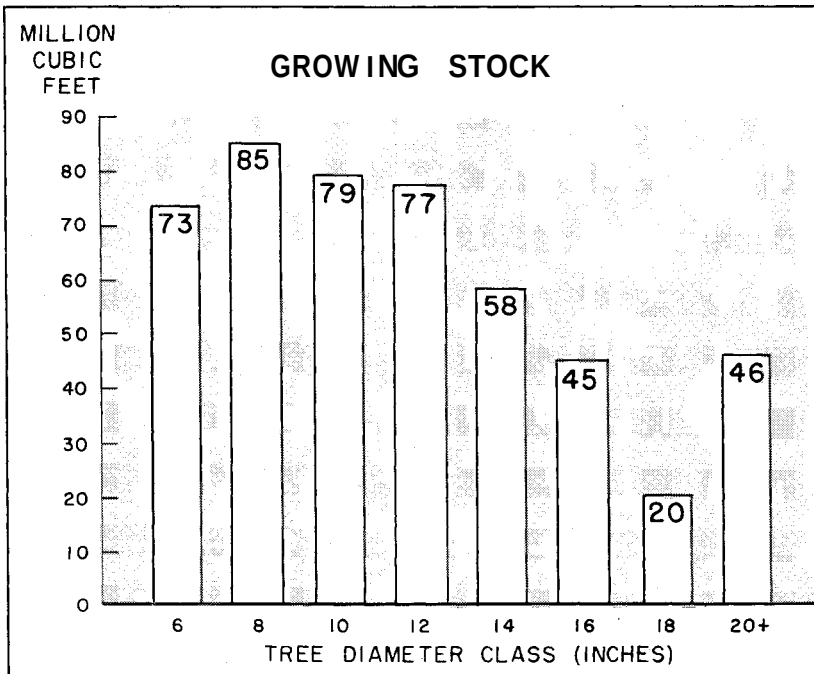


Figure 6.--Growing stock volume is concentrated in the smaller diameter classes.

in trees less than 15 inches in diameter (d.b.h.). What's more, the lumber cut from small trees is usually inferior to that produced from large trees.

For a stand of timber to be logged economically, it must contain at least 1,500 board feet per acre; and approximately half of Delaware's forest area is in such stands. Fortunately, almost all the State's sawtimber is found in such stands. Thus very little sawtimber is "lost" in stands with volumes too small to be economically harvested.

Trees suitable for pulpwood are those in which at least 8 continuous feet of the main stem meet pulpwood quality requirements.² Such trees can be sawtimber, poletimber, or even sawtimber "culls". Volume of pulpwood is expressed in standard cords of wood.

Delaware's timber inventory includes 5.8 million cords of wood that meets pulpwood specifications. Half this

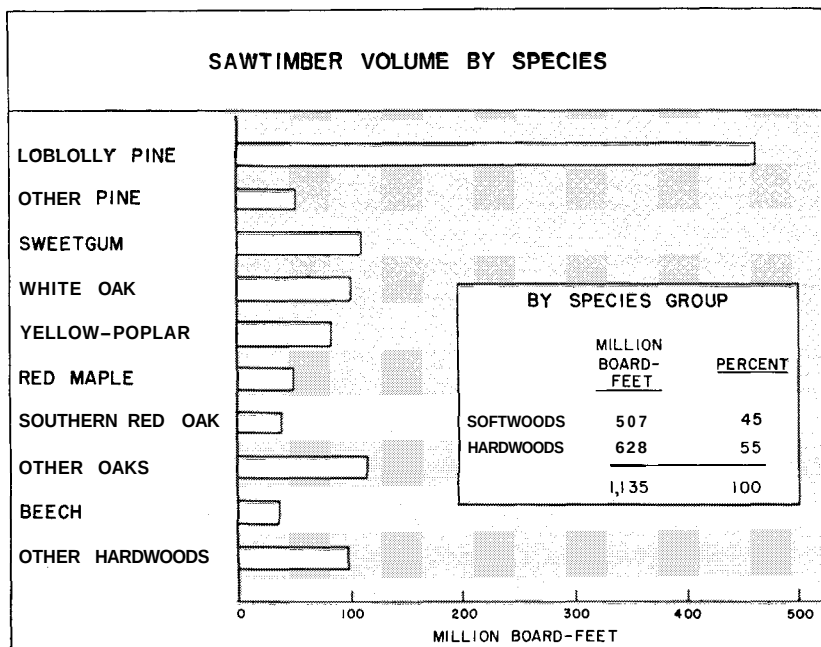


Figure 7.--The board-foot volume of loblolly pine is four times that of the next most abundant species.

volume is softwood, mostly loblolly pine. Because pulpwood specifications permit smaller diameters, the predominance of small trees in Delaware is not a serious handicap to pulpwood users.

