FOREST RESOURCES

OF THE

NORRIS DAM WATERSHED

by the

SOUTHERN FOREST SURVEY

SOUTHERN FOREST EXPERIMENT STATION

NEW ORLEANS, LA.

Unit Report 1

July 15, 1936

FOREST RESOURCES

of the

NORRIS DAM WATERSHED

by the

SOUTHERN FOREST SURVEY

I. F. Eldredge, Regional Survey Director

Staff Assignment

Preparation of Report
A. R. Spillers, Associate Forest Economist

In charge of Field Work
V. B. Davis, Associate Forest Economist

In charge of Computations
P. R. Wheeler, Associate Forest Economist

The Southern Forest Survey is an activity of the

SOUTHERN FOREST EXPERIMENT STATION
NEW ORLEANS, LA.

E. L. Demmon, Director

FOREWORD

Early in 1934 the Tennessee Valley Authority requested the Forest Service to make a survey of the Norris Dam Watershed, in order to provide information basic to the formulation of principles, policies, and plans for land use, forest management, and industrial development of the Tennessee River Valley tributary to the dam. This survey, which is also a part of the nationwide economic study of our forest resources authorized by the McSweeney-McNary Forest Research Act of 1928, is under the direction of the U. S. Forest Service[1] of the Department of Agriculture and has the following five objects: (1) to make an inventory of the present supply of timber and other forest products; (2) to ascertain the rate at which this supply is being increased through growth; (3) to determine the rate at which this supply is being diminished through industrial and local use, windfall, fire, and disease; (4) to determine the present requirement and the probable future requirement for timber and other forest products; and (5) to correlate these findings with each other and with existing and anticipated economic conditions, in order to provide a basis for the formulation of regional and national policies consistent with the most effective use of land suitable for forest production.

In the survey of the Norris Dam Watershed, three crews of three men each, directed by a supervisor, carried on the field work of the forest inventory. A line-plot system of survey was used. Parallel lines five miles apart were run North 20° West and South 20° East, which is generally at right angles to the direction of the drainage. Every one-eighth mile along the lines the crews established a one-quarter acre sample plot. For each plot they recorded the class of present land use, percent of slope, exposure, and degree of erosion. On forest plots the crews recorded the forest type, forest condition, fire damage, density and distribution of reproduction, and forest site quality; and they also tallied the trees by species and diameter classes. Increment borings were made to determine age and growth of the timber during the past ten years. These data furnished the basis for the statistics of area, volume, and growth presented in this progress report.

In the presentation of these survey data, it is to be noted that, owing to the sampling method used in collecting them, usually the greater the area or volume in any given classification the more accurate are the data for that classification. Classes that are of infrequent occurrence and relatively small in quantity generally cannot be determined with as high a degree of accuracy as is obtainable for classes that occur more frequently and in substantially greater quantities. Small tabular figures are to be taken as showing, not the exact magnitude of the classes involved, but their relative magnitude in comparison with that of other classes.

The Forestry Division of the Tennessee Valley Authority furnished the major part of the information concerning forest industries, and the data used in calculating the industrial drain against the growing stock. The 1930 Census reports were relied upon for a considerable amount of the information used in the description of the farm and population situation in the Watershed.

---

[1] In the South the Forest Survey functions as an activity of the Southern Forest Experiment Station, with headquarters at New Orleans, La.

FOREST RESOURCES OF THE NORRIS DAM WATERSHED

TABLE OF CONTENTS

	Page
Foreword	3
Survey findings in brief	9
Description of area	11
Topography	11
Climate	11
Soil	12
Transportation	15
History and population	15
Occupations	16
Land ownership	16
Land use	17
Erosion	19
Forest description	23
Forest conditions	23
Forest types	23
Forest sites	25
Size distribution	26
Quality	28
Reproduction	29
Fire damage	29
Fungi damage	30
Damage due to other causes	30
Sawtimber	31
Volume	31
Quality	33
Cordwood	35
Volume	35
Pulpwood	35
Distillation wood	36
Tannic acid materials	36
Fence posts	36
Bobbin and shuttle material	37
Fuelwood	37
Cubic foot contents	39
Volume	39
Deductions for cull	40

Page

Growth and yield 43
Sawtimber growth 43
Cordwood growth 44
Cubic-foot growth 44

Forest industries 46
Lumber 46
Stave and heading stock 47
Railroad ties 47
Hewn mine timbers 47
Poles 47
Fence posts 47
Hand-rived shingles 47
Pulpwood 48
Tannic acid extraction 48
Distillation wood 48

Forest drain 51
Lumber 52
Stave and heading stock 53
Railroad ties 53
Hewn mine timbers 53
Poles 53
Fence posts 54
Tobacco sticks 54
Hand-rived shingles 54
Pulpwood 54
Tannic acid wood 55
Distillation wood 55
Fuelwood 55
Drain from chestnut 55

Comparison of growth and drain 56

Measures to improve the situation 58
Rehabilitation of the growing stock 58
Forestry extension work 60
Increased fire protection 60
Development of market for all forest products 60

Glossary of terms used 62
Map

LIST OF TABLES

Table number	Title	Page
1	Size classification of large ownerships	17
2	Total area classified according to land use	17
3	Forest and agricultural area classified accrding to land use and slope	18
4	Correlation of land use and degree of slope with erosion	20
5	Forest area classified according to forest condition and forest type	24
6	Hardwood and pine-hardwood forest area classified according to forest condition and site quality	26
7	Percentage distribution of trees by diameter and quality classes in the hardwood type	28
8	Net board-foot volume (Scribner) in the various species groups and in the various forest conditions	32
9	Cordwood volume in material not suited for sawtimber in live trees	38
10	Sound stemwood (bark not included) in live trees of different quality classes under various forest conditions	39
11	Sound stemwood in live sound trees in the various forest conditions and species groups	41
12	Growth per annum in board feet, Scribner log rule, of the present forest stands	43
13	Volume growth in cubic feet, bark not included	45
14	Volume of wood products in 1934	51
15	Lumber production by species groups in 1934	52

LIST OF FIGURES

Figure number	Title	Page
1	Small fields on lower slopes and patches of timber on upper slopes, characteristic of the Watershed	13
2	Thrifty, second growth stands of hardwood trees	13
3	Relation of slope to land use	19
4	An abandoned field on a steep slope ruined by gullies	21
5	Forest area classified according to forest condition..	25
6	Average number of trees per acre in the hardwood type	27
7	Forest area classified according to volume of sawtimber per acre	33
8	Board-foot volume of individual species groups in the various log or tree grades	34
9	Sound stemwood in live trees, bark not included	42
10	Old-growth timber stand, partly cut over	49
11	Mine timbers and ties ready for loading on mine cars	49
12	Approximate net annual growth and drain of live sound trees other than weed species and chestnut	57
13	Desirable basal area per acre for a managed stand	59
14	Present basal area per acre of the established stands	59

SURVEY FINDINGS IN BRIEF

1. - Forests, comprised chiefly of oaks, yellow poplar, chestnut, hickories, and shortleaf pine, occupy 885,800 acres, or 47 percent of the total area of the Watershed. Eighty-six percent of the forest is hardwood type, and sites are generally only fair. A century of cutting has removed practically all of the old-growth timber of high quality, and some form of second growth is found on over three-fourths of the forest area.

2. - The stands contain a high percentage of defective and unmerchantable trees. The average number of trees per acre is considerably below the productive capacity of the site, and the number of the larger trees in the stands has been reduced considerably below a desirable proportion.

3. - In all living trees there is a net volume of 1,868,440,000 board feet[1] of sawtimber quality material; and 3,878,300 cords of wood not suited for sawtimber. The total volume of merchantable sawtimber and non-sawtimber is 643,230,000 cubic feet. The average forest acre has only about 700 cubic feet.

4. - On the growing stock (culls, weed trees, and chestnut excluded) there is an annual growth of about 49 million board feet plus 108,000 cords of material in trees remaining below sawlog size. The annual growth of merchantable sawtimber and non-sawtimber is 16 million cubic feet; on the average forest acre it is only 18 cubic feet per annum.

5. - In 1934 the various forest industries cut 45 million board feet from the sawtimber trees, or approximately 12 million cubic feet from both sawlog-size and small trees, of the growing stock. Although the present drain is less than the growth, the cut should be kept low until the stocking of sound trees, especially the large trees can be developed. After 10 years of good forest management, involving fire protection, elimination of weed trees and culls, and the building up of the growing stock, the annual increment might be increased as much as 50 percent in volume.

6. - The forest is playing an important part in protecting this valuable watershed from erosion. Although two-thirds of the forest area is on the steep slopes, only 7 percent shows marked erosion; while some form of marked erosion is found on 24 percent of the cropland, on 28 percent of the idle and abandoned land, and on 23 percent of the pasture.

7. - After agriculture and coal mining, forest industries rank next as a source of employment. Lumber, fuelwood, railroad ties, mine timbers, posts, pulpwood, tannic acid wood, and staves and heading are the principal products.

---

[1] Conversion according to International 1/4 inch log rule, which closely approximates lumber tally.

DESCRIPTION OF AREA

Norris Dam Watershed is a small but significant part of the Tennessee River Basin. It is the center of many important activities of the Tennessee Valley Authority in its plans for the development of the Valley as a whole. Approximately 175 miles in length and 17 miles in width, it contains the drainage basin above Norris Dam of Clinch River and its chief tributary, the Powell. It includes all or parts of Anderson, Campbell, Claiborne, Grainger, Hawkins, Hancock, and Union Counties in eastern Tennessee; and Dickenson, Lee, Russell, Scott, Tazewell, and Wise Counties in southwestern Virginia. According to the U. S. War Department, its area is 2,949 square miles, or 1,887,400 acres, 35,000 of which is to be flooded by Norris Lake (see map).

The boundaries of the Watershed are defined by clear-cut topographic features. Along the northwestern side the boundary roughly follows the southeastern edge of the Cumberland Plateau and the divide between the headwaters of the Clinch and New Rivers and coincides with the Virginia-Kentucky State line for most of its length. On the southeast side it follows for the most part the ridge of Clinch Mountain. Norris Dam, at the southwestern end of the area is about 25 miles northwest of Knoxville, Tennessee.

TOPOGRAPHY

The area as a whole slopes southwesterly. Elevations at the head of the valley in central Tazewell County, Virginia, vary from 2,500 to 4,700 feet above sea level. At the lower end of the region they vary from about 1,000 feet at Norris Lake to 3,400 feet in the nearby mountains.

The survey shows that of the 1,802,300 acres in forest and agriculture, 878,000 acres are on slopes with gradients of 30 percent or more and that 588,300 acres are on slopes with 16 to 30 percent gradients. Only 336,000 acres, or about one-fifth, are on slopes with less than a 16 percent gradient. While steep slopes are found on the ridges throughout the area, the roughest topography is located along the escarpment of the Cumberland Plateau.

Owing to the hilly to mountainous topography, and to the porosity of the soil and underlying rock formation, the rivers and underground channels furnish adequate drainage in all parts of the region. The Clinch and Powell Rivers, which converge seven miles above Norris Dam, have cut fairly deep channels and are bordered along much of their courses by steep slopes or cliffs. The alluvial plains that border the rivers are narrow and are often interrupted by bluffs that jut out to the river's edge. Norris Lake, when completely filled, will extend up Clinch and Powell Rivers for 40 miles, airline, from the Dam. It will cover about 35,000 acres, or about 2 percent of the entire area.

CLIMATE

Both temperature and rainfall are favorable for the establishment and rapid growth of valuable forest species.

The mean annual temperature is about 54° F.; for the warmest months, June, July, and August, it is about 71° F.; and for the coldest months, December,

January, and February, about 35° F. Periods of below zero weather are infrequent and never protracted. Frosts seldom occur after May 1st or before October 1st.

The average annual rainfall is about 48 inches, equaling that in the Atlantic Coastal Plain to the eastward, but 5 to 15 inches less than in the Central Gulf States. Precipitation is generally well distributed throughout the year, but September, October, and November, the three dryest months, have an average of only about 3 inches each. The heaviest rainfalls usually occur in the summer months, often in torrential downpours, and summer droughts are rare. The average annual snowfall is about 14 inches. Severe sleet storms occasionally do serious forest damage through the breakage of trunks and branches, but such storms ordinarily occur only once in fifteen or twenty years. Weather conditions are favorable for the planting of trees in November, December, February, March and the first half of April.

