FOREST SURVEY RELEASE NO. 5 JUNE 15, 1940

FOREST RESOURCES OF THE NORTHERN COASTAL PLAIN OF NORTH CAROLINA

by

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A FOREST SURVEY PROGRESS REPORT

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PREFACE

Through the McSweeny-McNary Act of 1928, Congress authorized the Secretary of Agriculture to conduct a comprehensive survey of the forest resources of the United States. The Forest Survey was organized by the Forest Service to carry out the provisions of the Act, and each of the 12 Regional Experiment Stations was made responsible for the work in its territory. In the Middle Atlantic States the Forest Survey is an activity of the Appalachian Forest Experiment Station, Asheville, North Carolina.

The work of the Survey is divided into 5 major phases:

1. Inventory. Determination of the extent, location, and condition of forest lands, and the quantity, species, and quality of the timber on these lands.

2. Growth. Determination of the current rate of timber growth.

3. Drain. Determination of the amount of industrial and domestic wood use, and the total loss resulting from fire, insects, disease, suppression, and other causes.

4. Requirements. Determination of the current and probable future requirements for forest products by all classes of consumers.

5. Policies and plans. Analysis of the relation of these findings to one another and to other economic factors as a basis for public and private policies and plans of forest land use and management.

This progress report presents preliminary information on the first three of these phases for the Northern Coastal Plain of North Carolina, one of the 4 units into which the State was divided. A similar release has been published for the Southern Coastal Plain Unit and releases for the Piedmont and Mountain Regions will be published during this calendar year.

Information on the physical forest resources was obtained by a field survey made in the summer and fall of 1937. A total of 8,131 sample plots was established at intervals of one-eighth of a mile on compass lines 10 miles apart, extending across the unit in a northeast direction. The statistical sample obtained from these plot records forms the basis for all area and volume estimates in this report, except where other sources are directly credited. Owing to the method of sampling, small tabular items have the greater probability of error and should be considered as indicating relative magnitude rather than actual values.

Data on consumption of forest products for industrial and domestic purposes were obtained by canvassing all primary manufacturing plants and a number of representative domestic consumers.

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C O N T E N T S

FOREST RESOURCES OF THE NORTHERN COASTAL PLAIN OF NORTH CAROLINA

DESCRIPTION OF THE UNIT

This report describes the forest resources of the northern part of the Coastal Plain of North Carolina. The area, designated by the Forest Survey as North Carolina Unit 2, includes 23 counties containing 6,657,300 acres. It occupies 21 percent of the total area of the State, contains 22 percent of the forest land, and has 17 percent[1] of the State's population.

Agriculture and timber production are the two most important activities. About half of the land is in farms, but forest land, including that on farms, occupies 61 percent of the unit area. Manufacturing is relatively unimportant; the value of products manufactured in 1935 was less than 3 percent of the value of all products manufactured in the State.[2] Most of the people employed in manufacturing were engaged in the textile and wood-using industries.

Physical Conditions

The land surface rises gradually from sea level on the coast to elevations of 300 to 375 feet on the western boundary. The eastern portion of the unit is practically level and is characterized by extensive swamps, shallow lakes, sluggish rivers, and an extremely broken shore-line along Albemarle and Pamlico Sounds. Drainage is poor, most of the run-off going into the Sounds by means of deep sluggish streams. The better-drained soils produce good crops but a large proportion of the soil is swamp or muck that is either too wet or too poor for agriculture. Originally heavily forested, much of the land is now stocked with second-growth timber. This low-lying, flat country has long been called the Tidewater of North Carolina (fig. 1).

The remainder of the unit is referred to in this report as the Western Coastal Plain although it includes a small part of the Piedmont. It differs physically from the Tidewater in that it is higher in elevation with a gently rolling topography, is generally well drained by the Chowan, Roanoke, Tar, and Neuse Rivers, and has soils of good quality for agricultural crops. These favorable natural features, combined with a mild climate, result in an intensive agriculture, centered upon the production of tobacco and cotton. There is a high percentage of forest land, much of which occurs as part of farm properties.

1/ U. S. Dept. Com., Bur. of the Census, 1930.

2/ U. S. Dept. Com., Consumer Market Data Handbook, 1939.

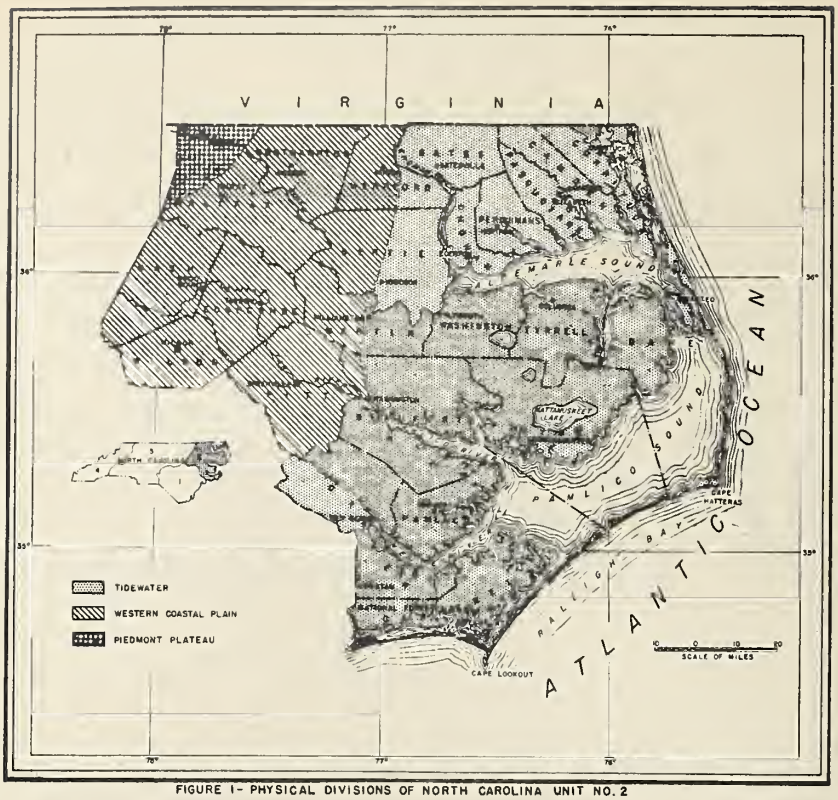

FIGURE 1- PHYSICAL DIVISIONS OF NORTH CAROLINA UNIT NO. 2

Economic Conditions

In 1930 the population was 533,500, or 17 percent of the total in the State. Sixty percent of the people lived on farms, 22 percent lived in small towns or rural communities, and only 18 percent lived in towns of more than 2,500 inhabitants. New Bern, Elizabeth City, Wilson, and Rocky Mount are the only cities with a population of more than 10,000. The Tidewater contained only 34 persons per square mile compared to 75 per square mile in the Western Coastal Plain. Population growth has been most rapid in the Western Coastal Plain where, since 1900, there has been an increase of 68 percent compared to an increase of only 22 percent in the Tidewater counties.3/

The available data indicate that there were about 157,000 individuals employed in the unit in 1935.4/ About 80 percent of these were engaged in agriculture, 9 percent in manufacturing, 6 percent in retail sales, 2 percent in wholesaling, and 3 percent in miscellaneous businesses, including the service industries. Among the 14,000 employees reported engaged in manufacturing were about 8,000 in the textile industry and about

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3/U. S. Dept. Com., Bur. of the Census, 1930.
4/U. S. Dept. Com., Consumer Market Data Handbook, 1939.

5,000 in the wood-using industries. It is known, however, that many more people were employed in the wood-using industries, at least part-time, as many of the farmers supplement their income by woods-work, and many small sawmills fail to report the number of their employees. Additional opportunities for work are needed, 12,000 persons reporting as unemployed at the time of the Census of Total and Partial Unemployment in November, 1937.

Agriculture is easily the leading industry in the unit. In 1936 the 53,000 farms produced crops valued at 63 million dollars. Tobacco and cotton are the two important cash crops in the western counties, with corn the most valuable feed crop. Irish potatoes and peanuts are substantial cash crops in certain localities; both Pamlico and Beaufort Counties produced about one million dollars worth of potatoes, while Bertie and Halifax Counties each produced peanuts valued at 1¼ million dollars. These 5 crops made up 88 percent of the value of all crops harvested in 1936. In the Western Coastal Plain tenants operate 70 percent of the farms but in the Tidewater they operate only 44 percent.5/ Because of the higher ratio of ownership in the Tidewater counties, there is a better opportunity for developing improved agricultural and forest practices on farmland.

Also, a large part of the non-farm population obtains its income by financing and supplying the farm population and marketing the harvested crops. This agricultural economy is based upon 3.5 million acres of land in farms, or 52 percent of the unit area.5/

Manufacturing has not developed as intensively here as in other parts of North Carolina. Only 6 percent of the people engaged in manufacturing in the State in 1935 were employed in this unit and they received only 4 percent of the manufacturing payroll of the State.6/ Value added by manufacturing amounted to only 12 million dollars compared to the State total of 378 million.7/ Forest industrial plants are most numerous, and are distributed throughout every county. Small plants manufacturing food products are next in numerical importance, but the 24 textile factories employ the most people and add most to initial values.

The transportation system is well developed in the Western Coastal Plain. The main line of the Atlantic Coast Line Railroad crosses the western tier of counties and the main line of the Norfolk and Southern passes through Pitt, Wilson, and Nash Counties. Branch railroads of the Atlantic Coast Line, Seaboard Air Line, and the Carolina Southern adequately supplement the main lines. Highways are generally paved and well distributed.

In the Tidewater counties the transportation facilities are less satisfactory. The only through railroad is the Norfolk and Southern which operates between Norfolk, Virginia and Charlotte, North Carolina. A few branch lines are available but their distribution is poor. The system of highways connects the towns but it leaves large rural areas without convenient all-season access to paved roads. Although deficient in railroads

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5/U. S. Dept. Com., Census of Agr., 1935.
6/U. S. Dept. Com., Consumer Market Data Handbook, 1939.
7/U. S. Dept. Com., Industrial Market Data Handbook, 1939.

and highways the Tidewater has several navigable waterways, notably the Intracoastal Canal and the lower reaches of the Chowan, Pamlico, and Neuse Rivers. Numerous smaller streams are navigable for shallow-draft vessels and Morehead City is a port for ocean-going vessels.

The assessed value of all real and personal property in this unit in 1937 was 290 million dollars, or 12 percent of the State total.8/ Forest land and timber accounted for 10 percent of the value of all property in Beaufort, Currituck, Hertford, Pasquotank, Pitt, and Washington Counties in 1937.9/ Although the proportionate value of forest property varied widely between counties, it did not exceed 21 percent in any of the 6 counties mentioned, and it is believed that 10 percent represents a close approximation to the ratio of forest property to all property in the unit.

For taxation purposes forest land is generally classified by tax assessors into 4 groups: waste land, cutover land, woodland, and timberland. Little uniformity exists between counties in the definition of these land classes, and in many counties one or more of the classifications may be omitted. Assessments, tax rates, and taxes per acre may vary greatly between counties, or even between townships of the same county. Data gathered in 1937 in the 6 counties mentioned above indicate that waste land was assessed at $3.21 to $6.99 per acre, cutover land at $8.87 to $10.60, woodland at $7.94 to $9.84, and timberland at $6.93 to $18.21 per acre. The county-wide tax rate, exclusive of special school or road district levies, ranged from 90 cents to $1.80 per $100 of assessed valuation. Taxes per acre ranged from 4.1 cents on waste land in Beaufort County to 17.3 cents on timberland in Hertford County.

Public ownership of forest land is limited to 87,000 acres in the Croatan National Forest in Carteret and Craven Counties, 23,000 acres in the Mattamuskeet and Swanquarter wildlife refuges, about 2,000 acres owned by the State Board of Education, and less than 2,000 acres in the Fort Macon and Cape Hatteras State Parks. About 1,777,000 acres of the forest land in private ownership is distributed among the 53,000 farms. Commercial holdings actively operated for timber production amount to at least 468,000 acres. The remainder, about 1,686,000 acres, is owned largely by railroads, insurance companies, heirs of dissolved lumber companies, banks, and interests promoting drainage projects. They generally lease the timber cutting rights to local operators.10/

Land-use involves a complex mingling of agricultural and forest land. A timber type map of 36 square miles in Pitt County illustrates the typical distribution of forest and crop land throughout much of the unit (fig. 2). Forest land is obviously preponderant. It occurs in small patches throughout the agricultural land as well as in extensive unbroken tracts. Open

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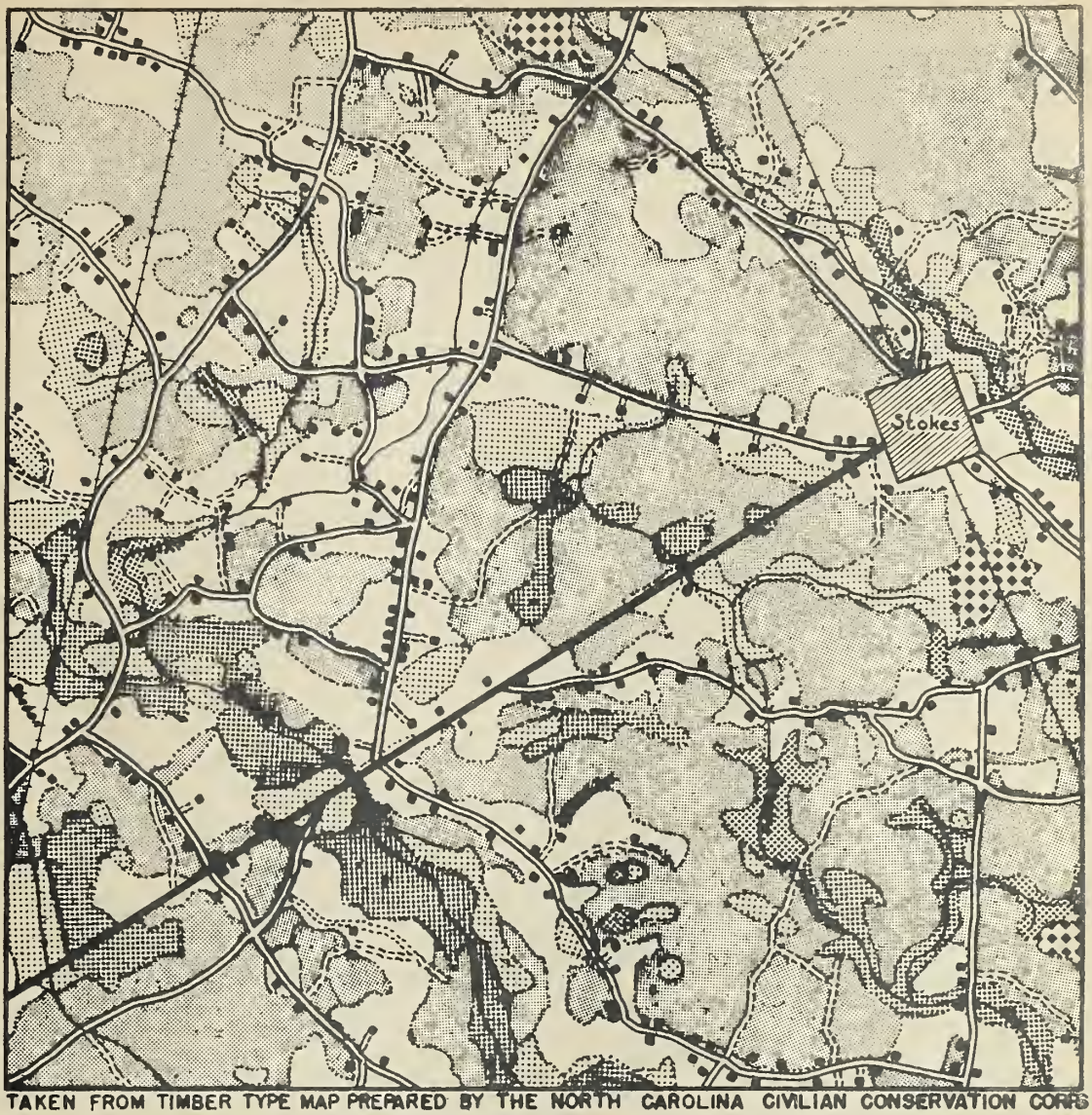
8/N. C. Ind. Dir. and Ref. Book, Dept. of Cons. and Dev., Raleigh, N.C.