Pulpwood, until recently, has been relatively unimportant in Delaware because there are no nearby wood-pulp mills and pulpwood transportation is costly. Nevertheless,

²Quality requirements of the pulpwood industry were developed by the Appalachian Technical Committee of the American Pulpwood Association.



Figure 8.--Stand of *loblolly* pine on one of the State Forests.

the pulp industry is interested in Delaware's timber, as evidenced by recent purchases and leasing of forest land by out-of-state pulp companies.

Prospective Changes in the Timber Supply

A SUPPLY of timber is not static, because trees grow. Thus, small trees represent potential sawtimber as well as current pulpwood volume. And so, rate of cutting relative to rate of growth will in part determine the amount and value of inventories for Delaware's forest industries of tomorrow. Data on cut and growth for prolonged periods are not available, but estimates for 1956 provide some basis for evaluating prospective changes in timber supplies.

To evaluate these changes, one should understand the components of net annual growth and annual cut. Net annual growth includes growth on live merchantable trees and "in-growth", which is the entire volume of potentially merchantable trees that reach the minimum size-class during the year.

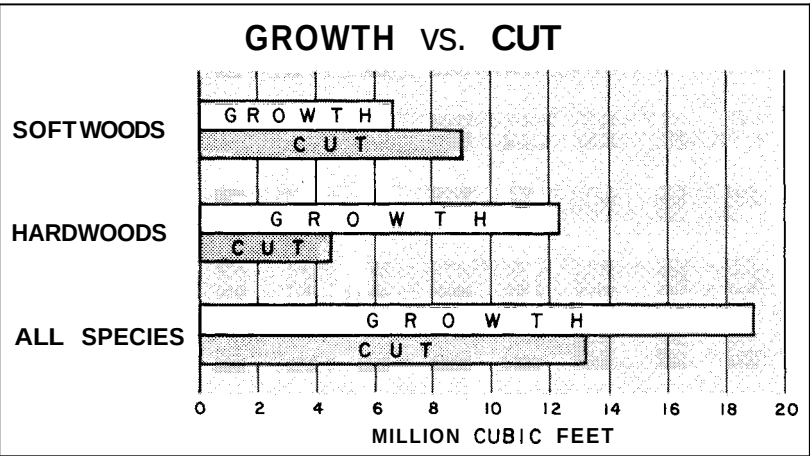


Figure 9.--More softwood volume was cut in 1956 than grown, but, for *all* species, more wood was grown than cut.

But net annual growth excludes "mortality", which is the volume of trees that die during the year. The timber-cut estimate includes the volume of timber products output and also the unutilized volume of logging residues.

According to our estimates of growth and cut in 1956, Delaware's timber inventory is getting larger, both in sawtimber volume and in growing-stock volume. Sawtimber growth in 1956 was 55 million board-feet, while the cut was 42 million. Growing-stock growth was 19 million cubic feet, the cut was 13 million.

But what about changes in volume by species? Delaware's vital softwood inventory apparently is declining (fig. 9), but its hardwood volume is increasing. Another serious note for the industry is the comparison of growth and cut in poletimber-sized trees--tomorrow's potential sawtimber. The following tabulation shows that even in these sizes, softwoods are being consumed faster than they are being replaced:

	Softwoods (million cu. ft.)	Hardwoods (million cu. ft.)
Sawtimber trees:		
Annual growth	5.1	8.4
Timber cut	7.0	3.8
Poletimber trees:		
Annual growth	1.5	3.9
Timber cut	1.9	.7

The Challenge of the Forests

TOO often in the past, indiscriminate cutting has converted superior timber stands into inferior ones, which, if stocked at all, are stocked with low-quality trees and second-rate species. Every means should be taken to rectify this situation: land in Delaware is too valuable a resource. Forests can be the most productive use for substantial amounts of it, but management must make the forests produce greater volumes, larger and better quality trees, and a

larger proportion of desirable species. If this is not done, other uses for the land may prove more productive.

The future for Delaware's forest resource could be very bright, for the total timber volume is increasing. In recent years the volume of timber grown has been nearly 50 percent greater than the volume cut. This favorable relationship and the highly productive forest soils in Delaware favor improvement of the forest resource.