The prevailing winds are from the west and southwest, with an average wind movement of about 7 miles per hour. Severe wind storms are practically unknown. Lightning storms seldom cause forest fires, since they are usually accompanied by heavy rains.

SOIL

Accurate soil surveys have been made for only a small fraction of the region, but the Bureau of Chemistry and Soils[1] classifies the soils into four broad groups: Hagerstown, Clarksville, and Muskingum soils, and Rough and Stony Land.

The Hagerstown soils, of limestone derivation, are usually reddish-brown and very fertile; they occupy about 30 percent of the area and are most prevalent in the northeastern half. The Clarksville soils, also of limestone derivation, are found mainly in the southwestern half, are usually greyish or yellowish-brown, and contain angular fragments of chert rock. Because they are generally so rocky and occupy rather steep slopes, they are ordinarily better suited to forests than to cultivated crops; they occupy about 30 percent of the area. The Muskingum soils, derived from sandstone and shales, are greyish-brown, and are sandy, shallow, and poorly developed---ordinarily of low value for agriculture. They occupy about 30 percent of the area, usually steep slopes, and are subject to severe erosion. On the Rough and Stony Land, which covers about 10 percent of the area, the soils resemble the Muskingum but are even shallower and have more numerous out-crops of bedrock. They are generally unsuited for cultivation and are largely forested.

The most highly prized agricultural lands are the narrow strips of alluvial soil along the streams. In the mountainous areas deep and fertile soils are usually found in the coves and benches. Generally speaking, both forests and fields are found on all soils, and land utilization is influenced by the gradient of terrain as well as by the quality of soil.

---

[1] Atlas of American Agriculture, part III, Soils of the United States, Bureau of Chemistry and Soils, 1935.

FIGURE 1. - SMALL FIELDS ON LOWER SLOPES AND PATCHES OF TIMBER ON UPPER SLOPES, CHARACTERISTIC OF THE WATERSHED

FIGURE 2. - THRIFTY, SECOND-GROWTH STAND OF HARDWOOD TREES

TRANSPORTATION

Although transportation by automobile and truck has increased rapidly in recent years, railroads continue to handle the bulk of the in-coming and out-going freight, particularly in the northwestern part of the region where the coal fields are located. The Louisville and Nashville, the Southern, the Norfolk and Western, the Clinchfield Railway Lines, and a few minor railroads, serve the area.

There are about 400 miles of hard-surfaced highways, found mostly in the valleys, connecting the unit with such nearby marketing centers as Knoxville, Morristown, Kingsport, and Bristol, Tennessee; Middlesboro, Kentucky; Bluefield, West Virginia; and Abingdon, Virginia. Some of the roads are of recent construction and are modern in all respects, but many are poorly surfaced and are relatively narrow with sharp curves and steep grades. Secondary and tertiary roads extend into the hills and coves. The secondary roads are gravelled and graded but often narrow and crooked. Only 12 percent of the farms are located on hard-surfaced roads, and only 11 percent on gravelled roads (according to U. S. Census, 1930); the vast majority of the rural population, therefore, is primarily dependent upon dirt roads of primitive character, many impassible to automobiles. Communities in hollows but a short airline distance from highways, railroads, and rivers, are often partially isolated because of the absence of passable roads.

At present very little shipping is done by water, but when Norris Dam is completed and the lake formed, it is expected that water transportation will be developed for forest products and other non-perishable commodities.

The Tennessee Valley Authority makes the following statement regarding the possibilities of Clinch River: "The Watts Bar project of the TVA on the Tennessee River will extend nine-foot navigation up the Clinch River about twenty-five miles above its mouth. While no further navigation development is recommended by the Authority, navigation could be extended from that point to Norris Dam, a distance of fifty-five miles, by the construction of two dams with single-lift locks. With the Clinch River navigable, Norris Lake could then be connected with the principal river transport routes by means of transfer facilities at the Dam."[1]

HISTORY AND POPULATION

Settlement of the region was begun about 1750 by Scotch and Irish hunters and trappers from eastern Virginia and North Carolina. Owing to the rugged mountain barriers, however, and the hostility of the Indians, the growth of the population was slow. By 1850, when several turnpikes were constructed, the population was approximately 60,000 mostly white and rural. Contact with the Coastal cities was strengthened by the completion, in 1852, of the Virginia and Tennessee Railroad, with railhead at Wytheville, Virginia, 40 miles northeast of the area. The coming of railroads into the region about 1890 stimulated both coal mining and lumber production. Prior to this, both industries had been active, but only on a small scale. Coal had been mined for use in local

[1] The Unified development of the Tennessee River System, Tennessee Valley Authority, March, 1936.

iron furnaces; and choice walnut, cherry, and poplar logs had been either hauled by wagon to Abingdon, Virginia, or rafted down the river to Clinton, Kingston, and Chattanooga, Tennessee. Today coal mining is outranked in importance only by agriculture. The peak of lumbering activity was reached around 1900; the heavy cutting that took place then has since been followed by a decline as the old-growth stands were depleted.

In 1900, according to the U. S. Census, the population in the Norris Dam Watershed was approximately 143,000; in 1930, it was about 188,000, i.e., 64 persons per square mile. Only three percent were negroes, and less than one percent foreign born; the descendants of the early settlers still predominate. In 1930 only 7 percent of the people lived in the four towns with a population of 2,500 or more (LaFollette, Tennessee; and Appalachia, Big Stone Gap, and Norton, Virginia); 51 percent of the people were classed as rural farm residents, and 42 percent were rural non-farm.

The establishment of the Tennessee Valley Authority in 1933 inaugurated a new chapter in this region's history. Broad economic and social development plans have been initiated. Norris Dam is an important unit in a system of dams to be constructed for coordinated purposes of flood control, navigation, and power development. As an outstanding source of raw materials for new and old industries, and as a means of increasing opportunity for gainful employment, the forest resources of the Watershed have an important part to play in the development of the area.

OCCUPATIONS

Approximately two-thirds of the land is in farm ownership, mostly small farms operated by their owners. In 1930, according to the Census, 48 percent of the people gainfully employed received their main income from farming. General crops such as corn, tobacco, hay, apples, peaches, cattle, and hogs are raised. In 1929, 46 percent of the cropland harvested was planted to corn and 30 percent to hay. Tobacco is confined to a small area but ranks high as a cash crop.

A considerable part of the farm labor is available for part-time forest work, and a material part of the farm cash income is so derived. The forest industries, which rank third as a source of employment and income, are treated in detail later in this report.

Coal mining is the principal industrial activity. It gives full or part-time employment to about 12,000 people, or 22 percent of the gainfully employed, and provides by far the greatest share or railroad freight tonnage. In 1930 an iron mine and smelter were active, and in addition several stone quarries were furnishing marble, building stone, road-material, and limestone fertilizer.

LAND OWNERSHIP

Small ownerships are typical of the Norris Dam Watershed. In 1930, according to the Census, the size of the average farm was 71 acres, with 49 acres cleared for cultivation or pasture; and 74 percent were operated by their owners.

A study made by the Tennessee Valley Authority in 1934 showed that there were only 77 ownerships in the watershed that exceeded 500 acres each. They constituted about 22 percent of the total area of the unit. Most of the tracts of over 1,000 acres are owned by coal companies. These large ownerships are classified according to size in table 1.

TABLE 1. - *Size classification of large ownerships*

Size of ownerships	Number of ownerships	Total area	Average area per property
acres		*acres*	
501 - 1,000	31	22,567	728
1,001 - 2,000	19	26,958	1,419
2,001 - 3,000	4	11,369	2,842
3,001 - 5,000	9	35,756	3,973
5,001 - 10,000	8	68,648	8,581
10,001 - 20,000	3	44,910	14,970
20,001 - and up	3	200,640	66,880

LAND USE

As shown in table 2, of the total area 47 percent is occupied by forests in some stage of development. Agricultural uses account for 49 percent, while towns, roads, railroads, and waterways occupy 4 percent. Of the 916,500 acres in the agricultural classification only 440,600 are being cultivated, while 36,100 acres have not been cultivated for two years or more, 20,800 acres show definite evidence of having been abandoned for agricultural use, and 419,000 acres are in improved pasture.

TABLE 2. - *Total area classified according to land use* [1]

Land use	Area in acres		Percent of total area
Forest		885,800	46.9
Agricultural:			
In cultivation:			
Old cropland	416,500	22.1	
Newly cleared cropland	24,100	1.3	
Out of cultivation:			
Idle	36,100	1.9	
Abandoned	20,800	1.1	
Improved pasture	419,000	22.2	
Total agricultural		916,500	48.6
Other:			
Roads, railroads, towns, and waterways including area to be flooded by Norris Lake		85,100	4.5
Total		1,887,400	100.0

[1] See glossary for definitions.

In table 3 the area of forest and agricultural land is classified according to its relative steepness of slope. As is to be expected, four-fifths of the old cropland is on either gentle or moderate slopes. These were the first areas to be cleared. Today practically all of the land suited for agriculture has been cleared, as well as much that is too steep or too poor and rocky. The figures on newly cleared cropland in table 3 indicate that three-fifths of the land currently being cleared is on steep slopes. That abandonment for agriculture takes place most extensively on steep slopes is indicated by the fact that there is over twice as much pasture and idle and abandoned farmland on the steep slopes as on the gentle. Use of land for pasture has generally followed use for cultivated crops.

The common farming practice is to allow the land to pass through a cycle of use-stages, starting with the natural forest. Forested areas are cleared and cultivated or pastured until erosion becomes serious. The fields are then abandoned and in time reforest naturally. Until a grass or tree growth is established, erosion continues after cultivation is abandoned unless check dams or other artificial run-off control is resorted to.

TABLE 3. - *Forest and agricultural area classified according to land use and slope* [1]

Land use [2]	Land slope			Total
	Gentle (0 - 15%)	Moderate (16 - 30%)	Steep (over 30%)	
	Area in acres			
Forest	71,400	237,300	577,100	885,800
Agricultural:				
Old cropland	162,200	168,000	86,300	416,500
Newly cleared cropland	3,300	6,700	14,100	24,100
Idle	5,800	13,700	16,600	36,100
Abandoned	2,100	8,700	10,000	20,800
Pasture	91,200	153,900	173,900	419,000
Total	336,000	588,300	878,000	1,802,300
Percent of total	18.7	32.6	48.7	100.0

[1] Total area in the unit, exclusive of roads, railroads, towns, waterways, and the area to be flooded by Norris Lake.

[2] See glossary for definitions.

Figure 3 shows graphically the influence of slope on land use. It shows for each slope class the proportion of land that is still forested and the proportion in agricultural uses. Only 21 percent of the gentle slopes are forested. Half of the gentle slopes, 30 percent of the moderate slopes, and 11 percent of the steep slopes are now in cultivation.

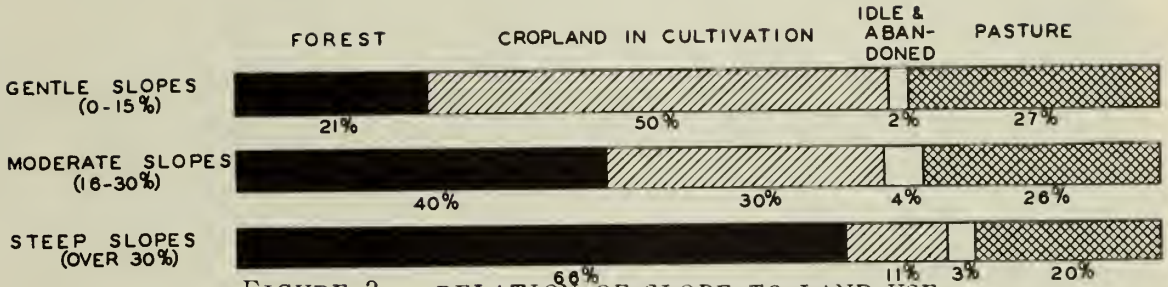

FIGURE 3. - RELATION OF SLOPE TO LAND USE

EROSION

It is recognized that soil erosion in some form and to some degree is occurring almost everywhere in the Watershed, but this report is concerned only with the well-marked and destructive stages. In the field classification the following forms of erosion were recognized; (1) sheet erosion, where the soil is washing off from a generally smooth surface; (2) shoestring erosion, where the soil surface is cut into, and a system of small, branching gullies from a few inches to not over 2 feet deep is formed; (3) gully erosion, where the soil surface is being destroyed by deep gully systems. Table 4 presents existing interrelationships between erosion, class of land use, and degree of slope. Marked erosion, in one or more of the three forms, is found on 24 percent of the cropland, 28 percent of the idle and abandoned land, 23 percent of the pasture, but on only 7 percent of the forest land, even though the forest is found mainly on the steeper slopes where excessive erosion might be expected.