9/Taxation of Forest Property in North Carolina, R. W. Nelson, Forest Taxation Inquiry, U. S. Forest Service.

10/Div. State and Private Forestry, Reg. 8, U. S. Forest Service, Atlanta, Georgia.



TAKEN FROM TIMBER TYPE MAP PREPARED BY THE NORTH CAROLINA CIVILIAN CONSERVATION CORPS

L E G E N D

LOBLOLLY PINE

LOBLOLLY PINE-HARDWOOD

POND PINE

BOTTOM LAND HARDWOODS

NONFOREST LAND

PAVED ROADS

GRADED ROADS

WOODS ROADS

RAILROADS

DWELLINGS

SCALE OF MILES

1 0 1 2

FIGURE 2- CHARACTERISTIC DISTRIBUTION OF FIELDS, FORESTS, DWELLINGS, AND TRANSPORTATION FACILITIES.

land parallels the roadways but nearly every field is bordered on at least one side by woodland. Stream margins are generally forested. Paved highways and improved secondary roads facilitate intensive land use as they provide convenient access to nearly every area, whether forested or agricultural. Dwellings are likely to be concentrated on the open land, where small farms provide the major share of the income, but forested land, with its capacity to produce raw material and provide work, is literally at the back door of every rural home. This close relation between agriculture and timber production means that nearly every farmer, both tenant and owner, has some influence upon the management of forest land.

A summary of the land-use situation at the end of 1937, as determined by the Forest Survey, is presented in table 1. Forest land comprises three-fifths of all the land in the unit and occupies nearly twice as much area as cropland and open pasture combined. In the Tidewater counties two-thirds of the land is forested, compared with about half in the Western Coastal Plain. The total area of forest land will fluctuate with the agricultural booms and depressions and also with the slow rotation typified by land clearing for new cropland, abandonment after several years of intensive cultivation, and the re-establishment of forest cover. Because of the low, swampy topography of a large part of this unit timber production is the most feasible land use.

Table 1. - Total area classified according to land use, 1937

Land use	Area	Proportion of total area
	Acres	Percent
Forest	4,045,500	60.8
Nonforest:		
Agriculture:		
Old cropland	2,073,900	31.1
New cropland	29,500	0.4
Pasture	52,400	0.8
Total agriculture	2,155,800	32.3
Abandoned cropland	37,600	0.6
Other nonforest	418,400	6.3
Total nonforest	2,611,800	39.2
Total area	6,657,300	100.0

DESCRIPTION OF THE FOREST RESOURCE

The forest occurs on 4,045,500 acres, or 61 percent of the unit area. It consists of trees of all sizes and ages, but is typically composed of medium-sized second-growth timber. Many species make up the forest stand, including four pines, white and red cedar, cypress, and a great variety of hardwoods.

Species

Loblolly pine is the most prevalent single species, making up about half of the sound-tree cubic-foot volume in the forest (table 2). It is found associated with all species and on all but the wettest sites. Black and tupelo gums are the next most abundant species-group. They are widely distributed, but Gates, Hertford, Bertie, Martin, Washington, and Tyrrell Counties contain most of the larger trees. Red gum is found all over the unit although less commonly in Dare and Hyde Counties. Pond pine is the characteristic species in these counties. It also occurs in relatively pure stands in parts of Tyrrell, Chowan, Beaufort, Pamlico, Craven, and Carteret Counties. The best stands of cypress are in Tyrrell County, along the lower reaches of the Roanoke River, and in the bottomlands at the confluence of the Meherrin and Chowan Rivers. In general, large white oaks are most common on the watershed of the Roanoke River and the headwaters of the Tar River. The greatest concentration of large red oaks and ash is in Martin and Bertie Counties in the bottomlands of the Roanoke River. Commercial stands of white cedar are found chiefly in Tyrrell County and the Dismal Swamp.

Forest Types

Certain groupings of species are so characteristic and wide-spread that they serve as a basis for classifying the forest into forest types. Eleven types were recognized in the field survey but in this report they have been combined into 4 broad types; loblolly pine-hardwoods, pond pine-hardwoods, upland hardwoods, and bottom-land hardwoods.

The loblolly pine-hardwoods type is the most extensive and most important commercially, occupying 47 percent of all the forest land and supplying fully three-fourths of the annual lumber cut. Almost half of the area in this type supports nearly pure stands of loblolly pine, the other half supports loblolly pine in mixture with hardwoods, with an occasional small area of longleaf or shortleaf pine. The loblolly pine-hardwood stands commonly occur along the streams in conjunction with the bottom-land hardwoods (fig. 2). Seventy-eight percent of the type volume is loblolly pine, 9 percent is red, black, and tupelo gum, and 5 percent is oak. The wide distribution of this type is indicated in figure 3, which shows the general location of the main forest types, but no distinction is made between forest and the included agricultural land.

The pond pine-hardwoods type, occupying 22 percent of the forest area, presents one of the major forest problems in the unit. It occurs as thinly-stocked stands in the swamps and pocosins throughout the Tidewater and is the dominant type over most of Dare, Hyde, and Tyrrell Counties. In these

counties particularly, repeated fires have destroyed much of the timber and in many cases have burned the peat soils for a depth of several feet, with the result that large areas of open land support only a dense cover of brush and an occasional snag or half-dead pond pine. Locally these are called "lights" or "open ground" and some are of such long standing that the oldest resident cannot remember when they were timbered. It is questionable whether any expense should be incurred in developing a forest cover upon these lands as the site is generally too poor to produce good-quality commercial timber. Sawlog-size pond pine is not much in demand because of its poor quality, low volume per acre, and inaccessible location.

Table 2. - Species composition of the forest types, 1937*

Species	Loblolly pine-hardwoods	Pond pine-hardwoods	Upland hardwoods	Bottom-land hardwoods		All types
				Mixed hardwoods	Cypress-white cedar	
	Percent					
Loblolly pine	78.2	8.3	13.8	6.6	6.4	49.8
Pond pine	0.9	85.6	--	0.2	1.0	6.0
Longleaf pine	1.2	0.8	0.4	--	--	0.8
Shortleaf pine	2.0	0.2	1.4	0.1	0.5	1.3
White cedar	0.2	0.8	--	0.6	29.0	2.4
Cypress	0.3	0.4	0.2	4.7	27.2	3.3
Red gum	5.5	0.3	16.8	18.8	2.0	8.4
Black gums**	3.2	1.9	5.2	38.3	23.3	13.1
Yellow poplar	0.8	Negl.	4.4	2.5	0.3	1.2
Red oaks	2.1	0.1	12.4	3.5	0.2	2.5
White oaks	2.8	0.1	21.4	3.4	0.9	3.1
Ash	0.1	--	0.4	3.6	1.6	1.0
Holly, dogwood, persimmon	0.4	--	2.6	1.0	0.2	0.5
Scrub hardwoods	0.4	0.7	3.1	1.3	1.0	0.8
Other hardwoods	1.9	0.8	17.9	15.4	6.4	5.8
Total	100.0	100.0	100.0	100.0	100.0	100.0

*Based on cubic-foot volume (o.b.) of trees 5.0 inches d.b.h. and larger.

**Includes black and tupelo gums throughout the report.

The upland hardwood type exists in such small scattered tracts that it is not feasible in figure 2 to delineate its area. Only 157,200 acres, or 4 percent of the forest land, support this forest type. Most of it is located in Beaufort, Bertie, Halifax, Nash, and Northampton Counties. The upland hardwood stands are usually contiguous with the loblolly pine-hardwood stands, differing only in having a smaller proportion of pine. White and red oaks with red gum make up half the volume, loblolly pine comprises 14 percent, and miscellaneous hardwoods the remainder.

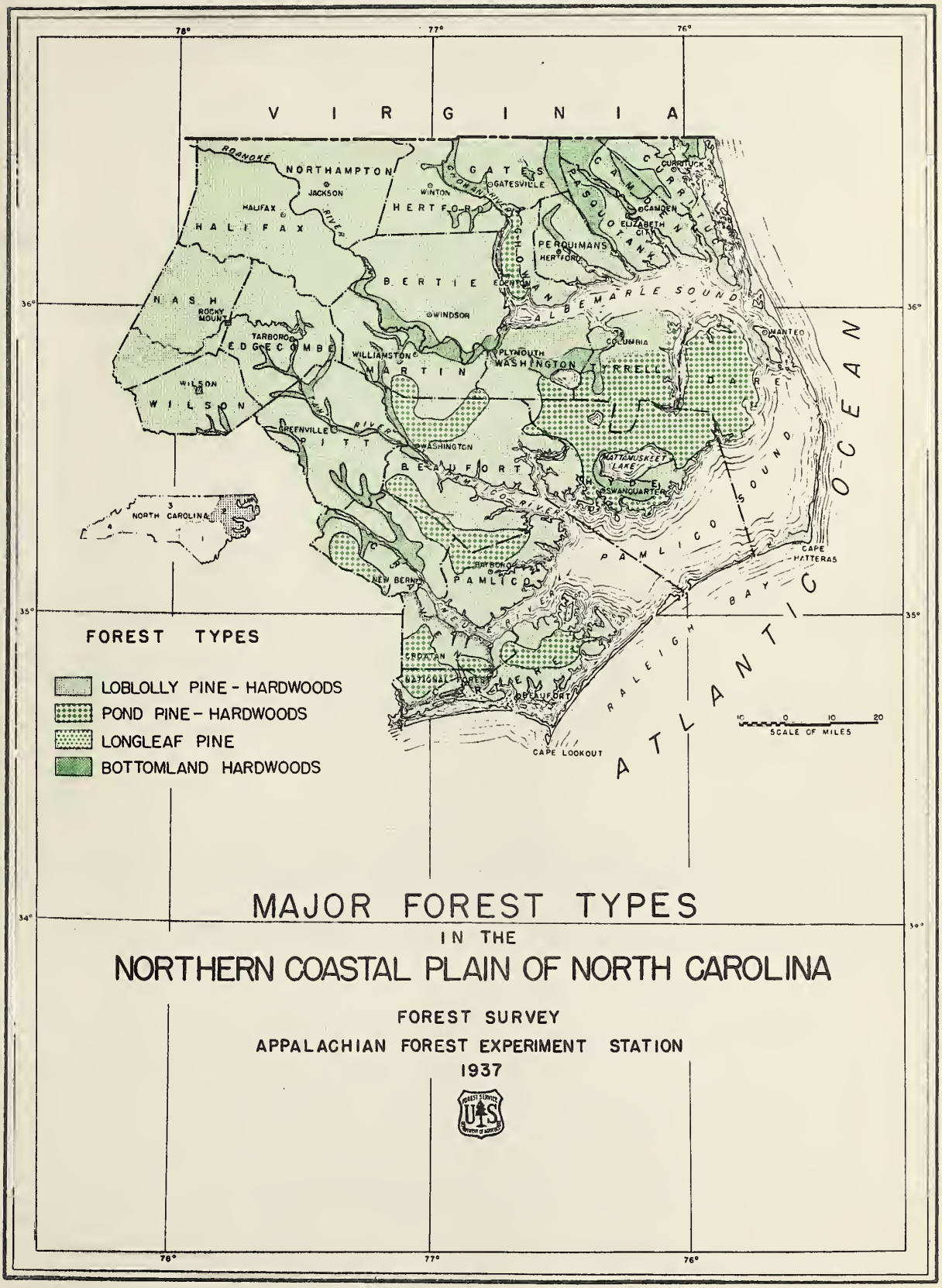

VIRGINIA
ROANOKE
NORTHAMPTON
JACKSON
HALIFAX
HALIFAX
ROANOKE RIVER
GATES
GATESVILLE
WINTON
CHOWAN RIVER
HERTFORD
CAMDEN
CURRITUCK
CURRITUCK
ELIZABETH CITY
PASQUOTANK
PERQUIMANS
HERTFORD
CHOWAN
BERTIE
EDENTON
ALBEMARLE SOUND
NASH
ROCKY MOUNT
WINDSOR
COLUMBIA
MANTEO
TARBORO
EDGECOMBE
WILLIAMSTON
PLYMOUTH
WASHINGTON
MARTIN
TYRRELL
DARE
WILSON
WILSON
GREENVILLE
PITT
TAR RIVER
WASHINGTON
BEAUFORT
MATTAMUSKEET LAKE
SWANQUARTER
PUNGO RIVER
NORTH CAROLINA
PAMLICO SOUND
CAPE HATTERAS
ATLANTIC OCEAN
BAYBORO
NEW BERN
PAMLICO
CRAVEN
CROATAN
NATIONAL FOREST
HAVELOCK
BEAUFORT
RALEIGH BAY
CAPE LOOKOUT
SCALE OF MILES
FOREST TYPES
LOBLOLLY PINE - HARDWOODS
POND PINE - HARDWOODS
LONGLEAF PINE
BOTTOMLAND HARDWOODS
MAJOR FOREST TYPES
IN THE
NORTHERN COASTAL PLAIN OF NORTH CAROLINA
FOREST SURVEY
APPALACHIAN FOREST EXPERIMENT STATION
1937

Figure 3

The broad type designated as bottom-land hardwoods occupies 27 percent of the forest land and includes 920,300 acres of mixed hardwoods, 82,700 acres of cypress and tupelo gum, and 81,900 acres of white cedar mixed with hardwoods. In table 2 the mixed hardwoods contain nearly 60 percent red, black, and tupelo gum, while the combined cypress and white cedar types contain 56 percent cypress and white cedar and only 25 percent gum. The bottom-land hardwoods type occurs along the rivers and smaller streams (fig. 2) and in the swamps, with the white cedar component most abundant in the swamps of Dare, Tyrrell, and Gates Counties.

An unusually high proportion (53 percent) of the forest land is in swamps, ponds, and river bottoms, topographic situations that are dominated by the pond pine-hardwoods and bottom-land hardwoods types. Of the remaining forest land, the loblolly pine-hardwoods type occupies 82 percent.

Table 3. - Forest area classified according to forest type and topographic situation, 1937

Forest type	Rolling uplands	Level lowlands	Bays, ponds and swamps	River bottom-lands	Total	Proportion of total
			Acres			Percent
Loblolly pine-hardwoods	424,200	1,124,900	189,900	173,600	1,912,600	47.3
Pond pine-hardwoods	--	101,500	789,300	--	890,800	22.0
Bottom-land hardwoods	--	86,000	246,500	752,400	1,084,900	26.8
Upland hardwoods	89,200	68,000	--	--	157,200	3.9
Total	513,400	1,380,400	1,225,700	926,000	4,045,500	100.0
Percent of total	12.7	34.1	30.3	22.9	100.0	

Forest Conditions

The forest resource is composed of stands having different ages, volumes-per-acre, and cutting histories, factors that serve as a basis for classifying the stand into forest conditions (table 4). Such a classification discloses 63 percent of the forest land supporting sawlog-size stands, 34 percent supporting under-sawlog-size stands, with less than 4 percent clear-cut.