Forests in the state would be more valuable if more of the timber were in softwood species, in larger trees, and in trees of higher quality. And more people would benefit from such forests--that is, forests with timber better suited to the requirements of its users. There are several measures that would improve the woodlands of the State:

Increase protection from fire, insects, and diseases

- Adopt stand-improvement practices--thinning, cull-tree removal, and so on.
- Plant idle and cut-over lands.
- Postpone cutting in young stands to take advantage of rapid growth of young trees.

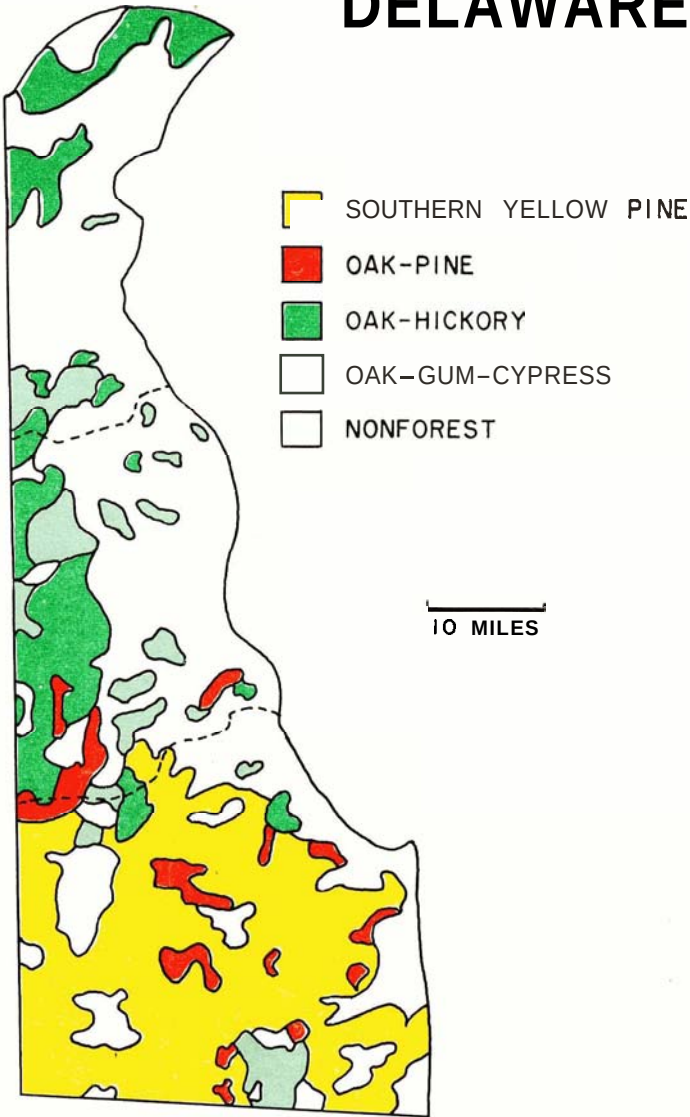
Also, cutting operations could be more carefully designed to encourage new stands of desirable species--pine in southern Delaware and valuable hardwoods such as oak, yellow-poplar, and sweetgum in the north.

Private owners--some 7,500 of them--hold virtually all of the forest land in Delaware. They can apply improvement measures directly. But the primary interests of many owners are far removed from forestry. And more than 90 percent of the forest land is in holdings too small to justify employing a professional forester on a full-time basis.

It might be noted, too, that people exert certain pressures on woodlands, pressures which can be summed up in the multi-use factors of water, recreation, hunting and fishing, and even aesthetic values. But far from being incompatible with these uses, good forest management can exist side-by-side with them, and can mean good campsites, clean streams, woods well stocked with game, a pleasing view from a roadway. And this is an aspect of producing timber that becomes increasingly important as Delaware's population grows.



THE MAJOR FOREST TYPES OF DELAWARE



Appendix

Forest Survey Data

To facilitate compilation of forest-survey data for any group of states, region, or the Nation as a whole, a standard set of tables is presented in the forest-survey report on each state. These tables contain information on forest area, timber volume, ownership, growth, timber cut, and so forth. The following tables present this information for the State of Delaware.

Table 1.--Land area of Delaware, by major classes
of land, 1957

Class of land	Area	
	<u>Thousand acres</u>	<u>Percent</u>
Forest:		
Commercial	<u>1</u> /391	31
Noncommercial	1	(<u>2</u> /)
Total	392	31
Nonforest ³	874	69
Total, all classes	1,266	100

¹Contains sampling error of $\pm$ 5 percent.

²Less than 1 percent.

³Includes 7,000 acres of water according to Survey standards of area classification, but defined by the Bureau of the Census as land.