Of the three different types of marked erosion, the gully form represents the most advanced stage. Obviously, gullies are found oftener upon the idle and abandoned land than upon any other class. About 11 percent of all the idle and abandoned land has gullies, as compared to about 4 percent of the pasture, 1 percent of the cropland, and 1 percent of the forest land. The reason why cropland in cultivation shows such a small proportional area affected by gullies is probably because it is abandoned about as soon as gullies are formed.

On land under forest cover, degree of slope apparently has no marked effect on erosion; the steep slopes show even less erosion than do the gentle slopes. Agricultural land areas present a different picture; on the gentle slopes 15 percent of the cultivated land and 5 percent of the idle and abandoned land show marked erosion, but on the steep slopes 31 percent of the cultivated land and 36 percent of the idle and abandoned land show marked erosion. The conclusion may be drawn safely that the cultivation of fields on the steeper slopes seriously increases the extent of erosion and run-off.

TABLE 4. - *Correlation of land use and degree of slope with erosion*

Land use	Degree of erosion	Land slope						Total	Percent of each land-use class
		Gentle (0-15%)		Moderate (16-30%)		Steep (over 30%)			
		Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
Forest	Sheet erosion	3,700	5.2	7,100	3.0	32,800	5.7	43,600	4.9
	Shoestring erosion	1,300	1.8	2,900	1.2	3,700	.6	7,900	.9
	Gullies	1,200	1.7	3,700	1.6	5,800	1.0	10,700	1.2
	Total active erosion	6,200	8.7	13,700	5.8	42,300	7.3	62,200	7.0
	None or erosion arrested	65,200	91.3	223,600	94.2	534,800	92.7	823,600	93.0
	Total	71,400	100.0	237,300	100.0	577,100	100.0	885,800	100.0
Cropland in cultivation	Sheet erosion	17,500	10.6	38,200	21.8	27,800	27.7	83,500	18.9
	Shoestring erosion	5,400	3.3	8,300	4.8	2,500	2.5	16,200	3.7
	Gullies	1,200	.7	3,800	2.2	1,200	1.2	6,200	1.4
	Total active erosion	24,100	14.6	50,300	28.8	31,500	31.4	105,900	24.0
	None or erosion arrested	141,400	85.4	124,400	71.2	68,900	68.6	334,700	76.0
	Total	165,500	100.0	174,700	100.0	100,400	100.0	440,600	100.0
Idle and abandoned cropland	Total active erosion	400	5.1	5,800	25.9	9,600	36.1	15,800	27.8
	None or erosion arrested	7,500	94.9	16,600	74.1	17,000	63.9	41,100	72.2
	Total	7,900	100.0	22,400	100.0	26,600	100.0	56,900	100.0
Pasture	Sheet erosion	8,200	9.0	20,700	13.5	35,800	20.6	64,700	15.4
	Shoestring erosion	2,500	2.7	7,400	4.8	5,400	3.1	15,300	3.7
	Gullies	2,900	3.2	8,000	5.2	4,500	2.6	15,400	3.7
	Total active erosion	13,600	14.9	36,100	23.5	45,700	26.3	95,400	22.8
	None or erosion arrested	77,600	85.1	117,800	76.5	128,200	73.7	323,600	77.2
	Total	91,200	100.0	153,900	100.0	173,900	100.0	419,000	100.0

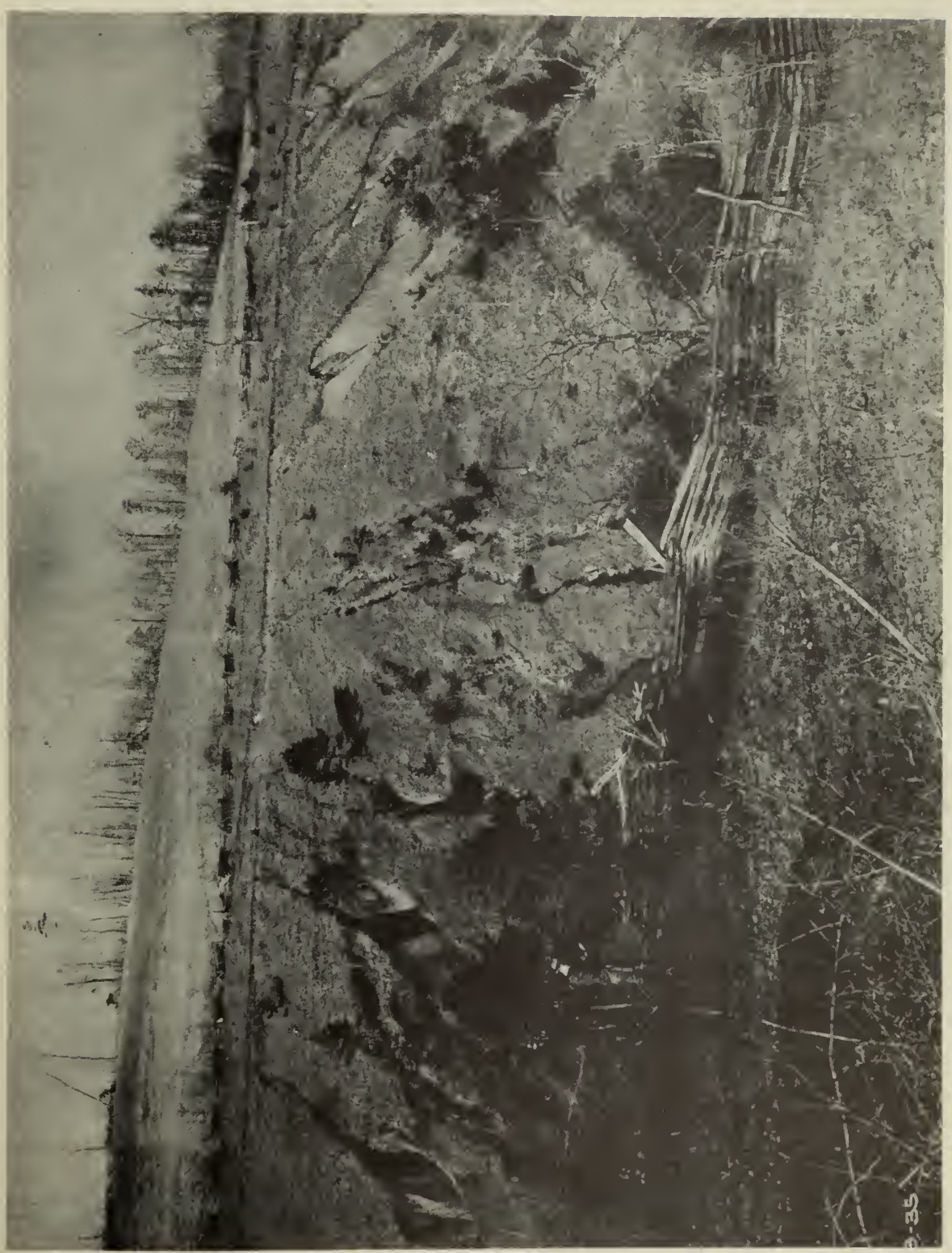

FIGURE 4. - AN ABANDONED FIELD ON A STEEP SLOPE RUINED BY GULLIES
(Photograph taken by Forestry Division of the T.V.A.)

FOREST DESCRIPTION

In the forests of this area the chief species are hardwoods of the oak-chestnut-yellow poplar association so prevalent in the Southern Appalachian Region. Hemlock occurs with the hardwoods to a limited extent in coves. Shortleaf, pitch, and Virginia pines, either in pure stands or mixed with hardwoods, are found on a small percentage of the area. White pine seldom occurs. Red cedar occurs on the limestone soils, either as an understory in hardwood stands or as pure stands in old fields and where rock outcrops are frequent.

For descriptive purposes the forest area has been classified according to: (a) forest conditions, on the basis of volume, age, and cutting history; (b) forest types, on the basis of association of tree species; and (c) forest sites, on the basis of timber producing capacity.

FOREST CONDITIONS [1]

As shown in table 5, page 24, and graphically in figure 5 on page 25, uncut, old-growth timber occupies only 22,400 acres or 2.5 percent of the 885,800 acres of forest land. It exists mostly in small isolated patches, either in farm woodlots or in areas where logging would have been very difficult and expensive. Practically all of the old growth is hardwood.

Second-growth stands are characteristic of the forest. They have been divided into sawlog-size, under-sawlog-size, and reproduction, on the basis of the breast-height diameter of the predominating trees. Such stands are found in all forest types throughout the Watershed in both large and small tracts. Uncut, sawlog-size stands occupy 22 percent of the forest area; partly-cut, sawlog-size stands, 13 percent; uncut, under-sawlog-size stands, 33 percent; and partly-cut, under-sawlog-size stands, 3 percent. The large area of uncut, under-sawlog-size stands is significant.

Reproduction, clear-cut, and non-commodity areas together occupy 8 percent of the forest land, practically all of it being reproduction. In the reproduction area, seedlings or sprouts less than one inch in diameter at breast height occur at the rate of more than 80 per acre; since such stands are usually in the process of being filled in, as a rule this minimum is greatly exceeded by the time they reach the under-sawlog-size, second-growth condition. On the clear-cut area, the number of seedlings or sprouts found is too small to permit classification as reproduction. The non-commodity area is covered either with natural brush or forest species that do not make commerical timber.

FOREST TYPES [1]

As indicated in table 5, page 24, the hardwood type is by far the most significant. It covers 86 percent of the forest area, being found upon almost every type of soil, slope, and aspect. It is composed of a general mixture of the Appalachian hardwood species, chief among which are yellow poplar,

[1] See glossary for definitions of terms.

chestnut, chestnut oak, the hickories, black oak, forked-leaf white oak, scarlet oak, and northern red oak. The more valuable species in this type are forked-leaf white oak, northern red oak, and yellow poplar.

The pine-hardwood type, a mixture of shortleaf, pitch, and Virginia pines, with hardwoods characteristic of the hardwood type, covers only 5 percent of the forest area. It is most prevalent in the southwest end of the Watershed.

The pine type, an almost pure stand of shortleaf, pitch, or Virginia pines, in mixture or separately, covers only 4 percent of the forest area. It occurs generally in the southwest end of the area, usually in small tracts, either on the dry soils of the ridges and hills or on abandoned fields.

The cedar type, with red cedar either pure or mixed with pine or hardwoods, occupies about 5 percent of the forest area. It is usually confined to the limestone soils of the valleys and lower slopes, frequently restocking old fields.

TABLE 5. - *Forest area classified according to forest condition and forest type*

Forest condition	Forest type				Total	Proportion of total forest area
	Hardwood	Pine-hardwood	Pine	Cedar		
	Area in acres					*Percent*
Old growth:						
Uncut	21,200	(1)	(1)	------	22,400	2.5
Partly-cut	156,900	5,400	6,200	------	168,500	19.0
Total old growth	178,100	6,200	6,600	------	190,900	21.5
Second growth:						
Sawlog-size:						
Uncut	170,100	15,400	8,300	------	193,800	21.9
Partly-cut	87,100	7,800	4,600	15,400	114,900	13.0
Under-sawlog-size:						
Uncut	249,300	15,400	14,500	14,900	294,100	33.2
Partly-cut	23,200	(1)	1,300	------	24,900	2.8
Reproduction [2]	51,900	2,500	3,300	9,500	67,200	7.6
Total second growth	581,600	41,500	32,000	39,800	694,900	78.5
Total all conditions	759,700	47,700	38,600	39,800	885,800	100.0
Percent of total	85.7	5.4	4.4	4.5	100.0	

[1] Since the areas in these classifications are small and may show considerable error because of the sampling method used in the survey, they are carried only in the totals.