Sawlog-size stands occupy about 10 percent more of the forest area in this unit than in the Southern Coastal Plain unit of North Carolina. About 57 percent of the 2.5 million acres of saw timber is loblolly pine-hardwoods, 29 percent is bottom-land hardwoods, 10 percent is pond pine-hardwoods, and only 4 percent is upland hardwoods. One-fifth of the saw-timber area is stocked with old growth, nearly two-thirds of which is bottom-land hardwoods. The 2 million acres of second-growth saw timber is predominantly loblolly pine-hardwoods although the bottom-land hardwoods are found on 20 percent of this second-growth area. The second-growth pine stands are the chief source of material for the pine sawmills while most of the hardwood mills are still cutting old-growth timber.

Under-sawlog-size stands (excluding clear-cut) occupy 1.4 million acres, or one-third of the unit area. These young stands will rapidly supplement the saw-timber stands, especially if they are protected from fire and are thinned where necessary. Least productive will be the one-half million acres in the pond pine type, making up two-fifths of all the under-sawlog-size area. These pond pine stands are subject to more frequent burning than the other types and generally grow on less productive sites.

Almost all of the area classified as clear-cut is the "open-land" in Dare, Hyde, and Tyrrell Counties. In most cases fire destroyed the timber, and clear-cutting by lumbermen is not an important cause of this devastation. Some of the land will restock to pond pine through natural seeding and sprouting, but most of it has been so heavily burned that planting is probably the only way to re-establish a forest cover. The site is so poor, however, that large scale planting is not recommended unless suitable research demonstrates that planting is practical and desirable.

Table 4. - Forest area classified according to forest condition and forest type, 1937

Forest condition	Loblolly pine-hardwoods	Pond pine-hardwoods	Upland hardwoods	Bottom-land hardwoods	Total all types	Proportion of total
			Acres			Percent
Sawlog size:						
Old growth:						
Uncut	45,000	22,900	1,700	124,500	194,100	4.8
Partly cut	95,800	9,000	23,700	217,000	345,500	8.6
Total	140,800	31,900	25,400	341,500	539,600	13.4
Second growth:						
Uncut	620,600	190,000	15,600	267,700	1,093,900	27.0
Partly cut	687,000	36,800	49,100	128,500	901,400	22.3
Total	1,307,600	226,800	64,700	396,200	1,995,300	49.3
Total sawlog size	1,448,400	258,700	90,100	737,700	2,534,900	62.7
Under sawlog size:						
Second growth	397,900	321,800	60,500	263,700	1,043,900	25.8
Reproduction	57,300	181,700	6,600	74,500	320,100	7.9
Clear-cut	9,000	128,600	--	9,000	146,600	3.6
Total under sawlog size	464,200	632,100	67,100	347,200	1,510,600	37.3
Total all conditions	1,912,600	890,800	157,200	1,084,900	4,045,500	100.0
Percent of total	47.3	22.0	3.9	26.8	100.0	

Site Quality

The productive capacity of forest land depends upon the quality of the site, which is determined by the interplay of many factors, chiefly those having to do with climate and soil conditions. A commonly used index of site quality is the height of average dominant forest trees at 50 years of age. In the loblolly pine-hardwood type area of nearly 2 million acres the land was classified according to site quality, using loblolly pine as the criterion. The results (table 5) show that the factors of site are very favorable for the growth of loblolly pine, as over 80 percent of the loblolly area had a 70-foot or better site index. Most of the 90-foot or better sites are located northeast of the Roanoke River. Differences in topography influenced site to some extent, most noticeably in the river bottom lands where the soil is more fertile and moisture more abundant.

Table 5. - Loblolly pine area classified according to site

Topographic division	Site index in feet		
	90 or more	70 and 80	60 or less
	Percent		
Rolling uplands	2	82	16
Level lowlands	6	75	19
Bays, ponds, and swamps	3	81	16
River bottom lands	21	74	5
Average	6	77	17

The vigorous appearance of the standing loblolly timber in this unit is visual evidence of the excellent growing conditions. Loblolly pine sites are better here than in the southern part of the North Carolina Coastal Plain. Even better sites occur, however, in the coastal plain of South Carolina where over 90 percent of the loblolly pine area has a 70-foot or better site index.

Age

Generally speaking, the forest of this unit is composed of many even-aged groups of trees. Clumps of reproduction, saplings, and saw-timber trees often occur together, resulting in a forest stand containing several age-class groups. On other areas, such as old-fields or forest tracts where clear-cutting was practiced, the stand may consist of one dominant age-class. Where practical the age of each survey plot was recorded and the resulting data provides an estimate of the age of the forest at various stages of development.

Most of the trees in the reproduction stage are less than 10 years old. At 10 to 15 years the trees are large enough for the stand to be classified as second-growth under-sawlog-size. When about 25 years old many of the stands reach sawlog size. A majority of the second-growth pine

saw timber is 25 to 55 years of age while the hardwood is 55 to 75 years. Very few stands of old-growth quality are less than 80 years old; most are 100 to 200 years. Stands less than 15 years old occupy 22 percent of the forest area, stands 15 to 25 occupy 11 percent, stands 26 to 75 occupy 51 percent, and stands more than 75 years old occupy 16 percent.

Stocking

The current amount or volume of sound timber on a given forest area is referred to as growing stock. The right quantity of growing stock for maximum volume increase varies with site and age of stand, but in all cases it is contingent upon complete use of the growing space. The term stocking refers to the quantity of growing stock; a fully stocked stand has a sufficient amount of growing stock for maximum growth while understocking connotes a deficiency.

In the diversified stands occurring in this unit the determination of the degree of stocking is a difficult matter. It is certain, however, that the stocking is highly irregular throughout the forest; a result of fires, uncontrolled cutting, and uneven natural restocking. Although total volume is of limited value as a measure of stocking it indicates in a general way the understocked condition of the forest stand under discussion. In the pine types a comparison is made of the average cordwood volume per acre on uncut areas in representative age-classes with the average volumes, weighted by site, of the best-stocked 10 percent of these same stands (table 6). These best-stocked stands approximate full stocking, indicating that the average volume per acre is now only 40 to 60 percent of the volume of fully stocked stands. There is evidently an excellent opportunity to increase the volume and quality of the growing stock with good fire control and with even the more simple forms of forest management.

Table 6. - Average volumes per acre, by age-classes, in the uncut conditions of the pine-hardwood types.

Age-class	Based on all stands	Based on best 10 percent of stands	Relation of all stands to best 10 percent
Years	Cords	Cords	Percent
21 - 30	8.8	23.0	38
31 - 40	17.5	42.0	42
41 - 50	24.5	47.4	52
51 - 60	28.4	49.5	57
Weighted average of all age-classes	19.3	37.7	51

The stocking of the second-growth sawlog-size condition (pine and hardwood types combined) is of particular significance because this condition occupies one-half of the forest area and is the source of most of the saw timber. A diameter-class comparison of the average number of pine and hardwood trees per acre is presented in figure 4. The number and distribution of hardwoods in the smallest diameter classes seems adequate to maintain or even increase the hardwood saw-timber growing stock. The diameter-class distribution of the 4-, 6- and 8-inch pines will increase the board-foot growing stock at the expense of the cubic-foot stand because with growth more trees will move out of the 6- and 8-inch diameter classes into sawlog size than will move from the 4-inch class into cubic-foot size (5.0 inches d.b.h.).

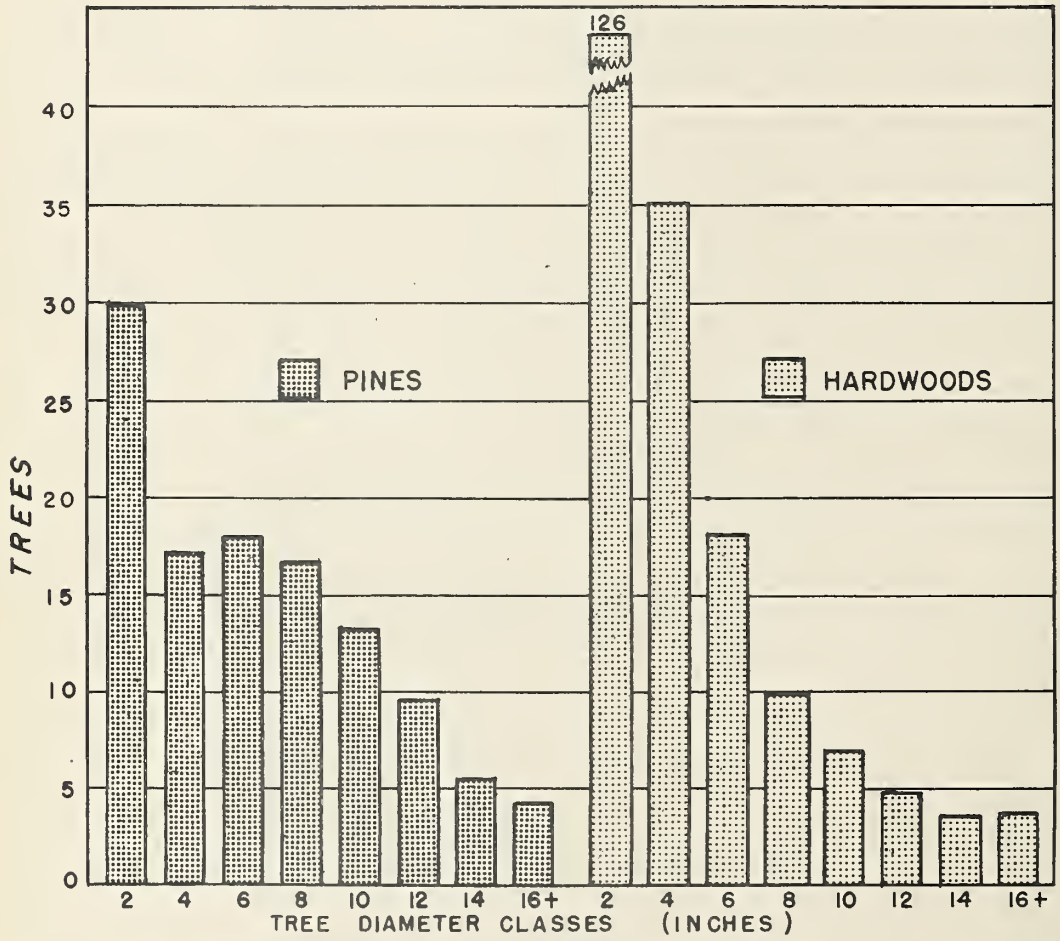


FIGURE 4.- AVERAGE NUMBER OF PINE AND HARDWOOD TREES PER ACRE IN THE SECOND-GROWTH SAWLOG-SIZE CONDITION.

Fire

Uncontrolled forest fires have an important and detrimental effect upon site quality and density of stocking, vital factors in the yield from the forest stand. Site quality is lowered when soil conditions are impaired by the destruction of the forest litter and the organic matter above the mineral soil. Stocking is reduced by surface fires that destroy seeds in the forest litter, kill reproduction and young saplings, and create fire-scars on larger trees allowing entrance of rot-producing fungi.

Surface fires are the most common kind in this unit, but the ground fires that occur in the muck lands supporting pond pine and cedar are more serious, as they frequently burn off not only all vegetation but the soil itself to a depth of several feet. At the time of the survey 71 percent of the forest land gave evidence of having been burned over; a proportion that represents the accumulated burned acreage of many fire seasons. Prevalence of fire and intensity of damage varied considerably within forest types. Evidence of fire was present on only half of the bottomland hardwood type area in contrast to the pond pine-hardwood type with 97 percent of its area burned, one-third with heavy damage. Fire had occurred on three-fourths of the loblolly pine-hardwood type area but heavy damage, evidenced by dead trees and numerous fire-scars, was apparent on only one percent.

THE VOLUME OF THE FOREST RESOURCE

The inventory of the timber resource in 1937 included the sound volume in all living trees 5.0 inches d.b.h. or larger. Volumes expressed in board feet include only the sawlog portion of saw-timber trees (pines, cypress, and white cedar 9.0 inches d.b.h. and larger, hardwoods 13.0 inches d.b.h. and larger). Cordwood volumes (wood and bark) include the sawlog portion of all saw-timber trees, the upper portion of saw-timber trees not used as sawlogs but acceptable as cordwood, the sound stems of under-sawlog-size trees, and the sound volume in cull trees. Bark is omitted from cubic-foot volumes, otherwise the material is similar to that contained in cordwood.

Board-foot Volume[1/]

At the time of inventory the volume of the forest resource was 14.3 billion board feet, expressed in the International $\frac{1}{4}$-inch log rule which is used throughout the report after table 7. This volume is the approximate amount of green lumber that could be sawed from the standing saw-timber trees and is one-third of the total board-foot volume in the forests of the State.

Table 7. - Net volume by the International, Scribner and Doyle rules classified according to species-group, 1937

Species-group	International*	Scribner	Doyle
	- - - - - - - Thousand board feet - - - - - - -		
Pines:			
Loblolly	8,106,300	6,970,000	4,761,700
Pond	756,600	629,700	390,800
Longleaf	119,400	101,500	68,700
Shortleaf**	158,700	133,200	85,500
Total pines	9,141,000	7,834,400	5,306,700
Hardwoods:			
Black gums	1,504,200	1,385,100	1,106,800
Red gum	1,259,600	1,152,800	915,400
Yellow poplar	190,600	174,400	138,700
Red oaks	285,600	264,400	224,600
White oaks	321,500	300,700	257,200
Ash	109,600	99,400	75,600
Other hardwoods	569,800	508,600	402,500
Total hardwoods	4,240,900	3,885,400	3,120,800
Cypress	636,000	563,300	396,700
White cedar	318,000	267,900	172,500
Total all species	14,335,900	12,551,000	8,996,700

*The scale by this rule approximates green lumber tally.
**Includes red cedar.

1/See glossary for description of material included in board-foot volume.

The Scribner rule is widely used in various parts of the country but only occasionally in the South. Until recently it was the official rule of the United States Forest Service, a distinction now shared with the International rule. The amount of lumber obtainable is underestimated by this rule because it is based upon a diagram of the small end of the log and does not allow for taper. Furthermore it was formulated over 90 years ago and fails to allow for the improved sawmill machinery and closer utilization of the present time. As a result the board-foot volume in the unit estimated by the Scribner rule is only 12.6 billion board feet.

Custom has long dictated the use of the Doyle rule in the South. It is a highly inaccurate rule and underscales small trees excessively. The percent of error varies with every stand of timber because of differences in diameter distribution, one reason why varying the stumpage price does not allow correctly for the inaccurate scale. In this unit where small trees predominate, the volume by the Doyle rule is only 63 percent of the volume by the International rule. In other words, the timber will saw out nearly 60 percent more lumber than the Doyle rule indicates.