Table 2.--Commercial forest-land area in Delaware, by ownership
and stand-size classes, 1957

Ownership class	Saw- timber stands	Pole- timber stands	Seedling- and-sapling stands	Nonstocked and other areas ¹	Total
	<u>Thousand acres</u>	<u>Thousand acres</u>	<u>Thousand acres</u>	<u>Thousand acres</u>	<u>Thousand acres</u>
Public ²	1	7	(3/)	1	9
Private:					
Farm	90	94	26	5	215
Industrial and other	120	28	19	(3/)	167
Total	210	122	45	5	382
All ownerships	211	129	45	6	391

¹Includes areas not classified elsewhere.

²Includes 8,100 acres of state-owned forest land and 900 acres of Federally-owned forest land.

³Less than 500 acres.

Table 3.--Area of commercial forest land in Delaware,
by major forest-type group, 1957

Forest type	Area	
	<u>Thousand acres</u>	<u>Percent</u>
Southern yellow pine:		
Loblolly pine	134	33
Loblolly-shortleaf-Virginia pine	43	11
Loblolly pine-hardwood	14	4
Yellow pine-oak	7	2
Total	198	50
Oak-hickory:		
Red oak	36	9
White oak	32	8
Yellow-poplar--oak	8	2
Sweetgum--yellow-poplar	6	2
Total	82	21
Oak-pine	22	6
Oak-gum-cypress	89	23
All forest types	391	100

Table 4.--Net volume of live sawtimber and growing stock
on commercial forest land, in Delaware,
by stand-size class, 1957

Stand-size class	Saw- timber	Growing stock
	<u>Million</u> <u>bd.-ft.</u>	<u>Million</u> <u>cu.ft.</u>
Sawtimber stands	1,082	381
Poletimber stands	51	98
Other stands	2	4
Total	<u>1/</u> 1,135	<u>2/</u> 483

¹Contains sampling error of $\pm$ 9 percent.

²Contains sampling error of $\pm$ 6 percent.

Table 5.--Net volume of live sawtimber and growing stock
on commercial forest land, in Delaware,
by ownership class, 1957

Ownership class	Saw- timber	Growing stock
	<u>Million</u> <u>bd.-ft.</u>	<u>Million</u> <u>cu.ft.</u>
Public	13	10
Private:		
Farm	530	241
Industrial and other	592	232
Total	<u>1,122</u>	<u>473</u>
All ownerships	1,135	483

Table 6.--Net volume of live sawtimber and **growing stock**
on commercial forest land in Delaware, by species, 1957

Species ¹	Saw- timber	Growing stock
	Million bd.-ft.	Million cu.ft.
Softwoods:		
Loblolly and shortleaf pine ²	466	181
Other	41	49
Total	507	230
Hardwoods:		
White oak ³		8
Red oaks ⁴		9
Other white oaks		2
Other red oaks		4
Red maple		8
Beech		8
Sweetgum	109	45
Blackgum	42	16
Hickory	10	4
Yellow-poplar	83	21
Other eastern hardwoods	45	18
Total	628	253
All species	1,135	483

¹Species from the national standard list that do not appear here are either not present in Delaware or were so rarely found that no reliable estimate of volume could be made.

²Includes a small amount of pond pine.

³Quercus alba.

⁴Quercus falcata and Q. rubra.

Table 7.--Net volume of live sawtimber on commercial forest land
in Delaware, by diameter-class group and species, 1957

(In millions of board-feet)

Species ¹	Diameter-class group (in inches)						Total
	1	12	14	16	18	20+	
Southern yellow pines	130	139	108	54	18	58	507
Hardwoods:							
White oaks	--	24	31	29	8	26	
Red oaks	--	35	17	28	12	42	
Sweetgum	--	29	33	19	18	10	109
Other hardwoods	--	48	44	60	33	82	267
Total	--	136	125	136	71	160	628
All species	130	275	233	190	89	218	1,135

¹Species from the national standard list that do not appear here are either not present in Delaware or were found so rarely that no reliable estimate of volume by diameter class could be made.

Table 8.--Net volume of all timber on commercial forest land
in Delaware, by class of material and species group, 1957

Class of material	Softwoods	Hardwoods	Total
	<u>Million</u> <u>cu.ft.</u>	<u>Million</u> <u>cu.ft.</u>	<u>Million</u> <u>cu.ft.</u>
<u>Growing stock:</u>			
Sawtimber trees:			
Sawlog portion	126	123	249
Upper-stem portion	15	22	37
Total	141	145	286
Poletimber trees	89	108	197
Total growing stock	230	253	483
<u>Other material:</u>			
Sound cull trees	6	11	
Rotten cull trees	2	9	
Hardwood limbs	--	44	44
Total other material ¹	8	64	72
Total, all timber	238	317	555

¹Salvable dead-tree volume is negligible.