[2] Includes 2,500 acres in clear-cut and non-commodity conditions.

In Figure 5, the forest area in the uncut, partly-cut, and reproduction conditions in old-growth and second-growth stands are shown graphically.

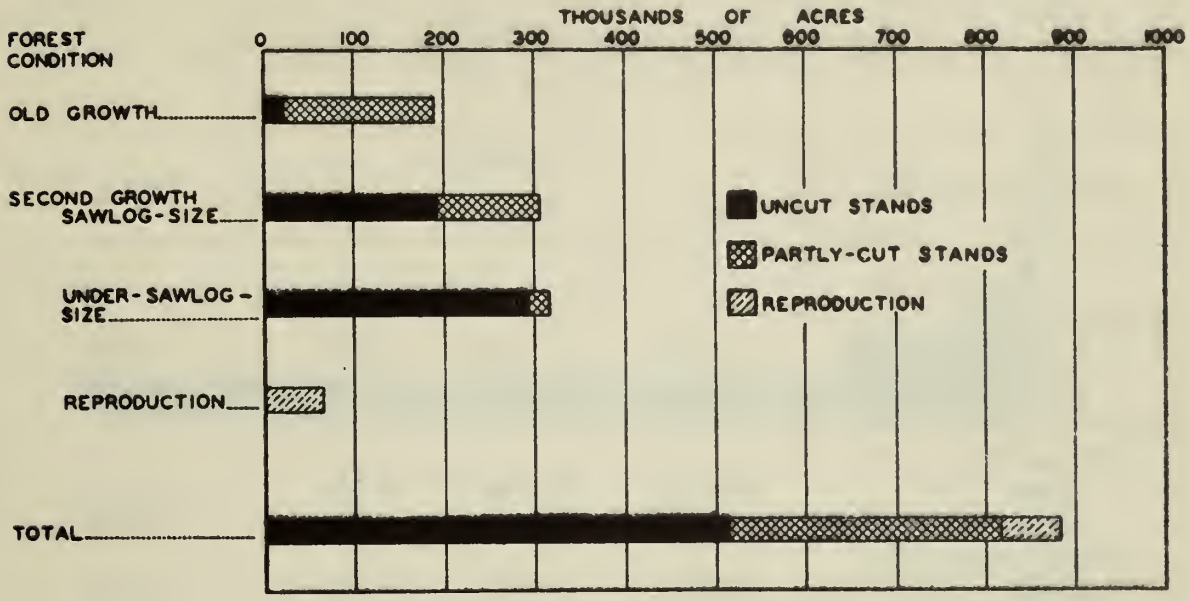

FIGURE 5. - FOREST AREA CLASSIFIED ACCORDING TO FOREST CONDITION

FOREST SITES

Site is the combination of the natural factors, such as soil, aspect, drainage, and moisture, that influence the rate of forest growth. Upon the good sites the growth is rapid and the trees are relatively healthy, tall, and well formed; whereas on the poor sites the growth is comparatively slow and the trees are often stunted and poorly formed.

Three broad site classes recognized were determined from curves of tree height in relation to age. A brief discussion of each site class follows:

Good: Found chiefly in coves and stream bottoms and on moist benches and lower slopes. The soil is usually deep fertile, and well drained. When not reduced by cutting or fire the timber stands are dense, and when mature are composed principally of clear-boled trees averaging for the hardwood species 3 or more 16-foot logs each, and for the pines 80 to 90 feet of total height at 50 years of age.

Fair: Found where soil and moisture conditions are not as favorable as on the good sites, but good commercial timber can be produced on a longer rotation. Mature stands consist of trees averaging for the hardwood species less than 3 logs but more than 1½ logs each, and for the pines 60 to 70 feet of total height at 50 years of age.

Poor: Usually found on the dry, upper slopes and ridges, mostly on southern and western exposures. The soil is shallow, sterile, and is frequently very rocky with occasional rock outcrops and cliffs. The

hardwoods are usually short-bodied and when mature seldom average as much as 1½ logs each. The pines will be 40 to 50 feet in height at 50 years of age.

TABLE 6. - *Hardwood and pine-hardwood forest area classified according to forest condition and site quality*

Forest condition[1]	Site quality			Total
	Good	Fair	Poor	
	acres			
Old growth:				
Uncut	7,900	12,400	1,700	22,000
Partly-cut	31,500	120,000	10,800	162,300
Second growth:				
Sawlog-size:				
Uncut	45,200	130,800	9,500	185,500
Partly-cut	10,000	78,300	6,600	94,900
Under-sawlog-size:				
Uncut	28,200	221,500	15,000	264,700
Partly-cut	2,100	19,900	1,600	23,600
Total	124,900	582,900	45,200	753,000
Percent of total	16.6	77.4	6.0	100.0

[1] Reproduction condition is omitted.

Manifestly important in gauging the productive capacity of the unit is that nearly four-fifths of these forest areas is in the fair site class, and less than one-fifth is in the good site class.

The pine forest area (reproduction area omitted) classified according to site quality of the shortleaf pine is as follows:

Site class	Area	Proportion
	Acres	*Percent*
Good	7,100	20.1
Fair	20,700	58.7
Poor	7,500	21.2
Total	35,300	100.0

SIZE DISTRIBUTION

Since the partly-cut old-growth, and uncut second-growth conditions, both under and over sawlog size, in the hardwood type constitute 65 percent of the total forest area (as derived from table 5, page 24), the forest stands for these conditions only are analyzed here. Only living trees are considered. Figure 6 shows graphically, by tree diameter classes, the average number of trees per acre in each of these forest conditions. The excessively large proportion of small trees is significant and will be discussed later.

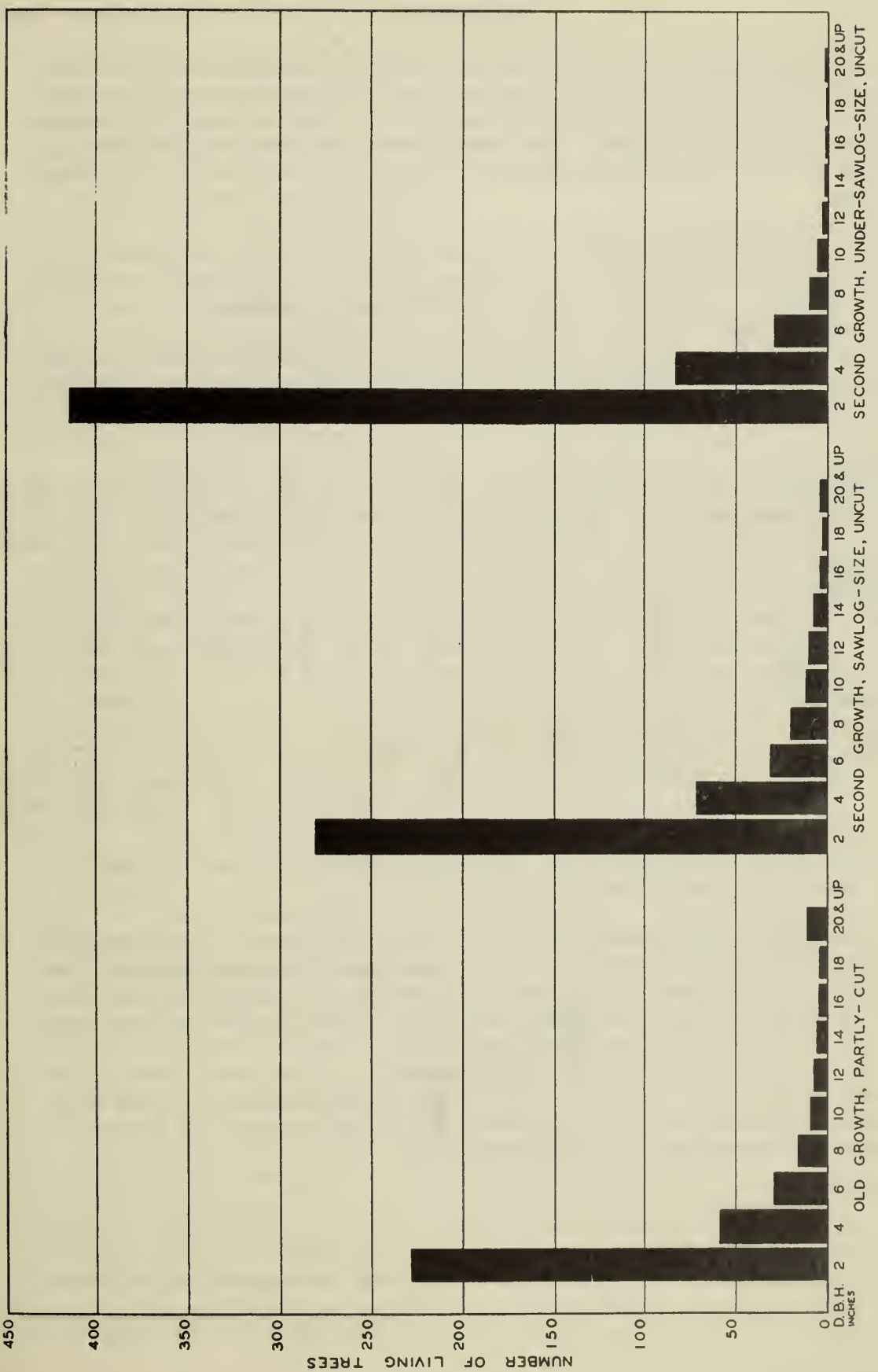

FIGURE 6. - AVERAGE NUMBER OF TREES PER ACRE IN THE HARDWOOD TYPE

QUALITY

From the standpoint of utilization value the living trees of the stand have been divided into three quality classes: sound trees, sound cull trees, and rotten cull trees.[1] In table 7 the percentages of trees in these three groups are given by diameter classes. The same forest conditions are considered as in figure 6, that is, partly-cut old-growth and uncut second-growth in the hardwood type.

TABLE 7. - *Percentage distribution of trees by diameter and quality classes in the hardwood type*[1]

Forest condition	Tree quality	Tree diameter (inches)									
		1.0-2.9	3.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-& up
		Percent									
Old-growth:											
Partly-cut:	Sound	65.0	76.7	71.4	84.3	78.5	76.9	76.8	76.9	76.7	74.1
	Sound cull	31.6	13.0	19.8	5.8	10.6	5.0	4.1	3.5	1.7	.5
	Rotten cull	3.4	10.3	8.8	9.9	10.9	18.1	19.1	19.6	21.6	25.4
Second-growth:											
Sawlog-size											
Uncut:	Sound	68.7	81.1	74.8	79.0	85.4	86.4	83.2	80.0	71.9	48.0
	Sound cull	28.2	13.0	16.1	11.5	6.7	3.7	2.4	2.2	2.2	.8
	Rotten cull	3.1	5.9	9.1	9.5	7.9	9.9	14.4	17.8	25.9	51.2
Under-sawlog-size											
Uncut:	Sound	75.9	82.9	81.6	76.8	79.2	70.5	53.4	48.0	20.7	19.8
	Sound cull	22.0	12.9	11.4	10.7	9.9	10.7	9.6	6.7	5.2	5.0
	Rotten cull	2.1	4.2	7.0	12.5	10.9	18.8	37.0	45.3	74.1	75.2

[1] Weed trees, such as sourwood, are tallied only in the sizes 5.0 inches or larger; they are all considered as sound culls.

In partly-cut old growth the proportion of sound trees is fairly constant throughout the diameter classes. In the second-growth stands, however, the proportion of cull trees (sound culls and rotten culls combined) increases markedly at about 19 inches because of the poorly formed and rotten trees that were left when the stands were first logged.

As a further indication of the relative quality of the forest, computations show that 25 percent of the basal area[2] of partly-cut old growth is made up of cull trees; 26 percent of the uncut, sawlog-size second growth; and 29 percent of uncut, under-sawlog-size second growth.