The total volume of pine saw timber, chiefly loblolly, exceeds 9 billion board feet (table 8). Only 18 percent of this volume is located in old-growth stands. Half of the pine volume is in sawlog-size stands of uncut second growth. These stands occupy about one million acres, average nearly 6,000 board feet per acre, and are in reality the main support of the pine lumber industry. Second-growth stands which have had part of their volume removed contain 29 percent of the volume. The residual volume averages about 4,000 board feet per acre, sufficient to justify commercial logging. The partial cutting improves growth conditions for the remaining trees and where possible these partly-cut stands should be left to make rapid growth for several years. About 3 percent of the board-foot volume is in young stands containing only an occasional saw-timber tree. Because these trees are scattered most of this volume will remain unutilized until the young stand as a whole grows to sawlog size.

About 55 percent of the hardwood volume is in old-growth stands, located chiefly in the less accessible swamps and bottom lands of the larger rivers. Part of this old-growth volume is composed of second-growth trees that occur in conjunction with the old growth. Nearly two-fifths of the total old-growth volume is red, black, and tupelo gum, species not extensively used for lumber when the region was first logged over. Second-growth stands, containing 43 percent of the hardwood board-foot volume, are three-fifths gum and nearly one-fifth oak. Less than 2 percent of the hardwood volume is in under-sawlog-size stands.

Table 8. - Net volume by the International $\frac{1}{4}$-inch rule classified according to species-group and forest condition, 1937

Species-group	Sawlog size				Under sawlog size*	Total	Proportion of total
	Old growth		Second growth				
	Uncut	Partly cut	Uncut	Partly cut			
	Thousand board feet						Percent
Pines:							
Loblolly**	699,400	837,400	4,103,600	2,564,700	179,300	8,384,400	58.5
Pond	79,600	37,500	496,900	74,700	67,900	756,600	5.3
Total pines	779,000	874,900	4,600,500	2,639,400	247,200	9,141,000	63.8
Hardwoods:							
Black gums	576,000	505,600	267,900	132,400	22,300	1,504,200	10.5
Red gum	215,700	355,600	371,400	295,700	21,200	1,259,600	8.8
Yellow poplar	41,300	25,100	79,300	40,400	4,500	190,600	1.3
Red oaks	34,200	70,000	97,800	80,100	3,500	285,600	2.0
White oaks	49,300	120,300	61,400	83,700	6,800	321,500	2.2
Other hdwds.	117,900	236,100	211,100	91,000	23,300	679,400	4.8
Total hardwoods	1,034,400	1,312,700	1,088,900	723,300	81,600	4,240,900	29.6
Cypress	180,100	203,700	191,500	53,000	7,700	636,000	4.4
White cedar	68,100	70,300	174,100	1,300	4,200	318,000	2.2
Total all species	2,061,600	2,461,600	6,055,000	3,417,000	340,700	14,335,900	100.0
Percent of total	14.4	17.2	42.2	23.8	2.4	100.0	

*Includes the reproduction and clear-cut conditions.
**Includes longleaf and shortleaf pines, and red cedar.

Although there is a considerable volume of oak, cypress, white cedar, and ash, the predominant supply of board-foot material is second-growth loblolly pine and the red, black and tupelo gums. In fact, loblolly pine and the gums account for 78 percent of all the board-foot volume in the unit.

Sixty-two percent of the pine volume is in trees 13.0 inches d.b.h. and larger (fig. 5). Many of the pine sawmill operators in the unit prefer logs from trees in the 14- to 18-inch diameter classes; such trees contain 46 percent of the pine volume. Logs from trees larger than 20 inches d.b.h. are difficult and expensive to handle in most of the small pine mills so common throughout the unit.

Trees less than 19.0 inches d.b.h. contain 58 percent of the hardwood and 75 percent of the cypress volume. Operators of large hardwood band mills generally prefer logs from trees over 20.0 inches d.b.h. but some operators of hardwood mills cutting about 20,000 board feet per day consider an 18-inch second-growth log of good quality the most desirable material.

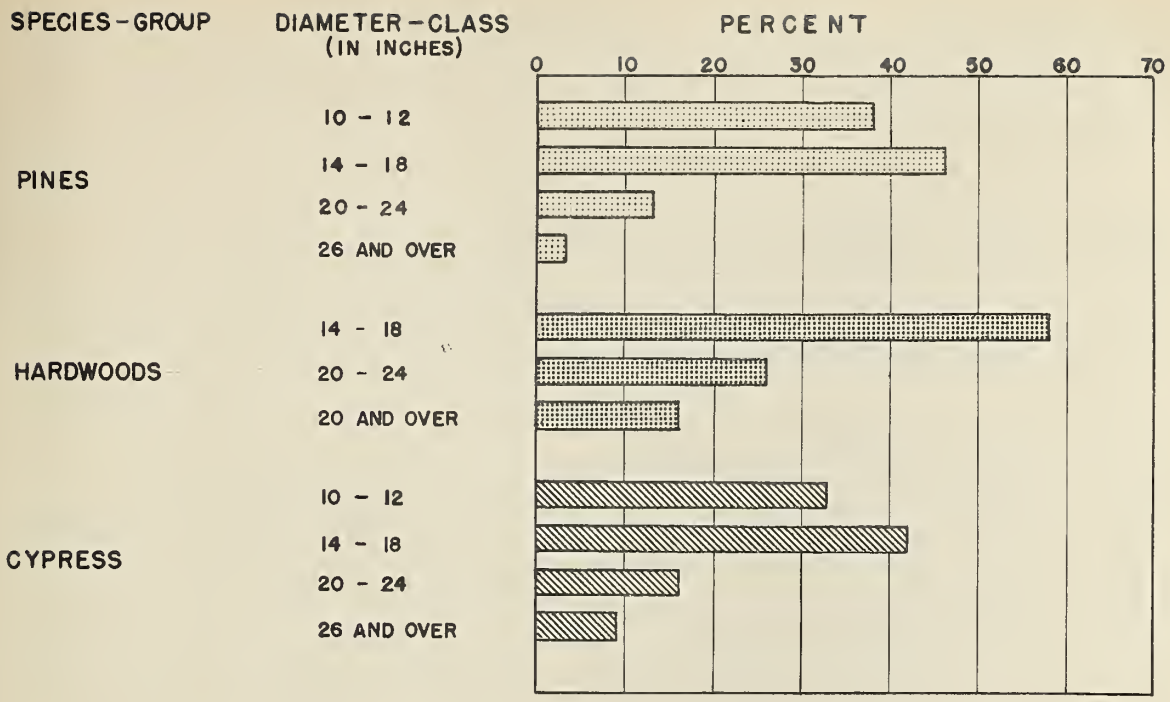
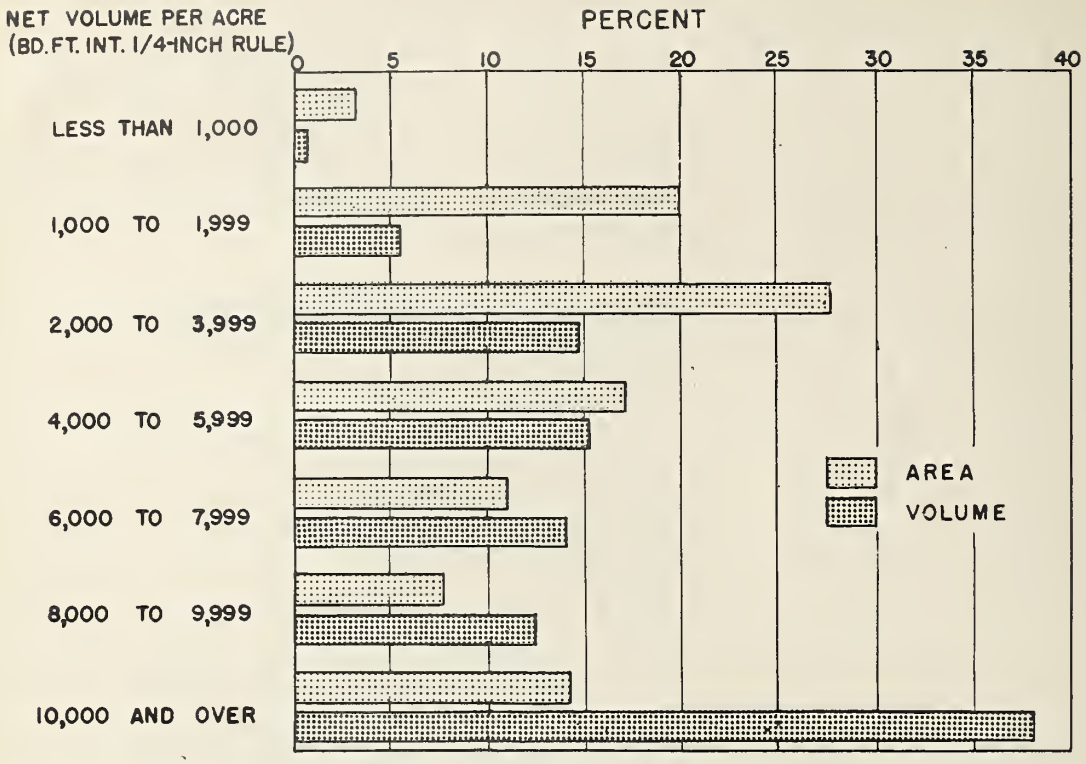


FIGURE 5: DIAMETER DISTRIBUTION OF BOARD-FOOT VOLUME (INTERNATIONAL 1/4-IN. RULE)

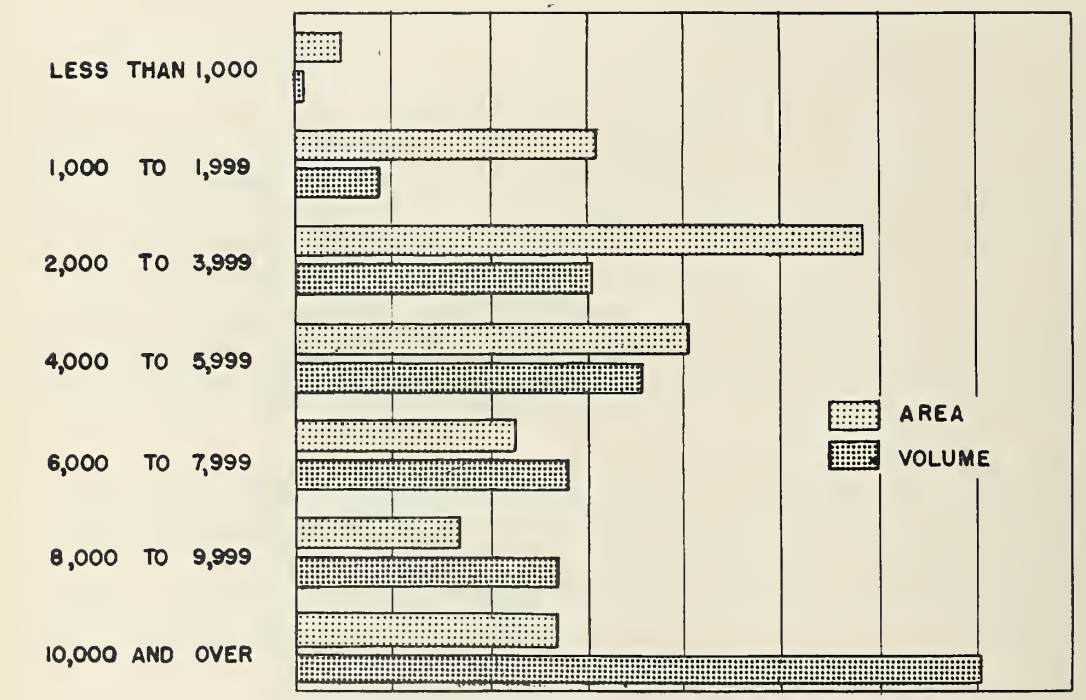
The effect of tree diameter upon lumber values has been investigated by the U. S. Forest Products Laboratory. A study of selective logging in a loblolly pine-hardwood stand of this unit led to the following statement, still generally applicable to pine even though lumber prices may have changed since the investigation. "Generally, the larger and older the tree the greater the proportion of high-grade lumber. Small trees not only yield poorer quality lumber than large trees but, grade for grade, it is worth less because the average width is less. For example, in loblolly pine the B and better lumber from 9-inch trees is worth only $41.42 per thousand board feet, whereas that from 20-inch trees is worth $47.02."2/

Although a high proportion of the board-foot volume is in small or medium-sized trees, most of the volume is concentrated on areas with a stand per acre heavy enough to provide for practical logging operations. This is illustrated in figure 6, where the proportion of the forest area supporting different volumes per acre is shown along with the proportion of the volume in these volume-per-acre classes. The volume under consideration is 98 percent of the total in the unit.

2/Garver, R. D. and J. B. Cuno. The portable band sawmill and selective logging in the loblolly pine forests of North Carolina. U. S. Dept. Agr. Tech. Bul. 337, p. 16. 1932.



A.- PINE - HARDWOOD TYPES



B.- HARDWOOD TYPES

FIGURE 6.- DISTRIBUTION OF AREA AND BOARD-FOOT VOLUME IN THE SAWLOG-SIZE CONDITIONS, CLASSIFIED ACCORDING TO VOLUME OF SAW TIMBER PER ACRE

The sawlog-size conditions of the pine-hardwood types (loblolly pine-hardwoods and pond pine-hardwoods) occupy 1.7 million acres and contain 9.4 billion board feet. Seventy-seven percent of this area is stocked with more than 2,000 board feet per acre, containing in the aggregate 94 percent of the board-foot volume. Nearly 40 percent of the volume is in stands of at least 10,000 board feet per acre.

The sawlog-size conditions of the hardwood types (upland and bottom-land hardwoods, including cypress and white cedar) occupy 828,000 acres and contain 4.6 billion board feet. Eighty-two percent of this area is stocked with more than 2,000 feet per acre, and 96 percent of the volume is contained thereon. About 35 percent of the hardwood volume is in stands of 10,000 board feet or more per acre.

Most of the loblolly pine volume is readily accessible. Waterways provide access to much of the land bordering the sounds and broad river-mouths, while farther inland the distribution of roads in relation to forest land resembles that shown in figure 2. Timber situated in the swamps and river bottoms is accessible if the volume per acre and the total loggable volume is enough to justify construction of a railroad or canal. Much of the pond pine is hard to log, and its poor quality and low volume per acre have retarded its exploitation. Before extensive use is made of the black gum inexpensive methods must be developed for logging the small trees in the gum "necks" and swamps.

The average stand per acre varies noticeably by forest condition and type (table 9). The heaviest average stand is found in the old-growth uncut condition of the loblolly pine-hardwood type but because of its restricted occurrence it has comparatively little significance as a source of saw timber. Of far greater importance is the average stand of 6,900 board feet per acre in the second-growth uncut condition of this same type. Occupying 15 percent of the forest land, the aggregate volume of these stands is 30 percent of all the volume in the unit. The average volume of all conditions in this type is 4,600 board feet per acre, compared with 2,930 board feet in the Southern Coastal Plain of North Carolina.

The pond pine-hardwoods type occupies nearly one-fourth of the forest area, but its average volume per acre is less than 1,000 board feet. Although this low volume reflects the influence of the large areas of reproduction and clear-cut land, the saw-timber conditions also contain only a small volume of timber per acre.