Table 9.--Net annual growth, annual mortality, and annual cut of live sawtimber and growing stock on commercial forest land in Delaware, by species group, 1956

Item	Sawtimber			Growing stock		
	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total
Net annual growth	<u>Million board-feet</u>			<u>Million cubic feet</u>		
	18	37	55	7	12	9
Annual mortality	2	2	4	2	1	3
Annual cut:						
Timber products	27	14	41	8	3	11
Logging residues	(2/)	1	1	1	1	2
Total	27	15	42	9	4	3

¹Contains sampling error of $\pm$ 13 percent.

²Less than 500,000 board-feet.

³Contains sampling error of $\pm$ 23 percent.

Output of timber products and annual cut of live sawtimber and growing stock in Delaware, 1956

Product	Output of timber products ¹				Annual cut of sawtimber				Annual cut of growing stock			
	Volume in standard units		Roundwood volume									
	Standard units	Number	Soft-woods	Hard-woods	Total	Soft-woods	Hard-woods	Total	Soft-woods	Hard-woods	Total	
<u>M cubic feet</u>												
Sawlogs	M board-feet ²	44,538	6,644	1,701	8,345	23,803	7,253	31,056	6,495	2,191	8,686	
Veneer logs and bolts	M board-feet	4,393	--	713	713	--	4,597	4,597	--	975	975	
Pulpwood	Standard cords ³	$\frac{4}{22},500$	1,800	--	1,800	997	--	997	1,284	--	1,284	
Fuelwood	Standard cords	$\frac{5}{12},913$	29	1,004	1,033	3	718	721	16	596	612	
Piling	M linear feet	1,860	689	465	1,154	2,248	1,884	4,132	697	600	1,297	
Posts	M pieces	167	1	109	110	--	205	205	1	107	108	
Mine timbers	M cubic feet	41	41	--	41	12	--	12	39	--	39	
Miscellaneous ⁶	M cubic feet	$\frac{4}{388}$	388	--	388	--	--	--	346	--	346	
Total	--	--	9,592	3,992	13,584	27,063	14,657	41,720	8,878	4,469	13,347	

¹Includes material from both growing stock and other miscellaneous sources.

²International 8-inch rule.

³Rough-wood basis.

⁴No plant residues used in 1956.

⁵Does not include 1,054,000 cubic feet of wood from mill residues used for domestic and industrial fuel.

⁶Includes excelsior bolts, etc.

Definitions of Terms

MEASURES OF FOREST AREA

Forest-land area.--Includes (a) lands that are at least 10 percent stocked by trees of any size and capable of producing timber or other wood products, or of exerting an influence on the climate or on the water regime; (b) land from which the trees described in (a) have been removed to less than 10 percent stocking and which has not been developed for other use; and (c) afforested areas. Forest tracts of less than 1 acre, isolated strips of timber less than 120 feet wide, and abandoned fields and pastures not yet 10 percent stocked with trees are excluded.

Commercial forest-land area.--Forest land that is (a) producing, or physically capable of producing, usable crops of wood (usually sawtimber), (b) economically available now or prospectively, and (c) not withdrawn from timber utilization.

Noncommercial forest-land area.--Forest land (a) withdrawn from timber utilization through statute, ordinance, or administrative order but that otherwise qualifies as commercial forest land or (b) incapable of yielding usable wood products (usually sawtimber) because of adverse site conditions.

FOREST-COVER TYPES

The forest-cover types are classified according to the predominant species or species group as indicated by cubic volume for sawtimber and poletimber stands, and number of trees for seedling-and-sapling stands. All local types are keyed to certain major types to facilitate combining the Delaware estimates with estimates made in other states. The map of Delaware's major forest types is highly generalized; therefore, small, scattered stands do not show.

Southern yellow pine type.--Forests in which 50 percent or more of the stand is loblolly, shortleaf, or Virginia pine singly or in combination. *Common* associates include pond pine, oaks, sweetgum, and red maple.

Oak-hickory.--Forests in which 50 percent or more of the stand is in the upland oak species, singly or in combination, except where yellow pine comprises 25 to 49 percent, in which case the stand would be classified as oak-pine. *Common* associates include hickory, yellow-poplar, and red maple.