---

[1] See glossary for definitions of terms.

[2] The sum of the cross-sectional areas (including bark and taken at 4-1/2 feet above the ground) of the stems of the individual trees composing the stand.

REPRODUCTION

In the preceding description of stands of timber only trees one inch or larger in diameter outside of bark at breast height are included, but in order to ascertain the extent to which the desirable species are reseeding or sprouting, the survey also recorded the presence or absence, and the distribution, density, and species, of seedlings and sprouts less than one inch in diameter in all forest types and conditions.

All of the species represented in the stands are reproducing themselves either from seed or from stump sprouts. The soil and climate is in general favorable to continuous restocking; and there is substantial evidence that when the forest canopy is opened up a new and ample crop of young trees occupies the ground. Species reproduction follows closely that of parent stands. An indication of the reproductive capacity of the Appalachian hardwoods is shown in figure 6, page 27, by the great number of 2 inch trees in stands of both old-growth and second-growth timber. The number of young trees under 1 inch in diameter is even greater than the number in the 2 inch class.

Reproduction on clear-cut forest areas protected from fire is prompt and generally dense. In the hardwood type it is composed largely of stump sprouts at the start, but seedlings soon establish themselves. Seedlings of forest species appear quickly in abandoned fields. Often stands of such species as sassafras and persimmon are the first to appear, followed by black locust and pines. Other hardwoods are next in order to establish themselves in the mixture. In abandoned fields on lower slopes having limestone soils, red cedar is frequently the forerunner of the new forest stand.

Recurrent forest fires are the greatest single factor preventing satisfactory reproduction. None of the species found in the region are fire resistant in their seedling stage. Even light surface fires greatly reduce and frequently wipe out the entire crop of seedlings. With protection from fire it seems certain that seedlings and sprouts will quickly restock openings in forest areas as they occur.

In large fields of abandoned farm land there are areas so far from seed trees that natural reforestation will be slow. On deeply gullied fields the instability of the soil may prevent the establishment of natural forests. Thus artificial reforestation may be justified especially if a stand of trees is desired immediately. Black locust and shortleaf pine are the species generally used for planting in erosion control; yellow poplar, black walnut and other species on better sites for commercial production. The Forestry Division of the Tennessee Valley Authority has two large forest nurseries and is doing artificial reforestation work on a large scale mainly for watershed protection.

FIRE DAMAGE

In the past the public has had an attitude of complacency regarding the burning of woods, owing to a lack of appreciation of the serious losses involved. As a result many forest tracts have been subjected to annual fires, caused by incendiaries, debris-burners, smokers, and campers. Now, State Forest Services, Civilian Conservation Corps, Tennessee Valley Authority, and other public and private agencies are cooperating in intensive fire protection of the area. Towers and telephone lines have been constructed, and organizations have been set up for the purpose of fire detection and suppression. Most of the fires

occur in the spring and fall while the leaves are off the hardwood trees.

The Forest Survey found damage resulting from forest fires on 40 percent of the forest area. Following is a tabulation of the relative areas showing varying degrees of damage:

No indication of fire	35	percent	of	the	forest	area
Fire indicated but no apparent damage	25	"	"	"	"	"
Fire damage light	18	"	"	"	"	"
Fire damage medium	13	"	"	"	"	"
Fire damage heavy	9	"	"	"	"	"

Most of the fires are ground fires and although not spectacular they kill the reproduction and injure the larger trees. Approximately one-fourth of all living trees are either sound culls or rotten culls, and fire is largely responsible for this condition. In addition, fire is the direct cause of 48 percent of the defective material in sound trees.

Fire damage in the hardwood type was more serious than in the pine-hardwood, pine, or cedar types; 24 percent of the hardwood area showed medium or heavy damage, as against only 13 percent for the other three types combined.

No significant difference was found in the prevalence or extent of fire damage among the different forest conditions.

FUNGI DAMAGE

Rot is very prevalent in all the forest types and conditions. Fungi are responsible for 40 percent of the deductions made for cull. One of the most prevalent and most destructive sources of damage is the chestnut blight, which has swept the area during the past decade leaving but a small fraction of the chestnut trees living. The survey found 725,500 cords of living chestnut as against 1,598,600 cords of dead standing chestnut. Previous to this inventory large quantities of the dead wood either have been removed or have become worthless. Although the living, blight-infested chestnut is carried in the inventory tables, it is dying so rapidly that none is included in the growing stock. Many other fungi found throughout the unit are not as spectacular in their effects as the blight, but they also cause large losses of merchantable material. Wounds resulting from fires are favorite entrance places for fungi and are probably partly responsible for some damage directly due to rot.

DAMAGE DUE TO OTHER CAUSES

Only a few trees have been killed outright by insects, but the quality and value of forest products have been materially reduced by the activities of insect pests. Ambrosia beetles and timber worms riddle the wood of oaks and other hardwoods; in many stands they have reduced the value of the oak sawtimber about 20 percent. The southern pine bark-beetle attacks the pines and some times succeeds in killing an occasional tree or small group of trees.

Other causes of cull are malformations such as forks, crook and excessive limbiness and damage due to winds, sleet storms and logging. These, with insects, cause 12 percent of the loss of the material in sound trees.

SAWTIMBER

The estimate of sawtimber volume shown in table 8 includes all the material in sound living trees that has the required qualifications for the production of lumber, but much of it will undoubtedly be manufactured into such forms as staves, mine timbers, pulpwood, etc. It is expressed in board feet, Scribner log rule.

Included in the sawtimber estimate are hardwood trees with an outside-bark breast-height diameter of at least 11 inches, pines and hemlock of at least 9 inches, and cedar of at least 7 inches. The individual hardwood and pine trees included have, in general, either a sound butt log at least 12 feet long, or at least 50 percent of their gross volume in sound sawtimber material. The individual cedar trees included have a usable length of at least 6 feet. The volume shown in table 8 includes the merchantable length of each stem to the highest usable diameter in the top; while there was no fixed minimum top, no material was taken with a diameter less than 8 inches (inside bark) in hardwoods and 6 inches in pine, hemlock, and cedar. Current utilization practice, which is rather more intensive here than in other southern hardwood regions, has been used as the basis for the stump heights, top diameter, and decisions as to cull material.

VOLUME

The total net volume of usable sawtimber material is 1,682,610,000 board feet, Scribner log rule; 1,308,510,000 board feet, Doyle rule; or 1,868,440,000 board feet according to the International ¼ inch log rule, the latter figure closely approximating green-lumber mill tally. Fifty-three percent of the sawtimber volume is found in the old-growth forest conditions; 41 percent in the second-growth sawlog-size conditions; and the balance, 6 percent, in second-growth under-sawlog-size and reproduction conditions.

The following four species or species groups contain over half of the saw timber volume: red oaks, 348,850,000 feet b.m., or 21 percent; yellow poplar group, 255,360,000 feet b.m., or 15 percent; chestnut, 158,790,000 feet b.m., or 9 percent; chestnut oak, 144,330,000 feet b.m., or 9 percent.

An analysis of the sawtimber volume by forest types shows that the hardwood type contains 89 percent, the pine-hardwood type 6 percent, the pine type 4 percent, and the cedar type 1 percent, of the total volume in the stands.

For the entire forest area, including clear-cut, reproduction, and non-commodity conditions, as well as areas of established forest stands, the average stand of sawtimber volume per acre is only 1,900 board feet. Old-growth uncut and partly-cut stands combined have an average volume per acre of 4,700 board feet; second-growth sawlog-size stands, 2,300 board feet; second-growth under-sawlog-size and reproduction conditions combined, 249 board feet, Scribner log rule.

These light stands of timber are characteristic of the Norris Dam Watershed and show the effects of recurrent fires and over-cutting, rather than a prevalence of poor sites.

TABLE 8. - *Net board-foot volume (Scribner) in the various species groups and in the various forest conditions*

Species group	Forest condition					Total living tree inventory
	Old growth		Second growth			
			Sawlog-size		Under-sawlog-size and reproduction	
	Uncut	Partly-cut	Uncut	Partly-cut		
	Thousands of board feet					
Pulping species:						
Yellow poplar, basswood, etc.	25,630	99,840	92,790	26,330	10,770	255,360
Soft maples	2,660	9,590	8,630	6,030	1,950	28,860
Other pulping hardwoods	2,140	17,450	15,710	7,520	4,710	47,530
Shortleaf and pitch pines	4,540	28,210	38,370	16,910	9,360	97,390
Other pines	710	6,890	7,220	14,210	3,560	32,590
Hemlock	42,230	35,160	9,190	5,020	1,190	92,790
Total	77,910	197,140	171,910	76,020	31,540	554,520
Nonpulping species:						
Red oaks	24,090	135,670	115,490	57,640	15,960	348,850
Forked-leaf white oak	12,980	80,940	25,540	12,970	3,490	135,920
Chestnut oak	16,970	83,260	24,700	12,210	7,190	144,330
Other white oaks	610	8,460	4,120	3,090	2,040	18,320
Hickories	5,120	70,190	40,160	12,820	8,640	136,930
Beech	2,390	26,470	13,420	7,410	1,590	51,280
Hard maple	6,100	26,880	12,560	1,140	1,280	47,960
Black walnut and cherry	810	7,050	5,560	3,960	3,130	20,510
Ashes	1,210	10,490	5,250	990	670	18,610
Birches	1,230	5,680	5,920	1,820	530	15,180
Other nonpulping hardwoods	------	4,910	3,360	230	940	9,440
Cedar	200	2,260	1,670	15,030	2,810	21,970
Chestnut	13,100	67,770	39,880	21,790	16,250	158,790
Total	84,810	530,030	297,630	151,100	64,520	1,128,090
Total all species	162,720	727,170	469,540	227,120	96,060	[1]1,682,610

[1] In terms of the Doyle rule the estimate totals 1,308,510,000 board feet; in terms of the International rule it is 1,868,440,000 board feet.

Figure 7 shows the percentages of the total forest area occupied by sawtimber stands of certain volumes per acre. Over half of the forest area of the Watershed has less than 2,000 board feet per acre; only seven percent has 6,000 board feet or more per acre.

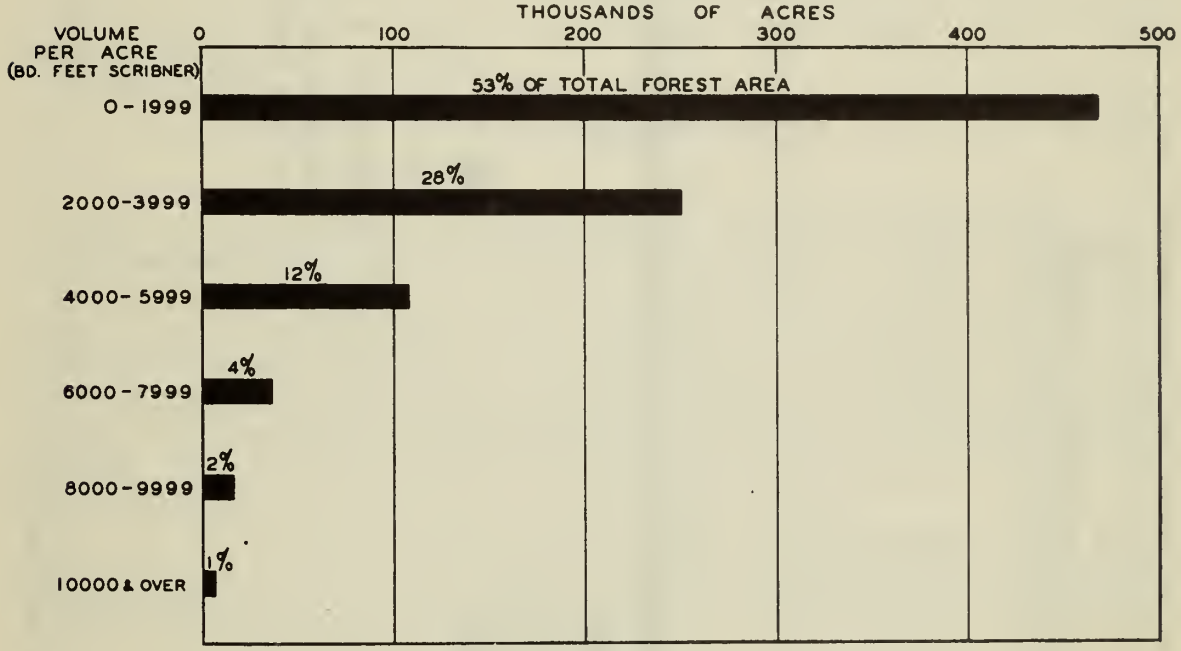

FIGURE 7. - FOREST AREA CLASSIFIED ACCORDING TO VOLUME OF SAWTIMBER PER ACRE

QUALITY

The sawtimber volume has been classified into three log grades for the hardwoods, and three tree grades for the pines and hemlock. Grade 1, for both logs and trees, includes material suitable for manufacture where a good proportion of the upper grades of lumber is required; grade 2 contains material that is approximately equal in quality to grade 1 but is limited because of size or other factors to such uses as cooperage stock and small dimension lumber; grade 3 contains material used for ties, low grade lumber and box, crate, and rough structural material. Because of the special qualifications set up in the use of the poorer white oaks, cedar, chestnut, and birch, these species are not graded.