Table 9. - Average board-foot volume per acre by the International $\frac{1}{4}$-inch rule classified according to forest type and forest condition, 1937

Forest type	Sawlog size					Under sawlog size*	Weighted average of all conditions
	Old growth		Second growth		Weighted average		
	Uncut	Partly cut	Uncut	Partly cut			
	Board feet						
Loblolly pine-hardwoods	15,300	8,770	6,940	4,090	5,970	340	4,600
Pond pine-hardwoods	3,330	4,090	2,800	1,920	2,770	100	870
Upland hardwoods	8,470	4,530	2,680	2,400	3,120	230	1,890
Bottomland hardwoods	10,300	6,810	4,400	3,260	5,900	310	4,110
Average all types	10,620	7,120	5,540	3,790	5,520	230	3,540

*Includes reproduction and clear-cut conditions.

Cordwood Volume[3/]

The net volume of 73 million cords (table 10) includes the entire stand of sound trees 5.0 inches d.b.h. and larger, as well as the sound volume in cull trees. It is difficult to grasp the quantitative significance of 73 million cords, but it is nearly 10 times the amount of wood consumed by the pulp and paper industry in the United States in 1935.

The total stand of pine is 32.8 million cords. Seventy-eight percent of this volume is in sawlog-size trees, 18 percent is in under-sawlog-size trees, and 4 percent is in cull trees. Under the existing forest industrial organization, most of the 21 million cords of saw timber will contribute to the sawmill industry. Silviculturally, it would be good practice for the local pulp mills to utilize the sound volume in cull trees, the volume thinned from young stands, and the cordwood volume in the upper stems of felled saw-timber trees. In practice, however, the upper-stem wood must be "sweetened" by a rather high proportion of small saw timber.

As usual in the Coastal Plain of the South the cordwood volume of hardwoods exceeds that of pine. The total hardwood stand contains 36.6 million cords of which only 46 percent is in sawlog-size trees, 30 percent is in under-sawlog-size trees, and 24 percent is in cull trees. Wood pulp industries should consider the large quantity of raw material in the cull gum trees, as it is reasonably accessible and is not in demand by other industries. The heaviest commercial stands of southern white cedar occurred originally in this region and the 1.3 million cords in this unit form a large part of the white cedar along the eastern seaboard.

3/See glossary for description of material included in cordwood volume.

Table 10. - Net volume of all sound material, expressed in cords of wood with bark, 1937

Species-group	Sawlog-size trees		Sound trees under sawlog size	Cull trees	Total all classes	Proportion of total
	Sawlog material	Upper stems				
	Cords					Percent
Pines:						
Loblolly*	19,306,700	3,865,500	5,136,500	537,500	28,846,200	39.4
Pond	1,811,200	531,800	919,300	662,200	3,924,500	5.4
Total pines	21,117,900	4,397,300	6,055,800	1,199,700	32,770,700	44.8
Hardwoods:						
Black gums	4,107,000	2,082,700	3,953,700	3,180,000	13,323,400	18.3
Red gum	2,987,800	1,728,000	2,176,400	1,034,100	7,926,300	10.8
Yellow poplar	450,600	261,600	274,500	122,000	1,108,700	1.5
Red oaks	751,000	395,300	751,100	480,100	2,377,500	3.3
White oaks	827,000	450,500	1,073,900	351,100	2,702,500	3.7
Other hdwds.	1,746,100	907,400	2,804,700	3,638,400	9,096,600	12.4
Total hdwds.	10,869,500	5,825,500	11,034,300	8,805,700	36,535,000	50.0
Cypress	1,537,200	425,200	286,600	208,000	2,457,000	3.4
White cedar	803,700	114,100	394,400	26,100	1,338,300	1.8
Total all species	34,328,300	10,762,100	17,771,100	10,239,500	73,101,000	100.0
Percent of total	47.0	14.7	24.3	14.0	100.0	

*Includes longleaf and shortleaf pines, and red cedar.

The cordwood volume shown in table 11 includes the entire stand of sound trees 5.0 inches d.b.h. and larger, but does not include cull trees or upper stems and limbs of sawlog-size hardwood and cypress trees. It is therefore 16.5 million cords less than the total volume in table 10. Among the species, red oaks have the highest proportionate volume in large trees and pond pine the lowest. Nearly 10 percent of all the volume shown is loblolly pine in the 6- and 8-inch diameter class.

Table 11. - Net cordwood volume of sound trees classified according to species-group and diameter-class, 1937

Species-group	Tree diameter-class (inches)				Total	Proportion of total
	6 - 8	10 - 12	14 - 18	20 and over		
	Cords (bark included)					Percent
Pines:						
Loblolly*	5,136,500	9,968,900	10,102,800	3,100,500	28,308,700	50.0
Pond	919,300	1,306,100	958,600	78,300	3,262,300	5.8
Total pines	6,055,800	11,275,000	11,061,400	3,178,800	31,571,000	55.8
Hardwoods:						
Black gums	1,508,200	2,445,500	2,581,600	1,525,400	8,060,700	14.3
Red gum	921,900	1,254,500	1,917,100	1,070,700	5,164,200	9.1
Yellow poplar	125,800	148,700	280,200	170,400	725,100	1.3
Red oaks	394,400	356,700	343,900	407,100	1,502,100	2.6
White oaks	518,100	555,800	400,000	427,000	1,900,900	3.4
Other hdwds.	1,375,500	1,399,200	1,216,800	559,300	4,550,800	8.0
Total hdwds.	4,843,900	6,160,400	6,739,600	4,159,900	21,903,800	38.7
Cypress	286,600	395,000	692,900	449,300	1,823,800	3.2
White cedar	394,400	492,100	372,300	53,400	1,312,200	2.3
Total all species	11,580,700	18,322,500	18,866,200	7,841,400	56,610,800	100.0
Percent of total	20.5	32.4	33.3	13.8	100.0	

*Includes longleaf and shortleaf pines, and red cedar.

A forest stand averaging 14 cords per acre (table 12) over 4 million acres is much better stocked than the average forest in the southern pine region. This average, moreover, includes clearcut, reproduction, and sapling areas having little volume. In the sawlog-size stands, occupying 63 percent of the forest area and containing the commercial volumes, the average stand is 21 cords per acre. The yield of 26 cords at an average age of 40 years in the second-growth uncut condition of the loblolly pine-hardwoods type indicates a yearly increase of nearly six-tenths of a cord under unmanaged conditions. By contrast, the same condition of the pond pine-hardwoods type increased by only two-tenths of a cord per year.

Table 12. - Average cordwood volume per acre, classified according to forest type and forest condition, 1937

Forest type	Sawlog size					Under sawlog size*	Weighted average of all conditions
	Old growth		Second growth		Weighted average		
	Uncut	Partly cut	Uncut	Partly cut			
	Cords						
Loblolly pine-hardwoods	41.2	25.3	25.8	16.4	21.8	3.7	17.4
Pond pine-hardwoods	10.3	14.0	11.3	7.8	10.8	0.9	3.8
Upland hardwoods	24.2	17.6	13.1	11.7	13.7	2.9	9.1
Bottomland hardwoods	33.0	23.9	21.6	16.1	23.2	4.0	17.1
Average all types	32.2	23.6	22.1	15.7	20.8	2.6	14.0

*Includes reproduction and clearcut areas.

Cubic-foot Volumes

Cubic volume affords the most uniform and accurate standard of measurement for both saw-timber and cordwood material. It is particularly useful in comparisons between stand volume, forest growth and wood use. In table 13 the net volume of all sound wood in the stand has therefore been summarized in cubic feet. Bark is not included.

Table 13. - Net volume of all sound material expressed in cubic feet, 1937

Species-group	Sawlog-size trees		Sound trees under sawlog size	Cull trees	Total all classes	Proportion of total
	Sawlog material	Upper stems				
	Thousand cubic feet					Percent
Pines	1,520,420	312,990	397,240	84,010	2,314,660	46.8
Hardwoods	736,330	346,110	701,290	564,990	2,348,720	47.5
Cypress	119,250	25,740	20,410	15,290	180,690	3.6
White cedar	62,240	8,770	29,290	1,990	102,290	2.1
Total all species	2,438,240	693,610	1,148,230	666,280	4,946,360	100.0
Percent of total	49.3	14.0	23.2	13.5	100.0	

Poles

During the course of the field inventory the loblolly, longleaf, and shortleaf pine trees ranging from 7.0 to 18.9 inches d.b.h. were classified as to their suitability for poles. About 12 percent of them qualified for this special use (table 14). Twelve million pole trees is an average of 3 per forest acre, but actually some large areas are almost devoid of pole timber while other areas are heavily stocked. The second-growth uncut stands of the loblolly pine-hardwoods type contain most of the poles, particularly those stands located between the Roanoke and Chowan Rivers. Because of the high proportion of short lengths the present distribution of size-classes in the forest does not correspond with industrial usage. The average piece cut in this unit for commercial use in 1937 was 40 feet long, whereas the average piece in the forest is only 25 feet long. It is not safe to assume that the great number of small, short pieces will grow into more desirable sizes, as most of them will be cut for saw timber or pulpwood long before they become attractive to the pole industry.

Table 14. - Total number of pine poles by length and diameter, 1937

D.b.h. of trees (outside bark)	Pole length (feet)						Total	Proportion of total
	20	25	30	35	40	45 or over		
Inches	- - - - - - Thousand pieces - - - - - -							Percent
7.0 - 8.9	2,615	298	74	--	--	--	2,987	24.7
9.0 - 10.9	2,347	1,343	718	170	43	--	4,621	38.2
11.0 - 12.9	674	861	727	420	107	80	2,869	23.7
13.0 - 14.9	35	134	332	535	127	58	1,221	10.1
15.0 - 16.9	--	--	39	90	103	125	357	2.9
17.0 - 18.9	--	--	--	3	12	28	43	0.4
Total	5,671	2,636	1,890	1,218	392	291	12,098	100.0
Percent of total	46.9	21.8	15.6	10.1	3.2	2.4	100.0	

THE INCREMENT OF THE FOREST

In general, the growing stock of a forest is the sum of the volume of all living trees. Specifically, in this report the growing stock includes all live sound trees 5.0 inches d.b.h. and larger. "Forest increment" denotes the net volume of wood produced by growth of this forest growing stock.

The Relation of the Elements of Increment

Net increment is the total growth reduced by the amount of mortality. Total growth is composed of 2 major parts, (1) the recruited volume of trees attaining minimum size during the growth period and (2) the volume of growth occurring on the sound trees remaining in the stand. The relative effect of mortality and the two elements of total growth upon net board-foot and cubic-foot increment in the several forest conditions is illustrated in figure 7.

Consider first the pine species-group. In under-sawlog-size stands 77 percent of the total board-foot growth was volume recruited from trees that became of sawlog size during the year. Only 23 percent of the growth was on trees already of sawlog size. Saw-timber stands of second growth had a smaller proportion of recruited volume. Even in the old-growth pine the recruited volume made up about 13 percent of the total growth reflecting the presence of second-growth trees in these stands. By contrast the proportion of volume recruited into the cubic-foot stands (trees 5.0 inches d.b.h. and larger) is much smaller in all conditions.

In the hardwood species-group over 80 percent of the total board-foot growth in the under-sawlog-size stands and nearly 50 percent in the second-growth sawlog-size was recruited volume. The large proportion of recruited volume in the board-foot growth of old-growth hardwoods is a result of the all-aged character of the stand. In contrast to the pines, the proportion of volume recruited into the cubic-foot stands is quite large in all conditions. It signifies a large reserve of small hardwoods that are constantly augmenting the cubic-foot growing stock.

Certain features of mortality deserve consideration. In the second-growth sawlog-size pine stands the mortality, when measured in cubic feet to include the smaller trees, was about double the mortality percent of the saw-timber trees alone indicating a high mortality of small trees. This has a marked influence upon the balance of increment and drain in cubic feet, discussed later in the report. In both the old-growth pines and hardwoods a volume equal to more than 20 percent of the total board-foot growth was lost because of mortality. In the hardwoods this volume loss was compensated by the recruited volume, although the quality of the new board-foot material was probably inferior.

Old age, tree competition, fire, wind, and insects were among the causes of mortality. An example of insect damage was the severe local infestation by the southern pine beetle (Dendroctonus frontalis) in Hertford County in 1938 in which an estimated 4 million board feet of old-growth

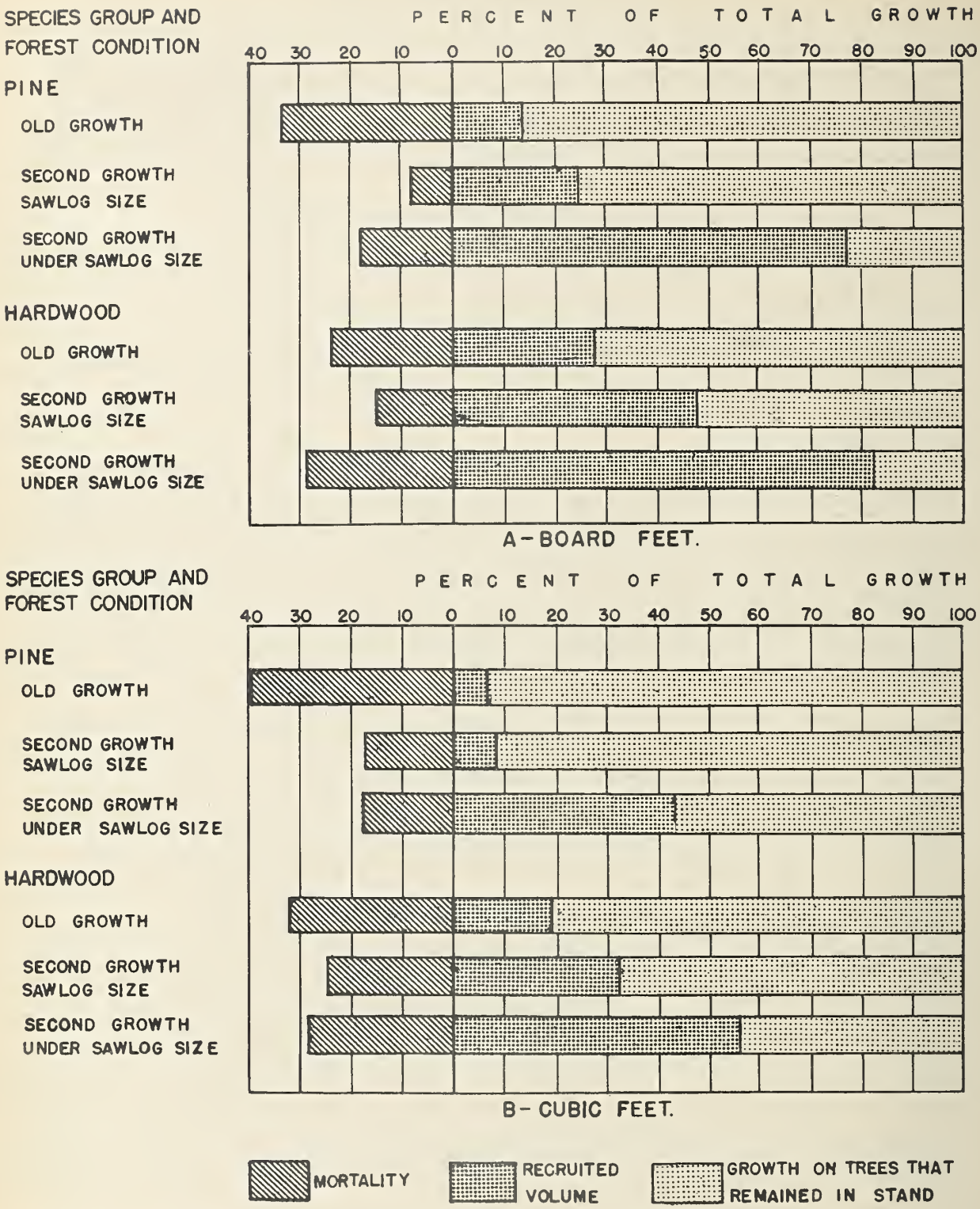


FIGURE 7 - PROPORTIONAL DISTRIBUTION OF THE ELEMENTS OF NET INCREMENT, 1937

pine was killed. Uncontrolled fire is one of the major causes of mortality in all forest conditions but the common practice of blaming all mortality losses upon fire is unjustifiable as trees dying from natural causes are present in practically every forest stand.