Oak-pine type.--Forests in which 50 percent or more of the stand is hardwoods, usually upland oaks, but in which yellow pines make up 25 to 49 percent of the stand. *Common* associates include sweetgum, hickory, and yellow-poplar.

Oak-gum-cypress type.--Bottomland forests in which 50 percent or more of the stand is in sweetgum, red maple, blackgum, swamp oaks, or cypress singly or in combination. Sweetgum predominates in many

stands. Sweetbay is often the most common associate. Holly is another common associate. Atlantic white-cedar occurs to a very minor extent.

STAND-SIZE CLASS

Sawtimber stands.--Stands that contain sawtimber trees having a minimum net volume per acre of 1,500 board feet, International $\frac{1}{4}$ -inch rule.

Poletimber stands.--Stands that fail to meet the sawtimber stand specification, but at least 10 percent stocked with poletimber and larger trees (5.0 inches d.b.h. and larger) and have at least half of the minimum stocking in poletimber trees. Poletimber stands carry at least 200 cubic feet per acre.

Seedling-and-sapling stands.--Stands that do not qualify as either sawtimber or poletimber stands, but have at least 10 percent stocking of trees of commercial species, and have at least half the minimum stocking in seedling-and-sapling trees.

Nonstocked and other areas not classified elsewhere.--Areas that do not qualify as sawtimber, poletimber, or seedling-and-sapling stands; areas that are less than 10 percent stocked with trees of commercial species.

TREE CLASSES

Sawtimber trees.--Trees of commercial species that contain at least one merchantable sawlog that meets the minimum log-grade specifications, as defined below, and that are of the following minimum diameters at breast height (d.b.h.): softwoods 9.0 inches and hardwoods 11.0 inches.

Poletimber trees.--Trees of commercial species that meet regional specifications of soundness and form, and that are of the following diameters at breast height: softwoods 5.0 to 9.0 inches; hardwoods 5.0 to 11.0 inches. Such trees will usually become sawtimber trees if left to grow.

Seedling-and-sapling trees.--Live trees of commercial species less than 5.0 inches in diameter at breast height and of good form and vigor.

Cull trees.--Live trees of sawtimber or poletimber size that are unmerchantable for sawlogs now or prospectively because of defect, rot, or species.

Hardwood limbs.--Limbs of hardwood sawtimber trees and sawtimber-size cull hardwood trees to a minimum diameter of 4.0 inches inside bark.

MEASURES OF TIMBER VOLUME

Growing stock.--Volume in cubic feet of live sawtimber trees and live poletimber trees from stump to a minimum 4.0-inch top of central stem inside bark, less deductions for rot.

Net sawtimber volume.--Volume in board feet (log scale, International $\frac{1}{4}$ -inch rule) of live sawtimber trees of commercial species less deductions for rot, sweep, and other defects affecting use for lumber. Sawtimber volume is measured in 16-foot merchantable sawlogs except that the uppermost merchantable sawlog may be as short as 8 feet.

Standard cord.--A unit of measure for stacked wood, encompassing 128 cubic feet of wood, bark, and air space. Cord estimates are derived from cubic-foot measurements by applying a factor of 80 cubic feet of wood (inside bark) per rough cord.

LOG GRADES

The log grades used in the survey are outlined in Figures 10, 11, and 12.

PULPWOOD SPECIFICATIONS

Source of Specifications

The pulpwood specifications used in this report are those set up by the Appalachian Technical Committee of the American Pulpwood Association.

Pulpwood Trees

Live trees of commercial species, 5.0 inches d.b.h. and larger, containing at least two contiguous pulpwood bolts and with 50 percent or more of the main-stem volume usable for pulpwood. (A pulpwood bolt is a section of the main stem 4 feet long; 4.0 inches or larger inside bark at the small end; free from any indication of rot, charred wood, metal, or hollow center; and contiguous to one or more other bolts that meet the same requirements. Crotches are excluded; sweep or crook in any section shall exclude the bolt if a line from center of top cut to center of bottom cut passes outside the wood at any point.)

Pulpwood Volume

Net volume in standard cords (including bark) of the main stem of pulpwood trees, from stump to point where the top breaks up into branches or to a minimum top diameter of 4.0 inches (inside bark). Deductions are made for all portions of the stem that fail to meet pulpwood bolt requirements.

MEASUREMENTS OF TIMBER GROWTH AND CUT

Net annual growth of sawtimber.--The change (resulting from natural causes) in net board-foot volume of live sawtimber on commercial forest land during a specified year.

Ingrowth of sawtimber.--The net board-foot volume of trees that grew up into sawtimber size during the inventory year as measured at the end of the year.