Figure 8 shows graphically the volume of the several grades found in the various species groups. Of the total volume in all species 33 percent is grade 1 material, 18 percent grade 2, and 49 percent grade 3.

From an industrial and economic standpoint it is significant that two-thirds of the sawtimber volume is classified as medium and low grade.

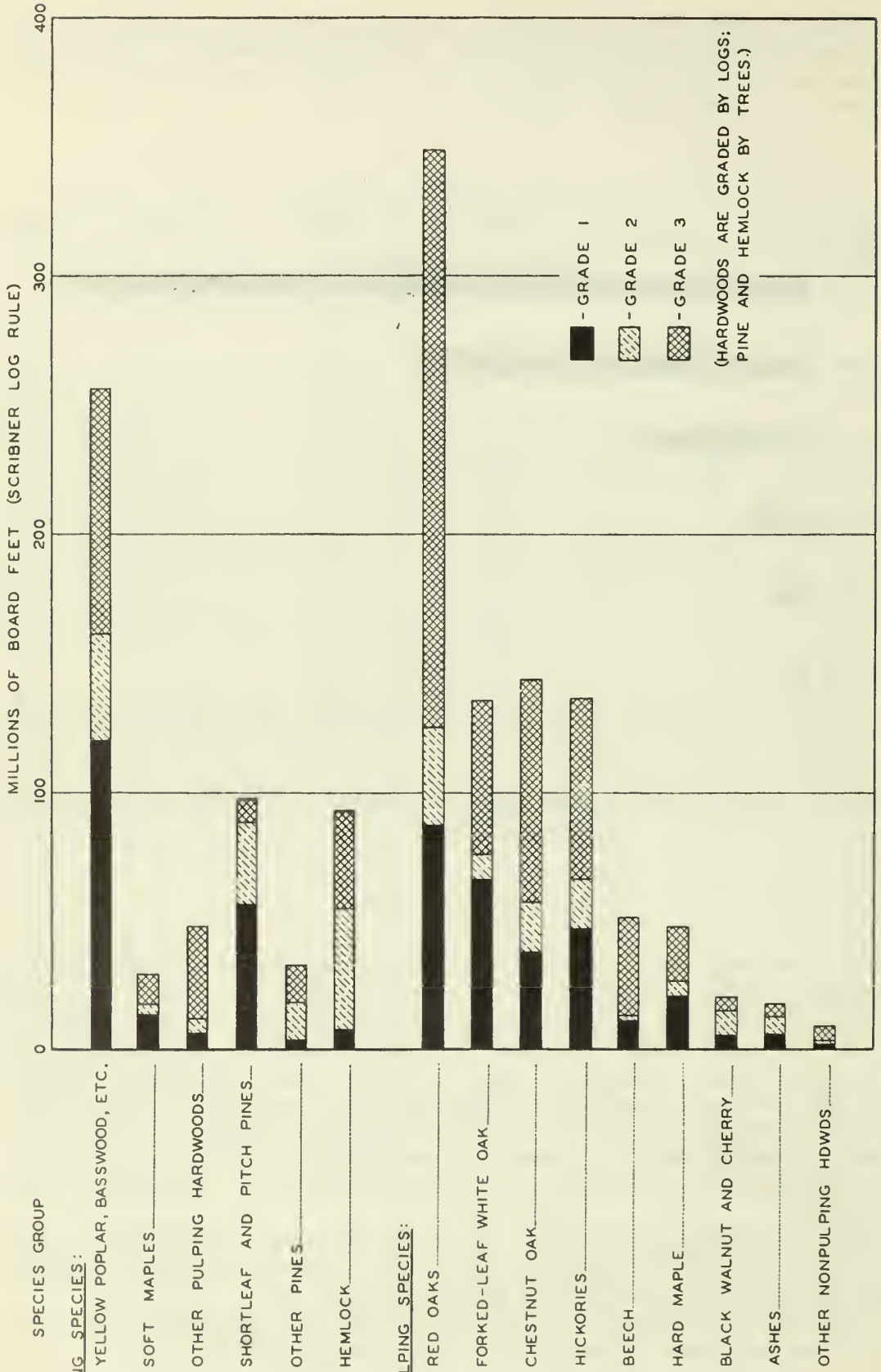

FIGURE 8. - BOARD-FOOT VOLUME OF INDIVIDUAL SPECIES GROUPS IN THE VARIOUS LOG OR TREE GRADES

CORDWOOD

Cordwood is here expressed in standard cords 4 x 4 x 8 feet, assumed to contain 90 cubic feet of wood (inside the bark) for the pines, hemlock, and cedar and 80 cubic feet for all other species. The estimate includes the sound stemwood to a top diameter limit of approximately 4 inches inside bark: in (1) total usable stems in live sound culls, rotten culls, and under-sawlog-size sound trees; and (2) top stems above the sawtimber in live sawlog trees. No limbwood is included.

VOLUME

In addition to the sawtimber volume, discussed previously, there is in living trees, exclusive of the cull material a volume of 3,878,300 cords of sound merchantable wood not suitable for sawtimber, as shown in table 9. This is found in the stems of trees that are not of sawtimber size and quality, and in the top portion of the stems of sawtimber trees. It includes only trees with a breast-height diameter of at least 5 inches, outside bark, and a usable bole of at least 8 linear feet, except as follows: 6 linear feet for cedar, black locust, mulberry, and sassafras; and 4 linear feet for dogwood and persimmon. This wood is suitable for distillation and tannic acid, fuel, fence posts, shuttle bolts, mine timbers, and other products.

Of the total volume, sound trees contain 70 percent; sound culls, 8 percent; and rotten culls, 22 percent. Old-growth stands account for 36 percent of the total volume; second-growth sawlog-size stands, 43 percent; and second-growth under-sawlog-size stands, 21 percent.

The species are divided into the following classes on the basis of the chief commercial use of their cordwood: (1) pulpwood; (2) distillation wood; (3) tannic acid wood; and (4) miscellaneous, which includes mainly species used for posts and bobbin and shuttle material.

PULPWOOD

Trees commonly used for pulp and paper making are yellow poplar, basswood, cucumber and other magnolias, red gum, buckeye, the soft maples, black gum, the pines, and hemlock. In live trees of pulping species there are 977,100 cords of pulping material, in addition to the saw-timber previously discussed. Of the cordwood volume 52 percent is contained in small trees, 27 percent in medium-size trees and 21 percent in large trees[1]. The following species groups contain approximately the indicated percentages of the total pulpwood volume: the yellow poplar, basswood, etc. group, 47 percent; soft maples, 12 percent; other pulping hardwoods, 18 percent; shortleaf and pitch pines, 12 percent; other pines, 7 percent; and hemlock, 4 percent.

---

[1] Small trees are 5.0 - 10.9 inches in diameter 4-1/2 feet from the ground; medium-size trees, 11.0 - 18.9 inches; and large trees, 19.0 inches and larger. These are tree sizes and should not be confused with the classification of forest conditions as given in the tables.

DISTILLATION WOOD

Distillation wood is obtained from sound green timber and sound tops of the following species: oaks, beech, birches, hard maple, hickories, ashes, sourwood, elm, and other nonpulping species except cedar and chestnut. Although the industry demands that all pieces be straight and free from rot, distillation wood is often cut from sound cull and rotten cull trees and discarded sections of sawtimber trees.

The estimate here includes the sound stemwood in small sound trees of these species, as well as in sound culls, rotten culls, and the tops of sawtimber trees. Of the total of 2,359,300 cords, small trees make up 41 percent; medium-size trees, 30 percent; and large trees, 29 percent.

TANNIC ACID MATERIALS

WOOD: Chestnut is used as a source of tannic acid, large quantities of both live and dead material being used. Reasonably straight, round or split billets, free from rot, are required. Usually peeled wood is specified. The spent chips are used for pulp after the tannic acid is extracted.

The estimate of cordwood volume includes the sound stemwood in live chestnut, which is in addition to the sawtimber material. About 19 percent of the volume is in small trees; 32 percent is in medium-size trees, and 49 percent in large trees.

Dead chestnut trees contain, in addition to the volume in the living trees, about 1,598,600 cords not included in table 9. Dead trees in old-growth stands make up 590,800 cords; in second-growth sawlog-size stands, 645,200 cords; and in all others, 362,600 cords. Approximately 15 per cent of the dead chestnut volume is in small trees; 39 percent in medium-size trees and 46 percent in large trees. (No sawtimber volume is figured for dead chestnut, although some of the medium-size and large trees may be used for lumber or poles.)

TANBARK: It is roughly estimated that there are about 227,000 tons of bark suitable for making tannic acid: 181,000 tons from chestnut oak and 46,000 tons from hemlock. In chestnut oak the bark estimate includes only live trees 13 inches or larger in diameter, and in hemlock 5 inches or larger. Three-fourths of the bark, in both species, is found in the old-growth conditions. Over 60 percent is on trees 19 inches or larger. The utilization of bark will likely go hand-in-hand with the wood-products utilization of the trees involved.

FENCE POSTS

Fence posts are cut mainly from black locust, mulberry, sassafras, and cedar, and the posts available in these species only are estimated. To be usable for posts, trees must be at least 5 inches in diameter at breast height and have a sound, relatively straight bole at least 6 feet long with a minimum top diameter inside bark of 4 inches (3 inches if cedar). For cedar the cordwood estimate includes the sound stemwood other than sawtimber material. For black locust, sassafras and mulberry, it includes all the sound stemwood in live trees; no sawtimber is figured since fence posts constitute their primary use.

In this cordwood volume it is estimated that there are approximately 14,400,000 posts, of which 3,600,000 are cedar, and 10,800,000 black locust, sassafras and mulberry. About two-thirds of the cedar posts are found in the cedar type; most of the balance in the hardwood type. Practically all of the black locust, sassafras and mulberry posts are in the hardwood type.

BOBBIN AND SHUTTLE MATERIAL

Dogwood and persimmon are utilized in making bobbins and shuttles used in textile mills. There is no bobbin and shuttle plant in the unit, but some wood is shipped to nearby plants. Trees are cut into bolts from 21 to 60 inches long which must be at least 4 inches at the small end. Each bolt must contain at least 2 inches of sapwood and be straight and reasonably free from knots, rot, and other defects. Only sound trees 5 inches or larger in diameter at breast height contain bobbin and shuttle material.

The cordwood volume shown for these species includes the sound stems in all live trees, including sound and rotten culls. There are about 30,000 cords, of which 24,000 cords are in sound trees. Since bobbin and shuttle material constitute the primary commercial use of sound dogwood and persimmon trees, no sawtimber volume is figured; their entire volume is included in this cordwood estimate.

FUELWOOD

Fuelwood is usually cut from cull trees, and from the tops and limbs of sound trees felled for other purposes; only a small portion is cut from trees that contain sawlogs or other valuable products or from small trees that promise to produce high grade material in the future. Most of it is cut from the oaks, chestnut, pines, and hickories, but all species are occasionally used.