Increment of the Total Stand

The increment of saw-timber material in 1937 amounted to 474 million board feet of pine and 175 million feet of hardwoods, a total of 649 million feet. About three-fourths of all the increment developed in second-growth sawlog-size stands. The increment of all sound trees 5.0 inches d.b.h. and larger amounted to 1.3 million cords of pine and 757,000 cords of hardwood, equivalent to 137 million cubic feet of wood without bark. Twelve percent of the cordwood increment was in old-growth stands, 70 percent in second-growth saw-timber, and 18 percent in under-sawlog-size stands.

Increment per Acre

The average increment per acre by forest condition (table 15) is given for 1938 because that is the year for which the most reliable estimates of timber volume by forest condition are available. In arriving at these values no reduction has been made for timber cut during the year, so the increment represents the natural yearly increase of stands in the various forest conditions and types.

This unit has a higher average increment per acre than any other Coastal Plain unit in North or South Carolina. Better soil and climatic conditions are not entirely responsible as there is little variation between units. The higher increment is rather a reflection of the larger volume of growing stock per acre -- in this unit 3,540 board feet compared to 2,200 in the Southern Coastal Plain of North Carolina and about 3,200 feet in the Coastal Plain of South Carolina. Opportunities for increasing the increment exist on much of the forest land, but it is distinctly favorable to find 15 percent of the forest area (second-growth uncut loblolly pine-hardwoods) producing annually nearly 400 board feet per acre, which is good growth even for a managed forest.

Less favorable is the almost negligible increment occurring in the clear-cut condition which occupies almost 4 percent of the forest land. Stocking and increment can be increased by fire protection and natural reseeding on some areas, on others planting will be necessary. Increment is likewise small in the reproduction condition but this is to be expected until the young seedlings become larger. When the reproduction grows into the under-sawlog-size condition, an increment similar to that occurring in the present under-sawlog-size stands can be expected. This amounts to about three-tenths of a cord per acre, which is about the usual average in under-sawlog-size stands throughout the South. In all forest conditions there is an opportunity to increase the increment by increasing the amount of growing stock per acre.

Table 15. - Average increment per acre classified according to forest condition and forest type, 1938

Forest condition	Saw-timber material					All sound trees in all types	
	Loblolly pine-hardwoods	Pond pine-hardwoods	Upland hardwoods	Bottom-land hardwoods	Average of all types	Including bark	Excluding bark
	Board feet					Cords	Cu.ft.
Sawlog size:							
Old growth:							
Uncut	160	31	179	211	177	.37	25.7
Partly cut	239	113	104	155	174	.50	35.2
Second growth:							
Uncut	380	156	126	199	293	.80	55.0
Partly cut	234	111	127	171	215	.62	42.3
Under sawlog size:							
Second growth	62	27	35	51	47	.34	22.4
Reproduction and clear-cut	8	2	2	1	3	.01	.8
Weighted average	237	50	83	137	163	.50	34.4

The loblolly pine-hardwoods type had the largest average increment per acre and also the largest average increment in the second-growth uncut condition. The bottom-land hardwoods type ranked next in productiveness, and the increment of its old-growth uncut condition exceeded the increment occurring in the same condition of the loblolly pine-hardwoods type. It is popularly believed that old-growth hardwood stands in the south and southeast do not add net annual increment. Such an assumption may be true in the relatively scarce virgin stands containing only over-mature timber. Old-growth hardwood stands, as defined and classified by the Survey, include not only these virgin stands but more typically the uneven-aged stands dominated by trees having the characteristics of old-growth timber. The presence of younger age-classes in the old-growth hardwoods results each year in a recruited volume alone (fig. 7) that frequently more than compensates for the mortality loss in the older trees. As a consequence, there is a net annual increment accumulating on the sawlog-size trees, a normal circumstance that has been demonstrated in many survey units. Least productive was the pond pine-hardwoods type. Its average increment of 50 board feet per acre measures the annual yield on 22 percent of the forest land.

THE PRIMARY FOREST INDUSTRIES

The forest resource provides raw material for a large number of wood-using plants, and also supplies wood for crossties, poles, firewood, and other miscellaneous products. The lumber industry is most important but the production of pulp and paper, furniture and package veneer, and slack cooperage is of consequence in certain localities.

The Lumber Industry

In 1937 the 335 sawmills operating in the unit produced 347 million board feet of lumber, including sawed crossties. About 80 percent of the lumber was pine, 15 percent mixed hardwoods, and 5 percent cypress and white cedar. Three-tenths of the pine, two-thirds of the hardwood, and three-fourths of the cypress and white cedar were cut from old-growth stands. Sixty percent of the total lumber production was obtained from second-growth timber. About 15 million board feet of pine and 3 million feet of hardwood sawlogs were brought into the unit from the Southern Coastal Plain and the Piedmont of North Carolina but 30 million feet of pine and 12 million feet of hardwood and cypress were shipped outside, chiefly to Franklin, Suffolk, and Norfolk in Virginia.

Table 16. - Descriptive summary of lumber production in sawmills of various size-classes, 1937

Item	Capacity in thousand board feet per 10-hour day				All mills
	1 - 9	10 - 19	20 - 39	40 and over	
Number of sawmills	267	37	27	4	335
Avg. 1937 production per mill (M bd.ft.)	296	1,405	5,096	19,600	1,036
Total production of pine (M bd.ft.)	69,300	40,100	105,400	65,800	280,600
Total production of hardwood (M bd.ft.)	9,700	11,900	32,200	12,600	66,400
Avg. no. of days worked per mill	100	214	252	275	123
Avg. no. of men per sawmill	5	15	47	100	11
Avg. no. of men per woods operation	4	11	26	80	8
Percent of mills using:					
Circular saws	100	95	30	0	93
Band saws	0	5	70	100	7
Resaws	Negl.	30	45	100	8
Edgers	65	95	100	100	72
Planers	40	75	70	100	47
Dry kilns	5	50	65	100	16

In 1937 there were only 5 sawmills operating in North Carolina that had a cutting capacity of more than 50,000 board feet per day. Four of these mills were located in this unit, at Washington, Elizabeth City, New Bern, and Hertford (figure 8). These 4 large mills cut 23 percent of the lumber produced in the unit. They are more completely equipped than the smaller mills (table 16) for the manufacture of good-quality lumber.

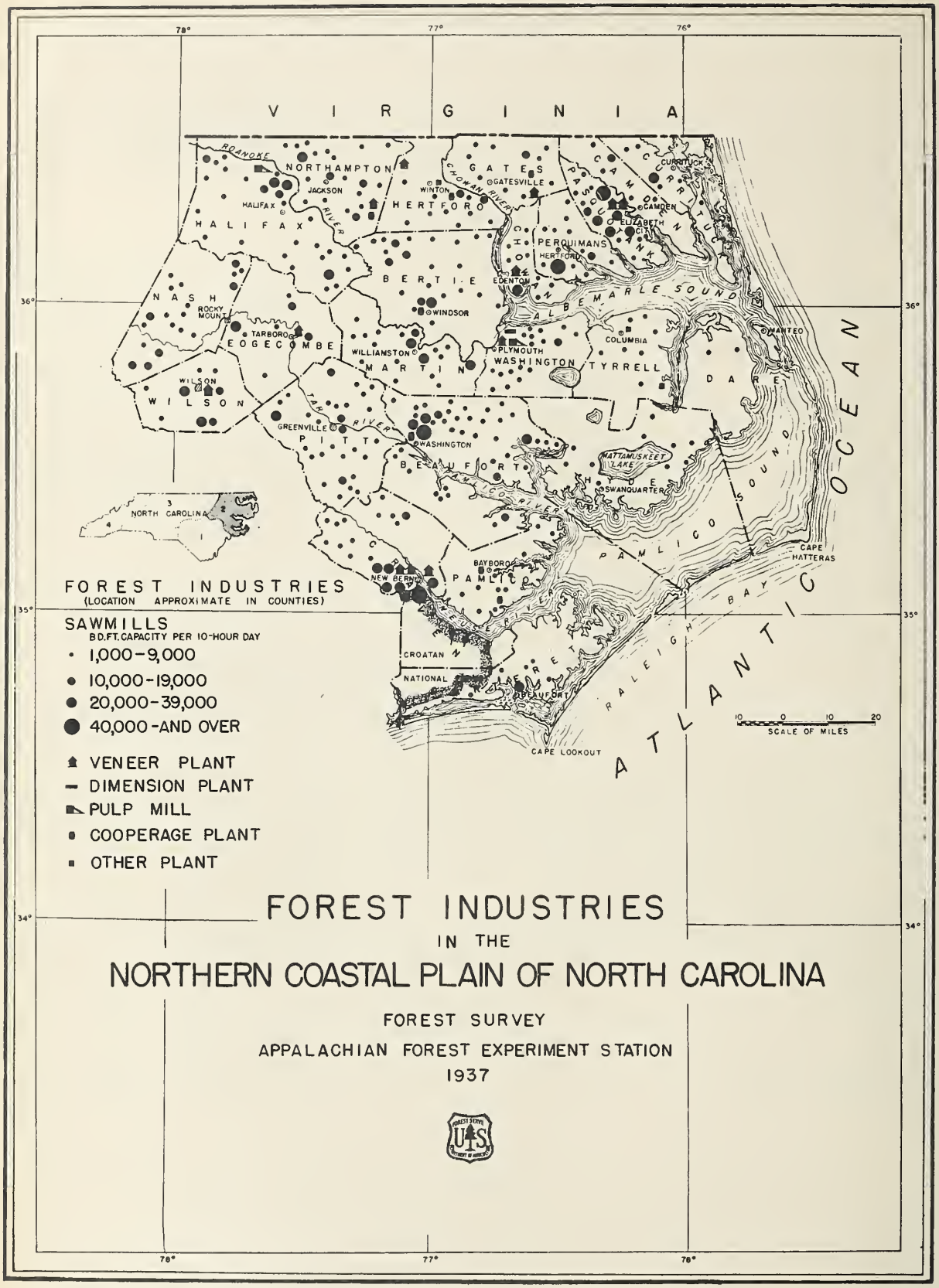

FOREST INDUSTRIES
(LOCATION APPROXIMATE IN COUNTIES)
SAWMILLS
BD.FT.CAPACITY PER 10-HOUR DAY
1,000-9,000
10,000-19,000
20,000-39,000
40,000-AND OVER
VENEER PLANT
DIMENSION PLANT
PULP MILL
COOPERAGE PLANT
OTHER PLANT
FOREST INDUSTRIES
IN THE
NORTHERN COASTAL PLAIN OF NORTH CAROLINA
FOREST SURVEY
APPALACHIAN FOREST EXPERIMENT STATION
1937
VIRGINIA
ATLANTIC OCEAN
NORTH CAROLINA
SCALE OF MILES
NORTHAMPTON
HALIFAX
GATES
CHOWAN
PERQUIMANS
PASQUOTANK
CAMDEN
CURRITUCK
ELIZABETH CITY
EDENTON
ALBEMARLE SOUND
NASH
ROCKY MOUNT
TARBORO
EDGECOMBE
WILSON
WINDSOR
BERTIE
WILLIAMSTON
MARTIN
PLYMOUTH
WASHINGTON
TYRRELL
COLUMBIA
MANTEO
DARE
GREENVILLE
PITT
WASHINGTON
BEAUFORT
NEW BERN
CRAVEN
PAMLICO
BAYBORO
PAMLICO SOUND
NATTAMUSKEET LAKE
SWANQUARTER
HYDE
CAPE HATTERAS
CROATAN
NATIONAL
MOREHEAD
BEAUFORT
CAPE LOOKOUT
RALEIGH BAY
ROANOKE
JACKSON
HALIFAX
WINTON
GATESVILLE
HERTFORD
CHOWAN RIVER
ROANOKE RIVER
TAR RIVER
NEUSE RIVER
CROATAN
78°
77°
76°
36°
35°
34°

Figure 8

The 27 sawmills with a capacity of 20,000 to 40,000 board feet per day produced 40 percent of the total lumber cut and nearly half of all the hardwood. These mills have a full complement of up-to-date equipment and their general design is correlated to the production of well-manufactured lumber from second-growth trees. Most of the mills without planers in this size-class are cutting hardwood which is sold unfinished. Slightly over half of the logs for these mills were purchased at the mill yard, 10 percent were cut from land owned by the lumber companies, and the rest were bought as stumpage.

Only 15 percent of the lumber was produced by sawmills in the 10,000 to 20,000 board-foot capacity class. Practically all of these mills use circular saws, otherwise their equipment compares favorably with that in mills of the next larger size-group. The 267 small mills cutting less than 10,000 board feet per day cut nearly one-fourth of the lumber. They operated the fewest number of days and had the least equipment. A surprising number of them had small planers but almost two-thirds of their production was sold rough. Both groups of mills buy standing timber to supply about 70 percent of their needs, logs purchased at the mill provide for 20 percent, while 10 percent of their production was contract or custom sawing.

The lumber industry holds an advantageous position in this unit. Pine lumber commands a net mill price higher than that produced in the deep South because of its nearness to the consuming markets of the large eastern cities. Good roads and truck transportation make it possible to deliver from sawmills and concentration yards direct to construction projects in Washington, Baltimore, or Philadelphia, with economies in transportation that benefit both the producer and consumer. The furniture factories of North Carolina also provide a convenient market for hardwood lumber. Since they are able to use random sizes the hardwood sawmills can obtain a higher degree of utilization than usual.

Other Forest Industries

Seven package veneer plants were operating in this unit in 1937. Their primary product was single-ply veneer which most of the plants fabricated into baskets, crates, and vegetable boxes. The total wood consumption of the mills amounted to 30 million board feet; one-fourth pine and the rest chiefly red, black, and tupelo gum. Practically all of the pine and at least one-third of the hardwood were cut from second-growth timber. About two-thirds of the log volume was purchased delivered at the yard.

The production of furniture veneers and plywood is relatively unimportant in this unit, only five plants operating in 1937. They used about 10 million board feet of second-growth and one-half million feet of old-growth gum and yellow poplar logs, about two-thirds of which were purchased delivered at the yard. There are no furniture factories of consequence in this unit but a nearby market for furniture plywood is available in some of the 125 factories operating in the Piedmont of North Carolina.

Other plants using saw-timber material include seven cooperage plants, three shingle mills, one handle plant, and one plant making sawn posts and mine props. They used about 14 million board feet of sawlogs. Slack cooperage was made from second-growth pine with the average log about 10 inches in diameter. The shingle mills used second-growth pine and a small amount of white cedar. Ash was used for practically all of the handles. The posts and mine props were cut from pine and cypress, and were treated by the cap-end pressure process.