HARDWOOD LUMBER LOGS

Figure 10.--
Grade standards used for
hardwood lumber logs in
forest survey
of Delaware.

GRADE FACTORS *		SPECIFICATIONS						
		Log Grade 1		Log Grade 2			Log Grade 3	
Position in tree		Butts only	Butts & uppers		Butts & uppers			Butts & uppers
Minimum diameter (inches)		13-15	16-19	20+	21	12t		8+
Minimum length (feet)		10+	10+	10+	10+	8-9	10-11	12+
Clear cuttings** on each of the 3 best faces	Min. length (feet)	7	5	3	3	3	3	2
	Max. number	2	2	2	2	2	2	--
	Min. yield in face length	5/6	5/6	5/6	2/3	3/4	2/3	1/2
Max. sweep and crook allowance (percent of gross volume)		15		30			50	
Max. cull and sweep allowance (percent of gross volume)		30		45			50	
*2nd defects, although not visible in standing trees, are important in grading cut logs. Instructions for dealing with this factor are contained in Forest Prod. Lab. Rpt. D1737. **A clear cutting is a portion of a face free of defects, extending the width of the face. A face is one-fourth the surface of the log as divided lengthwise.		'Ash and basswood butts can be 12 inches if otherwise meeting requirements for small No. 1's. 210-inch logs of all species can be No. 2 if otherwise meeting requirements for small No. 1's. 'Otherwise No. 1 logs with 51-60 percent cull can be No. 2. 'Otherwise No. 2 logs with 51-60 percent cull can be No. 3.						

TIE AND TIMBER LOGS

GRADE FACTORS		SPECIFICATIONS
Position in tree		Butts and uppers
Scaling diameter (inches)		8+
Length, without trim (feet)		8+
Clear cuttings		No requirements: not graded on cutting basis.
Max sweep allowance		One-fourth d.i.b. of small end for half logs, and one-half d.i.b. for logs 16 feet long.
Sound surface defects permitted	Single knots	Any number, if none has an average collar diameter that is more than one-third of log diameter at point of occurrence
	Whorled knots	Any number, provided the sum of the collar diameters does not exceed one-third the log diameter at point of occurrence.
	Holes	Any number not exceeding knot specifications if they do not extend more than 3 inches into the contained tie or timber.
Unsound surface defects permitted	Any number and size if they do not extend into contained tie or timber. If they extend into contained tie or timber, they shall not exceed size, number, and depth of limits for sound defects.	
Knot collar is the average of the vertical and horizontal diameters of the limb or knot swelling as measured flush with the surface of the log. **Interior defects are not visible in standing trees. They are considered in grading cut logs. No interior defects are permitted except one shake not more than one-third the width of the contained tie or timber, and one split not more than 5 inches long.		

Figure 11.--The standards used for hardwood tie and timber logs in the forest survey of Delaware.

YELLOW PINE LOGS

GRADE	DIAMETER (in inches, inside bark)	LENGTH (feet)	SURFACE REQUIREMENTS
1	10-16	8+	Surface clear (not considering adventitious knots or branches).
	16+	8+	Not more than three 2- to 4-inch knots and any number of smaller knots.
2	8-9	8+	Surface clear.
	10-13	8+	Any number of small knots (less than 2 inches in diameter).
	14+	8+	Not more than six 2- to 4-inch knots and any number of smaller knots.
3	6-7	8+	Any number of small knots not exceeding 1-inch in diameter.
	8-13	8+	Not more than six 2- to 4-inch knots and any number of smaller knots.
	14+	8+	More than six 2- to 4-inch knots. Any log with one or more knots 5 inches or larger.
	Knotty or crooked merchantable logs 8 inches d.i.b. or larger and 10 feet in length or longer that do not fall in either Grade 1 or Grade 2.		

Figure 12.--The grade standards used for yellow pine logs in forest survey of Delaware.

Annual mortality of sawtimber.--The net board-foot volume removed from live sawtimber on commercial forest land during a specified year through death from natural causes.

Net annual growth of *growing* stock.--The change (resulting from natural causes) in net cubic-foot volume of growing stock on commercial forest land during a specified year.

Ingrowth of growing stock.--The total net cubic-foot volume of trees that became growing stock size during the inventory year as measured at the end of the year.

Annual mortality of growing stock.--The net cubic-foot volume removed from growing stock during a specified year through death from natural causes.

Annual cut of *live sawtimber*.--The net board-foot volume of live sawtimber trees cut or killed by logging, or by land-clearing and cultural operations, on commercial forest land during a specified year.