In all living trees, in addition to sawtimber material, there are 3,878,300 cords of sound stemwood. A large portion of this, as explained in the preceding pages, is suitable for distillation and for the manufacture of pulp, tannic acid, fence posts, and bobbins and shuttles. Some of it, however, can be considered as constituting available fuelwood -- especially part of the 1,163,400 cords in cull trees, and part of the 1,235,600 cords in the tops above the sawtimber in medium and large trees.

It is very roughly estimated that limbwood in living trees contains an additional 1,000,000 cords; and that dead chestnut contains 1,598,600 cords. Dead wood other than chestnut is also available in large quantities, but its volume has not been estimated.

Table 9 gives the estimate of the sound merchantable cordwood not suitable for sawtimber in living trees. While the various species are grouped on the basis of their present commercial use, new forest industries or new uses may be developed that would justify other combinations.

TABLE 9. - *Cordwood volume in material not suited for sawtimber in live trees*[1]

Tree quality and forest condition	Commodity groups				Total
	Pulpwood[2]	Distillation wood	Tannic acid wood[3]	Miscellaneous	
	Cords				
Sound trees:					
Old growth	223,300	617,000	106,300	37,600	984,200
Second growth:					
Sawlog-size	347,000	687,400	84,100	91,100	1,209,600
Under-sawlog-size[4]	151,500	264,900	30,500	74,200	521,100
Total	721,800	1,569,300	220,900	202,900	2,714,900
Sound cull trees:					
Old growth	8,400	65,000	2,900	1,100	77,400
Second growth:					
Sawlog-size	19,500	114,100	3,100	4,900	141,600
Under-sawlog-size[4]	26,100	63,800	11,200	4,300	105,400
Total	54,000	242,900	17,200	10,300	324,400
Rotten cull trees:					
Old growth	67,300	229,600	24,600	5,600	327,100
Second growth:					
Sawlog-size	93,700	207,000	23,100	10,500	334,300
Under-sawlog-size[4]	40,300	110,500	17,800	9,000	177,600
Total	201,300	547,100	65,500	25,100	839,000
Total	977,100	2,359,300	303,600	238,300	[1]3,878,300

[1] It is roughly estimated that there are an additional 1,000,000 cords in living tree limbwood.

[2] A large part of the tannic acid wood has a secondary use as pulp material, the spent chips being so used.

[3] Dead chestnut contains 1,598,600 cords additional.

[4] Includes a small volume found in the reproduction and clear-cut conditions.

CUBIC FOOT CONTENTS

In table 10 an estimate is given of the cubic foot content of the total merchantable stem volume in live trees, including both the sawtimber portion and the non-sawtimber portion. All live trees are included that have a breast-height diameter of at least 5 inches, outside of bark, and a usable bole of at least 8 linear feet, except as follows: 6 linear feet for cedar, black locust, mulberry, and sassafras; and 4 linear feet for dogwood and persimmon. The sound stemwood of the trees is included to an inside bark minimum top diameter of approximately 4 inches. No limbwood is included, and the volume is exclusive of bark.

VOLUME

Of the total of 643,230,000 cubic feet, 44 percent is in the old-growth stands; 43 percent in the sawlog-size second-growth stands, and 13 percent in the under-sawlog-size and reproduction stands. The average stand for the entire forest area, including reproduction, clear-cut, and non-commodity areas, is about 700 cubic feet per acre. Old-growth uncut and partly-cut stands combined have an average volume per acre of 1,500 cubic feet; second-growth sawlog-size stands, 900 cubic feet.

Approximately 86 percent of the total volume is found in sound trees; 4 percent in sound cull trees; and 10 percent in rotten cull trees.

TABLE 10. - *Sound stemwood (bark not included) in live trees of different quality classes under various forest conditions* [1]

Tree quality	Forest condition					Total living tree inventory
	Old growth		Second growth			
			Sawlog-size		Under-sawlog-size and reproduction [2]	
	Uncut	Partly-cut	Uncut	Partly-cut		
	Thousands of cubic feet					
Sound trees	41,230	206,050	163,280	76,590	62,660	549,810
Sound cull trees	830	5,440	6,540	4,810	8,620	26,240
Rotten cull trees	3,740	22,450	20,020	6,760	14,210	67,180
Total	45,800	233,940	189,840	88,160	85,490	643,230

[1] Live chestnut volume included (58,040,000 cubic feet) is being rapidly killed by the chestnut blight.

[2] Includes a small volume found in the clear-cut condition.

In table 11, the total volume of 549,810,000 cubic feet in sound trees only is classified according to forest condition and species group. An analysis, by forest types, of the cubic-foot volume in sound trees shows that 89 percent is in the hardwood type, 6 percent in the pine-hardwood type, 4 percent in the pine type, and 1 percent in the cedar type.

Of the 549,810,000 cubic feet in sound trees, 330,380,000 cubic feet is sawtimber material, and 219,430,000 cubic feet non-sawtimber material (either in small trees or in the stems above the sawlogs in larger trees). In addition there are the 93,420,000 cubic feet in sound culls and rotten culls, which is all non-sawtimber material. In figure 9 is shown the relationship of sawtimber and non-sawtimber material in each species group in the various quality classes. The comparatively large volume in non-sawtimber material is an unusual feature of every species group.

DEDUCTIONS FOR CULL

In arriving at the net cubic volumes for sound trees included in the preceding figures, deductions for cull material varied from 2 to 20 percent, depending on the species. For sound cull trees the gross volume was reduced uniformly 20 percent plus the cull factor for sound trees of the same species. For rotten cull trees a constant cull factor of 65 percent was used.

Fully one-fifth of the volume was classed as cull in all living trees, and amounted to about 174,000,000 cubic feet. This abnormal cull loss is a significant characteristic of the forests of this unit, and shows the effects of the prevalent forest fires, of the wide-spread decay, and of the years of cutting operations in which the best trees were taken and the poorer ones were left to accumulate in the stand.

TABLE 11. - *Sound stemwood in live sound trees in the various forest conditions and species groups*

Species group	Forest condition					Total
	Old growth		Second growth			
			Sawlog-size		Under-sawlog-size and reproduction	
	Uncut	Partly-cut	Uncut	Partly-cut		
	Thousands of cubic feet					
Pulping species:						
Yellow poplar, basswood, etc.	5,870	25,810	29,040	7,780	8,420	76,920
Soft maples	710	2,890	2,930	2,370	1,110	10,010
Other pulping hardwoods	700	5,860	5,880	2,820	2,510	17,770
Shortleaf and pitch pines	1,140	6,630	11,500	5,280	4,480	29,030
Other pines	230	1,980	2,910	4,200	2,300	11,620
Hemlock	7,760	7,300	2,430	1,360	360	19,210
Total	16,410	50,470	54,690	23,810	19,180	164,560
Nonpulping species:						
Red oaks	6,330	37,610	37,030	18,310	10,410	109,690
Forked-leaf white oak	3,100	20,430	8,830	4,650	2,900	39,910
Chestnut oak	5,290	26,240	10,820	5,140	4,680	52,170
Other white oaks	260	2,510	1,660	1,250	1,110	6,790
Hickories	1,620	20,550	14,670	4,860	4,710	46,410
Beech	710	7,740	4,580	2,360	780	16,170
Hard maple	1,620	8,370	4,580	660	950	16,180
Black walnut and cherry	270	2,090	2,380	1,560	2,880	9,180
Ashes	310	2,960	2,390	610	1,340	7,610
Birches	490	1,720	2,110	690	200	5,210
Post species	580	1,650	4,000	1,230	4,990	12,450
Dogwood and persimmon [1]	60	640	730	250	250	1,930
Other nonpulping hardwoods	-----	1,420	1,030	200	920	3,570
Cedar	40	470	530	4,130	1,380	6,550
Chestnut	4,140	21,180	13,250	6,880	5,980	51,430
Total	24,820	155,580	108,590	52,780	43,480	385,250
Total all species	41,230	206,050	163,280	76,590	62,660	549,810

[1] Volumes less than 1,000,000 feet have a high standard error; see statement in Foreword on error in small quantities.

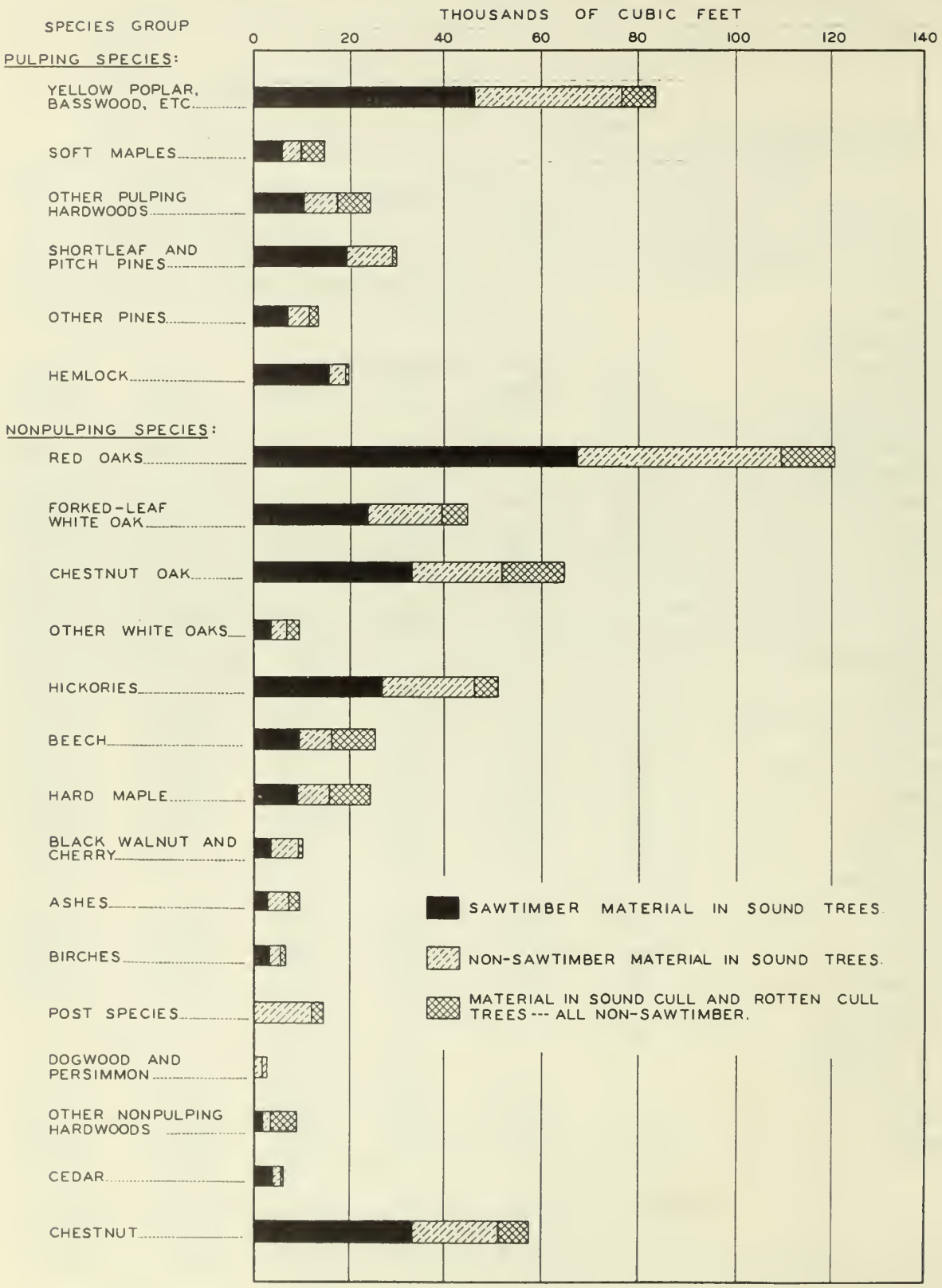

FIGURE 9. - SOUND STEMWOOD IN LIVE TREES, BARK NOT INCLUDED.

GROWTH AND YIELD

The growth, like the growing stock, includes all live sound trees other than weed species (which rarely produce sawtimber) and chestnut (which is rapidly being destroyed by the chestnut blight). It is assumed that the present situation, in which the cut each year approximately equals growth, will continue. The figures are net, necessary deductions having been made for cull material and for normal mortality.