The pulp and paper industry was represented by two mills, one at Plymouth and one at Roanoke Rapids. Production began at Roanoke Rapids in 1907, this plant being one of the earliest producers of kraft pulp in the South. The Plymouth mill is one of the numerous plants built in the South since 1935. It attained full operation in 1938 and at present (1940) it is practically doubling its facilities for producing sulphate pulp. Second-growth pine is used in both plants, and these two plants plus a third one in Virginia, purchased about 42,000 cords in this unit in 1937. Since the Plymouth mill has achieved full production, an increased volume of pine wood has been purchased as well as some black and tupelo gum.

Products cut from the forest and sold without further manufacture included 135,000 pine poles and piles, 53,000 hewn crossties, 270,000 board feet of mine props, and 295,000 board feet of export logs. Most of the poles and piles were purchased by treating plants in Portsmouth and Norfolk, Virginia. Public-carrier railroads used about 10,000 of the cross-ties and logging railroads the remainder. The mine props of unseasoned pine were shipped to coal mines in Pennsylvania. They varied from 9 to 27 feet in length and from 8 to 16 inches in diameter. The export logs, shipped from Norfolk, Virginia, contained high-quality hardwood veneer and saw-timber material.

About 1,077,000 cords of fuelwood and 42,000 cords of miscellaneous material were cut and used locally. Of the fuelwood, about two-thirds were pine and one-third mixed hardwoods. Fuelwood used in homes, schools, and small commercial establishments amounted to three-fourths of the total, while wood used in curing tobacco accounted for the rest. Fence posts, tobacco barns, and peanut stakes comprised most of the miscellaneous material used on farms. Peanuts are an important crop in the northern counties, and many thousand stakes were used. Peanut stakes are 6 to 8 feet long and about 2 inches in diameter. Round pine or gum saplings are most frequently used, although a small proportion are split from 5- or 6-inch pine trees.

Employment

Nearly three million man-days of labor were expended in the primary forest industries in 1937 (table 17). Work in the woods and mills for a cash wage amounted to 1.6 million man-days, or 55 percent of all employment. The remainder, 1.4 million man-days, was utilized chiefly in the production of fuelwood for home use and consequently returned little direct cash income to the individual wood-cutter.

Approximately 5,000 wage-earners were employed in the various primary forest-products plants. About 3,000 of these worked in sawmills, 1,400 in

veneer plants, and the remainder in cooperage, pulp, handle and shingle mills. Wood procurement for the forest industrial plants and the production of crossties, poles, mine props, and export logs required the services of at least 4,000 more workers, fully 70 percent of whom were engaged in the lumbering industry. At 25¢ per hour these commercial forest activities would return about four million dollars in wages to the 9,000 or more woods and mill laborers of this unit. With the present minimum hourly wage scale of 30¢ they would have received about one million dollars more, assuming the continued operation of all the forest industrial plants when confronted with a 20 percent increase in labor costs.

Table 17. - Production and employment in the primary forest industries, 1937

Kind of plant or commodity	Number of plants	Material cut in woods	Produced or used by plants	Employment provided		
				In woods	In plants	Total
		M bd.ft.			Thousand man-days*	
Sawmills	336	371,900	347,000	509	631	1,140
Furniture veneer	5	19,200	10,400	36	41	77
Package veneer	7	45,300	29,900	85	116	201
Cooperage	7	10,400	10,400	27	33	60
		M pieces				
Hewn crossties	--	65	--	9	--	9
Poles and piles	--	135	--	30	--	30
		M cords				
Fuelwood	--	1,076	--	1,291	--	1,291
Misc. manufacture**	7	53	50	54	77	131
Misc. farm use	--	42	--	47	--	47
Total	361	--	--	2,088	898	2,986

*Based on a 10-hour day.

**Includes 2 pulp mills, 3 shingle mills, 1 handle plant, 1 making mine props, and export logs.

Commodity Drain

The commodity drain from the pine and hardwood sound-tree growing stock includes both the material utilized and the sound merchantable material left in felled trees. The drain on the saw-timber portion of the trees, including both the utilized and wasted portions, is expressed in board feet whereas the volumes given in cubic feet and cords include drain on saw-timber material, upper stems of sawlog-size pines, and small trees ranging from 5.0 inches d.b.h. to sawlog-size. The small drain on hardwood tops is not included.

In 1937 the drain of saw-timber material amounted to 578 million board feet (table 18). Forest industries and domestic consumers in the unit used 502 million board feet, 69 million feet were shipped outside the unit, and about 7 million board feet were left unutilized in felled trees in the woods. An additional 19 million board feet were used by the local forest industries, but this volume was obtained from other forest areas in North Carolina. About 70 percent of the total board-foot drain was pine, the remainder mixed hardwoods and a small amount of cypress and white cedar. Two-thirds of the total drain was cut from second-growth timber stands.

Table 18. - Commodity drain from the sound-tree growing stock, 1937

Commodity	Saw-timber material			All sound trees*		
	Pine	Hardwood	Total	Pine	Hardwood	Total
	- Thousand board feet -			- Thousand cubic feet -		
Lumber	295,700	76,200	371,900	55,800	12,670	68,470
Veneer	8,600	61,300	69,900	1,620	9,950	11,570
Cooperage	10,400	--	10,400	1,960	--	1,960
Crossties	600	1,100	1,700	110	280	390
Poles and piles	14,100	--	14,100	2,670	--	2,670
Pulpwood	8,800	--	8,800	2,870	--	2,870
Fuelwood	74,400	17,900	92,300	25,770	12,970	38,740
Misc. manufacture	1,100	4,000	5,100	210	660	870
Misc. farm use	2,300	1,600	3,900	1,280	830	2,110
Total	416,000	162,100	578,100	92,290	37,360	129,650

*Total drain from the growing stock expressed in cords of wood with bark: pine 1,286,400; hardwood 549,200.

Eighty-three percent of the total cubic-foot drain was obtained from saw-timber trees. Three-tenths of the total cut was taken from old-growth stands, six-tenths from sawlog-size growth, and one-tenth from under-sawlog-size stands. About half of the drain was caused by the lumber industry, and 30 percent by the local demand for fuelwood. Nearly half of the fuelwood requirement was obtained from cull trees, hardwood tops, and sawmill waste and was not included as commodity drain, otherwise the fuelwood drain upon the growing stock would have been nearly as great as the drain for lumber.

COMPARISON OF INCREMENT WITH COMMODITY DRAIN

A continuous supply of wood for existing and prospective forest industries is contingent upon a favorable balance between net increment and commodity drain. It is good forest economy, however, to increase production when market conditions are good and to build up the growing stock when prices and demand have fallen off. Consequently the balance of increment and drain for a single year should not be used as an arbitrary criterion of the forest situation. Changes in wood requirements, utilization practices, intensity of fire control, and management practices are a few of the unpredictable factors that may change the whole picture in the space of a few years. Analysis of the specific elements affecting the increment and drain relation in a single year is of value nevertheless, in arriving at an intelligent appraisal of existing conditions.

Comparison in Board Feet

The increment of both pines and hardwoods was more than the commodity drain in 1937 (table 19). Although the pine saw-timber growing stock increased by 58 million board feet, the trend was toward replacement of the old-growth timber with young second growth of poorer quality. The drain in old-growth pine was 3 times the increment, while in sawlog-size second-growth it was only three-fourths of the increment. At the present rate of over-cutting the old-growth pine will soon be reduced to a negligible quantity. The effect upon the wood-using industries will be slight, however, as only a few plants in the unit are operating entirely in old-growth pine. The surplus of increment over drain in the second-growth pine stands is enough to compensate for the over-cut in the old growth and provide a small reserve for building up the saw-timber growing stock.

Table 19. - Balance between increment and drain of saw-timber material, 1937

Item	Pine	Hardwood	Total
	- - - - Thousand board feet - - - -		
Net growing stock, January 1, 1937	9,082,800	5,182,000	14,264,800
Growth, 1937	542,300	216,800	759,100
Mortality, 1937	68,100	41,800	109,900
Net increment, 1937	474,200	175,000	649,200
Commodity drain, 1937	416,000	162,100	578,100
Net change in growing stock, 1937	+58,200	+12,900	+71,100
Net growing stock, December 31, 1937	9,141,000	5,194,900	14,335,900

An increase of 13 million board feet in the hardwood growing stock, which here includes cypress and white cedar, does not, of itself, indicate a propitious situation. The multiplicity of hardwood species of varying quality and current utilization practices are important factors influencing the increment and drain relation of hardwoods in this unit. Increment is

calculated for all species, several of which contribute only infrequently to the commodity drain. For instance, black and tupelo gums make up one-third of the hardwood saw-timber volume and a large share of the total increment, but industrial use of these species is relatively small. In effect, the better-quality red and white oaks, red gum, ash, yellow poplar, and cypress are being overcut and the less valuable water and post oaks, black and tupelo gums, bay, and elm are making up an increasing proportion of the stand. Furthermore, the old-growth timber is being cut about twice as fast as it is growing and the second growth replacing it is not equal in quality. Eventually the forest industries will be affected, for at present about two-thirds of the hardwood drain is cut from old-growth stands.

Comparison in Cubic Feet

The total sound-tree growing stock, 5.0 inches d.b.h. and larger, increased by 7 million cubic feet in 1937, but the pine component of the forest decreased by 4 million cubic feet (table 20). It is rather unusual to have the pine saw-timber volume increasing (table 19) and at the same time have the total pine stand decreasing. Figure 7 provides one explanation of this seeming inconsistency. Because of its great volume and the large drain upon it, the second-growth sawlog-size condition has a controlling influence upon the balance of increment and drain. Growth of the board-foot growing stock in this condition is augmented by a considerable recruited volume, while growth of the cubic-foot growing stock is bolstered by very little recruited volume. Furthermore, the mortality lost from the cubic-foot growth is proportionately twice the loss from the board-foot growth. This combination of proportionately small recruited volume and high mortality is the major cause of the small deficit in the pine cubic-foot growing stock.

Table 20. - Balance between increment and drain of all sound material, 1937

Item	Pine	Hardwood	Total
	- - - - Thousand cubic feet - - - -		
Net growing stock, January 1, 1937	2,234,890	1,666,320	3,901,210
Growth, 1937	109,030	66,420	175,450
Mortality, 1937	20,980	17,800	38,780
Net increment, 1937	88,050	48,620	136,670
Commodity drain, 1937	92,290	37,360	129,650
Net change in growing stock, 1937	-4,240	+11,260	+7,020
Net growing stock, December 31, 1937	2,230,650	1,677,580	3,908,230

In spite of the large quantity of small hardwoods used for fuelwood, there was an increase in the hardwood growing stock. Drain exceeded increment in the old-growth stands, but it was less than half the increment in second-growth stands. The accumulating second-growth material is entirely

suitable for fuelwood, the second largest use of hardwood, but much of it is unsatisfactory for saw timber. To prevent the constant deterioration of the hardwood stands lumbermen should make every effort to utilize as many species as possible and farmers should cut their fuelwood from the least desirable species and poorest-quality trees.

Comparison in Cords

A comparison in cords (fig. 9) finds total growth of both pines and hardwoods materially in excess of commodity drain. Mortality drain was an important item, however, and cordwood and saw-timber losses from this cause were great enough to occasion a decrease of 17,000 cords in the pine growing stock. A large part of this pine mortality was in second-growth saw-timber stands providing material eminently suited for pulpwood. Overcrowded stand conditions and forest fires, both factors that can be corrected with more intensive forest management practices, were responsible for most of the mortality losses. Reduction of pine mortality loss is especially desirable in view of the probable increase in commodity drain when the enlarged Plymouth pulp mill goes into production.

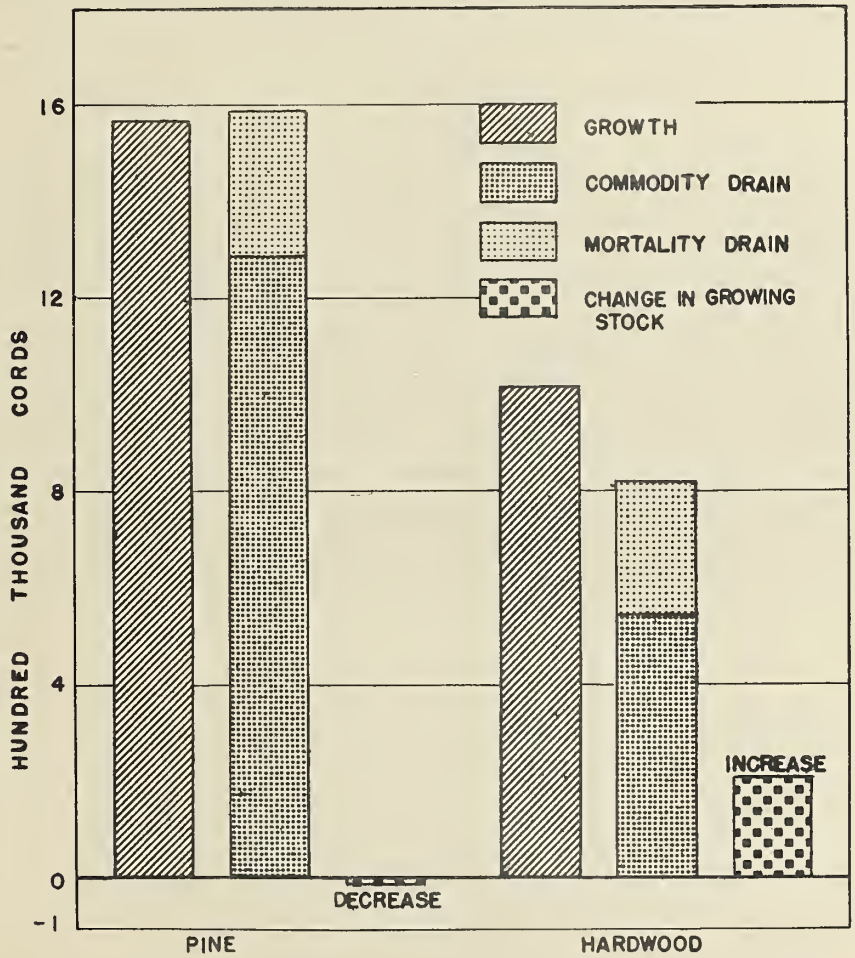


FIGURE 9.- COMPARISON OF GROWTH WITH MORTALITY AND COMMODITY DRAIN, 1937

FAVORABLE ASPECTS OF THE FOREST SITUATION

Although the forest situation can be improved materially, it has at least two favorable features worthy of mention: the character of the forest stand and the diversity of markets for forest products.

Character of the Stand

Nearly two-thirds of the forest land is stocked with commercial saw-timber stands that average 5,500 board feet per acre. It is profitable to both timber-land owners and forest industries to have such large average volumes per acre on so much of the forest land. Increment is likewise high, averaging 163 board feet per acre for the entire forest. The second-growth uncut forest condition, which occupies about one-fourth of the forest, has an increment rate of nearly 300 board feet per acre. Furthermore, about half of the forest land is occupied by the loblolly pine-hardwoods type, the most important type from the standpoint of industrial supply and profitable forestry. Its sawlog-size stands have an average volume of 5,970 board feet per acre and the increment is as high as 380 board feet per acre in the second-growth uncut stands. Forest problems exist to be sure, but for most of the forest stand, they involve making better what is already reasonably good.