Annual cut of *growing* stock.--The net cubic-foot volume of live sawtimber and poletimber trees cut or killed by logging, or by land-clearing and cultural operations, on commercial forest land during a specified year.

Forest Survey Methods

These forest statistics are based on information obtained from aerial photographs and from sample plots examined on the ground. First, photo-interpretation plots were marked off on the aerial photographs. These plots were distributed uniformly by mechanical means over photographs of the entire state. Trained photo-interpreters then classified each photo plot as either forest or nonforest. Forest plots were classified further according to stand size and forest type.

Field crews inspected some of the photo plots on the ground. Enough plots were selected at random to attain a specified level of statistical accuracy. Species and volume data were collected on these ground plots; and the photo classification of stand size and forest type was verified or--if necessary--changed.

Growth was computed from measurements of radial growth and inventory data on numbers of trees by species and diameter class, after adjusting for cutting and expected mortality. Radial growth was measured on increment cores extracted from sample trees. The final new estimate was of average annual periodic net growth at the time the inventory was made.

Estimates of timber cut in Delaware were based on production surveys and wood-utilization studies conducted by the Northeastern Forest Experiment Station. The production surveys yielded estimates of the output of all timber products. From studies conducted on all types of logging operations, estimates of logging residues were developed, which, when added to the volume of timber products, gave estimates of timber cut.

RELIABILITY OF DATA

The estimates in this report may contain two kinds of error. The first type results from possible human errors such as mistakes in judgment, and mistakes in measuring or recording, and errors of reporting. There is no practical way of determining the frequency or magnitude of these errors, but close training and supervision minimize them. The second kind of error is associated with sampling procedures and can be estimated. If errors of the first kind are negligible, the probabilities are two out of three that the actual areas and volumes do not vary from the estimates by more than the percentages shown at the bottom of tables 1, 4, and 9.

In every case, total figures are more reliable than subtotals, and subtotals are more reliable than any of their component figures. Figures that are small in relation to totals are subject to much larger sampling errors.

SPECIES TALLIED

The various tree species³ tallied in Delaware are listed below. Other tree species occur within the State, but unless they were tallied on the field plots they were not included in the following list.

Commercial Softwood Species

Loblolly pine	- <i>Pinus taeda</i>
Shortleaf pine	- <i>Pinus echinata</i>
Virginia pine	- <i>Pinus virginiana</i>
Pond pine	- <i>Pinus serotina</i>
Atlantic white-cedar	- <i>Chamaecyparis thyoides</i>
Bald cypress	- <i>Taxodium distichum</i>

Commercial Hardwood Species

White oak	- <i>Quercus alba</i>
Northern red oak	- <i>Quercus rubra</i>
Southern red oak	- <i>Quercus falcata</i>
Other white oaks:	
Swamp white oak	- <i>Quercus bicolor</i>
Post oak	- <i>Quercus stellata</i>
Swamp chestnut oak	- <i>Quercus michauxii</i>
Other red oaks:	
Black oak	- <i>Quercus velutina</i>
Scarlet oak	- <i>Quercus coccinea</i>
Pin oak	- <i>Quercus palustris</i>
Water oak	- <i>Quercus nigra</i>
Willow oak	- <i>Quercus phellos</i>
Cherrybark oak	- <i>Quercus falcata</i> var. <i>pagodaefolia</i>

³Little, Elbert L., Jr. Check list of native and naturalized trees of the United States (including Alaska). U. S. Dept. Agr., Agr. Handbk. 41. 472 pp. 1953.

Red maple
 American beech
 Sweetgum
 Blackgum
 Hickory
 Yellow-poplar
 Other eastern species:
 River birch
 Ash
 Elm
 Black walnut
 Black locust
 Flowering dogwood
 Common persimmon
 American holly
 Willow
 Sweetbay

- *Acer rubrum*
- *Fagus grandifolia*
- *Liquidambar styraciflua*
- *Nyssa sylvatica*
- *Carya* species
- *Liriodendron tulipifera*

- *Betula nigra*
- *Fraxinus* species
- *Ulmus* species
- *Juglans nigra*
- *Robinia pseudoacacia*
- *Cornus florida*
- *Diospyros virginiana*
- *Ilex opaca*
- *Salix* species
- *Magnolia virginiana*

Noncommercial Species

Eastern hophornbeam
 Gray birch
 Sassafras
 American hornbeam
 Downy serviceberry

- *Ostrya virginiana*
- *Betula populifolia*
- *Sassafras albidum*
- *Carpinus caroliniana*
- *Amelanchier arborea*

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