Markets

The location and diversity of markets for forest products favor timber production. The large consuming centers of the Northeast, including Philadelphia and New York, are within truck haul of this unit. Transportation costs are lower than for producing areas farther south, so that a larger margin is left for stumpage or manufacturer's profit. The furniture industry in the nearby Piedmont area of North Carolina provides a market for hardwood lumber as well as for hardwood furniture veneers and plywood. A market for pine cordwood is available at the two pulp mills in the unit, and at several pulp mills in Virginia. There is also a demand for hogsheads, boxes, crates, and baskets in which to market tobacco and truck crops. These varied markets provide a strong incentive for timber growing.

FOREST PROBLEMS AND REMEDIAL MEASURES

Under existing conditions of forest use the pine cubic-foot growing stock is decreasing in volume and the hardwood stand, while increasing, is building up a surplus of increment only in the less valuable species. Fire protection is lacking on one-third of the forest land, the growing stock is deficient in total volume and size-class distribution, and there are large areas of denuded pond pine land. These unfavorable aspects of the forest situation warrant more detailed comment.

Forest Fires

Forest fires are a serious deterrent to the attainment of increased forest production. The North Carolina Division of Forestry has most of the Western Coastal Plain counties under protection and forest fires are held within reasonable limits. Intensification of fire control is desirable in these counties but the greater need is for the extension of organized protection to the 10 unprotected counties in the Tidewater portion of the unit. Forests are of especial importance to the inhabitants of these counties, and in several of them fire has damaged the timber stands severely. The pond pine-hardwoods type has suffered particularly from fire, and it is safe to say that productive use of about one-fourth of the forest land in the unit depends primarily upon the control of fire in this type.

The present system of fire control is based upon the use of state and federal funds to provide state cooperation with the county governments in the form of county protective units, and with private individuals in the form of private protective associations. The State Division of Forestry has charge of all protection activities in both the county and private associations. In the period between 1921 and 1938 the non-federal forest land under organized protection in the State has been increased from 675,000 acres to 12 million acres. The burned area in the 1937-38 fiscal year was only 1.7 percent of the protected acreage. With this experience and efficiency the Division of Forestry can extend fire control to the 10 unprotected counties in this unit as fast as sufficient funds are obtained to finance the protective organization. These counties contain approximately 1.5 million acres of forest land. Intensive fire protection would cost about $65,000 per year, but protection equivalent to that in the remainder of the unit could be provided for about $25,000 per year.

Deficiency of Growing Stock

The growing stock is incomplete because it is deficient both in total volume and in size-class distribution. The pine types average less than half of full stocking (table 6) and the hardwood types are comparable. Growing-stock volume in the pond pine-hardwoods type is especially small. Another fault of the pine growing stock is the relative scarcity of the smallest diameter classes. In the total pine stand the ratio of 4-inch to 6-inch trees is 1.2 to 1.0, and in the 6- to 8-inch trees it is 1.3 to 1.0. Ratios in other survey units with a better distribution of small trees approximate 1.8 to 1.0 and 1.6 to 1.0, respectively.

It will be impossible to obtain full stocking on every forest acre. To the extent that it is possible, the forest will contribute that much more raw material for industry and employment for labor. Improvement in stocking depends upon the adoption of better forest practices by the individual land-owner. Forest fires should be controlled, open spaces in the stand should be restocked artificially or naturally with skillful handling of seed trees and soil, abandoned fields should be planted if natural restocking is not satisfactory, thinnings should be made at intervals to maintain fast growth and the cut should be restricted to less than the increment until the desired stocking is obtained. These measures would increase the proportion of young pines in the stand, but adequate restocking also should be assured by harvesting methods designed specifically to aid in re-establishing a forest cover.

Denuded Areas

The large areas of denuded pond pine land locally known as "lights" or "open land" are so extensive and unproductive that they influence the economy of whole counties. Dare County is affected most, but Hyde, Tyrrell, and Carteret Counties suffer from the presence of extensive acreages of these non-producing lands. The "open lands" are relatively inaccessible, except along the watercourses, and frequent fires burn unchecked in the heavy cover of brush. The soil is naturally poor and fires have further destroyed its fertility. Establishing a forest cover will be difficult and it is doubtful whether these areas should be considered potential commercial forest lands.

Any program designed to improve conditions upon these denuded lands must recognize their unsuitability for agricultural use. Timber or game production seem to offer the best possibilities. In either case complete fire control is the first step. Planting will be necessary on more than 100,000 acres to restock the area with timber. Before a large-scale planting program is decided upon, research is needed to determine possibilities, methods, species, and planting costs. Because of the expense and long-time nature of the project some form of public ownership may be necessary if restocking is considered beneficial to the public interest.

Developing the game resources of these lands appears to be a possible solution. A definite game propagation and exploitation program could be developed without exhorbitant expense and such a program would increase the revenue from the denuded lands. Deer and bear hunting in these unique coastal areas could become an important attraction especially when coordinated with the wild fowl hunting upon the Swanquarter and Mattamuskeet Wildlife Refuges in Hyde County.

Management of Pond Pine

Very little is known concerning the management of pond pine. Reliable information is needed in this unit, where the pond pine type occupies 22 percent of the forest land. Some of the pulp companies, larger lumber companies, and investment owners, holding thousands of acres of pond pine, wish to adopt management practices that will provide a greater and better quality yield of wood. At present they are not sure of the correct procedures.

The basic need is for scientific study of the many problems by competent men trained in technical forest research. Experimental plots should be established in the pond pine type so that methods can be worked out and checked under actual forest conditions. Woodland owners are now asking should pond pine pocosins be drained? -will light burning of the ground cover open fallen seed cones satisfactorily? -will the sun open cones that are on lopped and scattered tops? -must the top layer of the soil be burned off for the seedlings to survive? -and how can the open spaces in pond pine stands be restocked naturally? The field and demand for research in the management of pond pine extends all the way from soil treatment to the harvest cuttings in mature stands.

Utilization of Hardwoods

Two undesirable conditions result from present practices of hardwood utilization. Concentrating the cut upon old-growth timber of a few species has the effect of high-grading the timber stand both as to species and quality. It results in removing the best material much faster than it is being replaced. Greater immediate profits may accrue to the hardwood industries but such a policy will shorten their lives. Ways and means must be found to make profitable use of the lower-quality second-growth hardwoods. High-grade well-equipped hardwood dimension mills offer one solution. Such mills practice close utilization, manufacture their product with especially designed equipment to meet U. S. Bureau of Standards commercial specifications, use a variety of hardwood species, and produce a refined product that has a higher market value than lumber.

Partly because of the narrow range of hardwood utilization, there has developed a great quantity of black and tupelo gum not being utilized in proportion to its rate of increase. Sound trees of these species contain 10 million cords and cull trees contain over 3 million cords, a total volume of sound material that amounts to 18 percent of the cordwood volume in the unit. This immense volume of material should contribute more to the forest economy of the unit through increased use by industry. One of the pulp mills in the unit plans to use gum for a part of its requirements. The available supply justifies its use by other pulp mills that draw upon this territory. Lacking an expansion of use by existing mills, there is an opportunity for a new pulp mill that will use gum as raw material. Also, hardwood dimension mills can now utilize both black and tupelo gum because of improvements in kiln-drying and the development of higher speed machinery.

REVIEW OF THE REPORT

Forests constitute one of the major natural resources of this unit. They occupy three-fifths of the land, supply raw material to about 360 manufacturing plants and provide direct employment to about 9,000 workers. Forests are an important adjunct of many farms, providing domestic fuelwood, tobacco-curing wood, rough construction material, and forest products for sale. They also provide a means of returning to productive use the tobacco and cotton land occasionally abandoned. In certain parts of the unit the forest also shelters a considerable game population that is the basis for a small recreation industry.

About 4 million acres of forest land are distributed throughout the unit; 47 percent on rolling uplands or level lowlands, 30 percent in pocosins or swamps, and 23 percent in river bottoms. Loblolly pine is the most abundant species, making up nearly half of the total cubic-foot volume. Pine types occupy nearly 70 percent of the forest area but the less valuable pond pine-hardwood type is found on about one-third of the pine land. Eighty-three percent of the forest is second growth. About 63 percent of the forest land supports sawlog-size stands, 34 percent supports under-sawlog-size stands, and 3 percent is clear-cut. The total saw-timber volume is 14.3 billion board feet, about two-thirds pine and one-third hardwoods. There are 73.1 million standard cords of wood with bark or 4.9 billion cubic feet of wood only. Increment amounted to 649 million board feet, 2.0 million cords, or 137 million cubic feet. The average increment per acre was 163 board feet of saw timber or one-half a cord of all sound material.

Fully 360 forest industrial plants operated in 1937. These included 335 sawmills, 12 veneer mills, 7 cooperage plants, 2 pulp mills, 3 shingle mills, a mine prop plant and a handle plant. About one million cords of fuelwood, 372 million board feet of sawlogs, and 75 million feet of veneer and cooperage logs were cut, as well as smaller quantities of crossties, poles, pulpwood, mine props, shingles, export logs, and handle stock. The forest resource thus provided 3 million man-days of employment or full-time work to about 9,000 people. Commodity drain was 578 million board feet of saw timber or 130 million cubic feet of all sound material. The board-foot increment was greater than drain so the forest growing stock increased by 71 million board feet. The cubic-foot increment of pines was less than the drain but a surplus of increment in the hardwoods more than compensated for the deficit, so the forest as a whole increased by 7 million cubic feet.

Although the forest growing stock increased slightly in 1937, there was not enough surplus to justify a general expansion of the forest industries. A few plants to utilize low-grade hardwoods are needed now but other plants cannot be established upon a sound basis until the forest yields are increased. This can be accomplished by improving the present growing stock through more intensive fire control, education of landowners in forest management practices, restoration of denuded areas, research in management of pond pine, and improved methods of timber utilization. These measures should increase the forest yields in the unit as a whole by at least one-half, thus providing for a parallel increase in the forest industries. Because of its favored position in relation to markets this unit can well benefit from an intensified development of its forest resource.

GLOSSARY

General

Forest Survey Unit. -- The term "forest survey unit" denotes an area of 4 to 10 million acres in which topographic, forest, economic, and industrial conditions are reasonably homogeneous.

Land-use Classes

Productive forest area. -- Forest land having qualities essential for the growth of commercial timber.

Nonproductive forest area. -- Forest land lacking qualities essential for the growth of commercial timber.

Cropland, old and new. -- Land used for production of farm or orchard crops or evidently so used during the past 5 years. This includes new cropland, i.e., land converted from forest to cropland within 5 years prior to survey.

Pasture. -- Cleared or open land under fence used primarily for grazing.

Abandoned cropland. -- Land once cultivated but showing distinct evidence of having been abandoned for agricultural crop production.

Other non-forest. -- Areas included within the corporate limits and surburban or industrial sections of cities and communities; power, rail, and highway rights-of-way; marsh; and nonmeandered waterways.

Forest Types

Loblolly pine-hardwoods. -- Stands in which pines make up 25 percent or more of the dominant and codominant stems with loblolly pine predominating.

Pond pine-hardwoods. Stands in which pines make up 25 percent or more of the dominant and codominant stems with pond pine predominating.

Upland hardwoods. -- Stands in which mixed oaks and other hardwoods make up 75 percent or more of the dominant and codominant stems, usually found on the rolling upland sites.

Bottom-land hardwoods. -- Stands in which hardwoods make up 75 percent or more of the dominant and codominant stems, usually found in river bottoms and swamps.

Diameters

D.b.h. (diameter at breast height). -- Diameter, outside of bark, measured at $4\frac{1}{2}$ feet from the ground.

Diameter class. -- All trees were recorded in 2-inch diameter classes, including diameters 1.0 inch below and 0.9 above the stated midpoint, e.g., trees 7.0 to 8.9 inches d.b.h. are placed in the 8-inch class.

Tree Classification

Sound sawlog-size tree. -- A pine, cypress, or white cedar tree at least 9.0 inches d.b.h., or a hardwood tree at least 13.0 inches d.b.h., with not less than one sound butt log 12 feet long, or with 50 percent of the gross volume of the tree in sound saw timber.

Sound under-sawlog-size tree. -- Any tree over 1.0 inch d.b.h. and less than sawlog-size, with a reasonably straight sound stem.

Cull tree. -- Any tree that fails to qualify as a sound sawlog or under-sawlog-size tree because of form, limbiness, rot, or other defect.

Pole tree. -- Pine trees that will produce a pole conforming to specifications of the American Standards Association.

Forest Conditions

Sawlog Size

Old growth, uncut. -- Stands composed of trees having the characteristics of the original mature timber of the region and containing at least 1,000 board feet per acre of merchantable species in hardwood types, and 600 board feet per acre in pine types, with less than 10 percent of the volume cut.

Old growth, partly cut. -- Old-growth stands from which 10 percent or more of the volume has been cut, leaving a minimum of 1,000 board feet per acre in the hardwood types, or 600 board feet per acre in the pine types.

Second growth, uncut. -- Stands of second growth having at least 600 board feet per acre in trees of sawlog-size, and with less than 10 percent of the sawlog-size trees removed.

Second growth, partly cut. -- Stands of second growth from which 10 percent or more of the sawlog-size trees have been removed but with the remaining stand containing 600 or more board feet per acre.

Under Sawlog Size

Second growth. -- Young second-growth stands in which the volume of timber in trees of sawlog size is less than 600 board feet per acre and the remainder of the trees are below sawlog size.

Reproduction. -- Stands too young to classify as second growth having at least 80 well distributed seedlings per acre.

Clear-cut. -- Cut-over areas having insufficient young growth to qualify either as second growth or reproduction.

Volume Estimates

Board-foot volume. -- Only the saw-timber portion of sawlog-size trees are included in this estimate. Top diameters vary with the limits of usable material. Deductions are made for woods cull and for loss in sawing at the mill.

Cordwood volume. -- This volume (including bark) is derived from the following sources:

1. The sawlog portion of sawlog-size trees.

2. The portion of saw-timber trees not usable as sawlogs but acceptable as cordwood. This includes the upper stems of pine and cedar and, unless otherwise noted, the upper stems and limbs of hardwoods and cypress. The minimum diameter limit is 4.0 inches outside bark.

3. The full stem of sound under-sawlog-size trees, at least 5.0 inches d.b.h., to a variable top diameter not less than 4.0 inches outside bark.

4. The estimated sound material in cull trees.

Deductions for cull include only the volume in defects which cause the material to be unsuited for cordwood. Sweep and slight crook are not regarded as defects.

Cubic-foot volume. -- This volume is derived from the same sources as the cordwood volume except that bark is not included.

Standard cord. -- A stacked pile of round or split wood bolts measuring 4' x 4' x 8' and estimated to contain 90 cubic feet of wood and bark in the pine, cedar, and cypress species, and 80 cubic feet of wood and bark in the hardwood species.

Increment

Growing stock. -- The sum of the volumes of all sound trees 5.0 inches d.b.h. and larger; dead and cull trees and tops of hardwood and cypress not included.

Board-foot increment. -- Includes the net growth on the saw-timber portion of sawlog-size trees, plus the volume in sound trees reaching sawlog-size.

Cordwood increment. -- Includes the net growth on the sound stemwood of pines and cedar 5.0 inches d.b.h. and over, on under sawlog-size hardwoods and cypress, and on the sawlog portion of sawlog-size hardwoods and cypress, plus the sound-tree volume of all species reaching 5.0 inches d.b.h. during the increment period.

Cubic-foot increment. -- Omits bark volumes, otherwise material is identical with cordwood.

Mortality

Mortality. -- The volume lost from the growing stock of the forest through the death of individual trees. Natural causes of mortality include lightning, tree competition, old age, disease, insects, drought, and wind. Fire is the major man-caused source of mortality.