SAWTIMBER GROWTH

In table 12 is given the current annual growth in board feet of the present forest stands. It includes the increase in volume in the trees of sawtimber size plus the sawtimber volume newly-created by (1) hardwoods now below sawtimber size but becoming 11 inches or larger in diameter at breast height in the next year, (2) pines and hemlocks becoming 9 inches or larger, and (3) cedars becoming 7 inches or larger.

For the growing stock of 1,523,820,000 board feet, Scribner log rule, in all forest conditions, (derived by subtracting the chestnut from the total living tree inventory as given in table 8) the estimated growth is 43,403,000 board feet.

TABLE 12. - *Growth per annum in board feet, Scribner log rule, of the present forest stands* [1]

Forest condition	Area in acres	Present volume of growing stock [2]	Growth per year [3]		Average acre values	
					Present volume	Growth per year
	Acres	*M bd.ft.*	*Percent*	*M bd.ft.*	----- *bd.ft.* -----	
Old growth:						
Uncut	22,400	149,620	1.27	1,900	6,679	85
Partly-cut	168,500	659,400	1.41	9,298	3,913	55
Second growth:						
Sawlog-size:						
Uncut	193,800	429,660	3.79	16,284	2,217	84
Partly-cut	114,900	205,330	3.93	8,069	1,787	70
Under-sawlog-size:						
Uncut	294,100	69,800	9.23	6,443	237	22
Partly-cut	24,900	8,460	16.66	1,409	340	57
Reproduction	67,200	1,550	(4)	-----	----	--
Totals and weighted averages	885,800	1,523,820	2.85	[5] 43,403	1,720	49

[1] See glossary for definitions.

[2] Sound trees other than chestnut and weed species.

[3] Assuming a cut each year in each forest condition approximately equal to the growth.

[4] Too small to require consideration.

[5] By the International 1/4 inch kerf log rule the annual growth is 49 million feet b. m.

Old-growth stands make up 26 percent of the growth; sawlog-size second-growth stands, 56 percent; and under-sawlog-size stands, 18 percent.

In terms of the International $\frac{1}{4}$ inch log rule, which approximates green lumber tally, the annual increment is about 49 million board feet.

The average growth per acre per year for the entire forest area is only 49 board feet, Scribner log rule; for the old-growth conditions, 59 board feet; and for the second-growth sawlog-size conditions, 79 board feet. This growth is low but it is to be expected as long as the stands remain poorly stocked with sound trees of sawtimber size.

These figures represent the full annual increment on the present growing stock, but not the possible annual cut. To build up, under good forest practice, the present run-down stands, some part of the possible cut must be postponed until a heavier stocking and a greater representation of trees of the larger diameters have been brought about.

CORDWOOD GROWTH

In addition to the sawtimber growth in sound trees other than chestnut and weed species, assuming a cut each year approximately equal to the growth, there is an annual increment of 108,000 cords of material in trees remaining below sawlog size --- material suitable for such commercial uses as pulp, distillation, fence posts, bobbin and shuttle bolts, and fuel. This figure includes the annual increase in cordwood volume of the smaller trees that will become 5 inches or larger in one year. Cordwood growth figures are net, neccessary deductions having been made for cull material and normal mortality.

Approximately 43 percent of the cordwood growth is in the pulpwood species, that is the pines, hemlock, and softer hardwoods; 45 percent in the distillation wood species, oaks, hickories, beech, hard maple, etc.; and 12 percent in the post and specialty use species, black locust, sassafras, mulberry, cedar, dogwood, and persimmon.

CUBIC FOOT GROWTH

The only unit of measurement common to all forest products harvested in the Watershed is the cubic foot. Table 13 gives the net annual growth in cubic feet of both sawtimber and cordwood, in live sound trees other than chestnut and weed species, assuming a cut each year approximately equal to the growth.

On the growing stock of 498,380,000 cubic feet, the growth is 15,822,000 cubic feet. Old-growth stands make up 20 percent of the total; sawlog-size second-growth stands 48 percent; and under-sawlog-size second-growth stands, 32 percent. Annual growth rates range from 0.8 percent in the uncut old-growth stands to 9.3 percent in the uncut second-growth, under-sawlog-size stands. The average annual growth per acre ranges from 13 cubic feet in uncut, old-growth to 27 cubic feet in the uncut sawlog-size second-growth stands, and averages 18 cubic feet.

The growth in cubic feet is low, even when it is considered that the sites are generally only fair. Better stocked stands of similar types and conditions and on comparable sites in the Appalachian region show greater growth.

TABLE 13. - *Volume growth in cubic feet, bark not included*

Forest condition	Area in acres	Present volume of growing stock[1]	Growth per year[2]		Average acre values	
					Present volume	Growth per year
	Acres	*M cu.ft.*	*Percent*	*M cu.ft.*	----- *cu. ft.* -----	
Old growth:						
Uncut	22,400	37,090	.77	286	1,656	13
Partly-cut	168,500	184,870	1.53	2,829	1,097	17
Second growth:						
Sawlog-size:						
Uncut	193,800	150,030	3.46	5,191	774	27
Partly-cut	114,900	69,710	3.50	2,440	607	21
Under-sawlog-size:						
Uncut	294,100	50,610	9.30	4,707	172	16
Partly-cut	24,900	5,280	6.98	369	212	15
Reproduction	67,200	790	(3)	-----	----	--
Totals and weighted averages	885,800	498,380	3.17	15,822	563	18

[1] Sound trees other than chestnut and weed species.

[2] Assuming a cut each year in each forest condition approximately equal to the growth.

[3] Too small to require consideration.

FOREST INDUSTRIES

Before proceeding further it is necessary to understand the organization of the forest products industries. The following description is condensed from a report[1] made by the Forestry Division of the Tennessee Valley Authority as the result of a special study of all forest utilization activities in the unit.

The total sale value of the forest products made in the Watershed in 1934 was $2,663,000. Approximately 503,000 man-days of employment were provided. At the average wage of $1.70 per day for all woods and mill workers, the total cost of the labor was $855,000.

LUMBER

Four sawmills outside, and 85 sawmills within the boundaries of the Norris Dam Watershed draw on its forest resources for all or a part of their raw material. With the exception of one band-sawmill, all in the unit are small portable mills with circular saws. The average annual production per mill in 1934 was only 217,000 board feet. Fifty mills do custom sawing, that is, they manufacture lumber on order from logs furnished by the owner charging, as a rule, from $4.00 to $6.00 per thousand feet, lumber tally, or accepting one-half of the lumber sawed in lieu of cash. The remainder either saw their own timber or purchase logs.

The rough, rocky country, and the limited size of the tracts of timber, make logging difficult and expensive. Some operators, finding it cheaper to move their mills than to haul logs long distances, set up to cut out patches of timber containing as little as 20,000 board feet. Logging is carried on throughout the year, except possibly for a few weeks in the winter when heavy rains make roads impassable. Since the majority of the workers and the live stock used come from farms, work in the winter between the harvesting and planting seasons is common, even though carried on under adverse conditions part of the time.

Disregarding the future welfare of the stands, operators usually cut the timber closely, including even those trees as small as 9 or 10 inches in diameter breast height. Wood utilization is poor, and stumps 1½ to 2½ feet high, as well as usable material in the tops, are left in the woods to rot. Because very few operators have edgers or planers, rough lumber makes up most of the production. Mill waste is so great that the loss in slabs, edgings, trimmings, and sawdust is estimated to be at least 50 percent of the cubic content of the log.

Sawtimber stumpage prices vary from $3.00 to $10.00 per thousand board feet, lumber tally. Chestnut oak usually sells for $3.00 per thousand feet; short leaf pine for $4.00; and clear poplar and white or red oak for as much as $10.00. Owing to the poor quality of the logs and to the manufacturing methods used, lumber produced by the small mills is low grade and brings at the mill an average of about $14.20 per thousand board feet. Boards and dimension stock are nearly all sold to farmers and others in the locality; sawed ties to railroads; and sawed mine timbers to coal mines.

---

[1] "Utilization and Drain of Forest Products in the Norris Dam Watershed in 1934" by the Tennessee Valley Authority, Division of Forestry, Knoxville, Tenn.

In 1934 approximately 48,000 man-days (10-hour days) were required in the woods and mills to produce the total volume of lumber, and wages paid amounted to about $82,000.

STAVE AND HEADING STOCK

Stave and heading stock is produced for tight cooperage for whiskey barrels. Stave bolts are split by hand from white oak billets, or short logs, 22 inches or larger in diameter. The heading stock is sawed from white oak billets by a small heading mill. Approximately 5,500 man-days of employment were provided in the manufacture of stave and heading stock in 1934.

RAILROAD TIES

Practically all of the railroad ties produced in the unit are sawed by the small sawmills in connection with the manufacture of rough lumber. Most of the timber comes from the farm woodlands. The production and delivery of this commodity involves about 37,000 man-days per year.

HEWN MINE TIMBERS

Large quantities of mine timbers are used by the coal mines in the region. They are produced from most the local species. They may be round, split, or sawed, and usually measure 3 to 12 feet in length, and 5 to 7 inches in diameter at the small end, with collars up to 18 feet long and 9 inches in diameter. The hewn ties used are 6 feet long and 4 to 6 inches square. About 42,000 man-days of employment are provided per year in the production of mine timbers.

POLES

The production of telephone, telegraph, and power-line poles in the Norris Dam Watershed is rapidly declining. Formerly large numbers of chestnut poles were produced, but the blight has killed most of the chestnut and there is no other suitable pole species available in large quantities. The production of the 3,000 chestnut poles cut in 1934 involved about 600 man-days of employment.

FENCE POSTS

The principal users of fence posts are the farmers and the railroad companies. Posts range in length from 6 to 9 feet, with the average about 7 feet. Those with a top diameter of less than 6 inches are usually used round; those from 6 to 8 inches are usually halved; and those larger than 8 inches are usually split several times. The average life per post is about 15 years. About 18,600 man-days per year are needed for the production of the posts.

HAND-RIVED SHINGLES

In 1934 the building program at the town of Norris, Tennessee (just south of the unit) stimulated the production of hand-rived shingles for roofing and siding. The manufacture of shingles gave about 2,100 man-days of employment.

PULPWOOD

Two pulp and paper mills situated just outside the unit---one at Kingsport, Tennessee, and the other at Bristol, Virginia---absorb the pulpwood output of the Watershed. Farmers cut practically all of the wood during the winter months, and approximately 7,800 man-days of employment are involved per year.

TANNIC ACID EXTRACTION

Two plants for the extraction of tannic acid from chestnut wood are located within shipping distance of the Norris Dam Watershed---one at Knoxville and one at Harriman, Tennessee. These two companies produce tannic acid as their main product, with corrugated paper from the digested pulp as a secondary product. Most of the chestnut wood comes from within 110 miles of the mills; 25 to 50 percent is transported by trucks, and the remainder by railroad. All of the acid wood cut in the Watershed is sold to these two companies; its cutting and hauling furnish about 6,500 man-days of labor per year.

In addition to the plants mentioned above, two plants nearby, engaged in the extraction of tannic acid from bark, occasionally obtain small quantities of hemlock and chestnut oak bark from the Norris Dam Watershed. Most of it is produced by farmers in connection with the small sawmill operations. The bark is peeled from sawlogs, tie-logs, or poles, and is air-dried for a month or longer in loosely stacked piles before delivery.

No appreciable amount of hemlock, but about 2,100 tons of chestnut oak bark were sold from the Watershed in 1934. Since relatively all of it came from sawlog-size trees that were used for lumber and other products, it caused no direct drain upon the forest. Approximately 4,200 man-days were involved in its cutting and hauling in 1934.

DISTILLATION WOOD

The Tennessee Eastman Corporation at Kingsport, Tennessee (just east of the Watershed), is the only consumer of chemical wood from the unit. It produces acetic acid, alcohol, other chemicals, and charcoal, drawing its raw material from a radius of about 100 miles. One-third of the wood used is trucked to the plant; the remainder is shipped by rail. The plant uses annually several thousand cords of wood from within the Norris Dam Watershed. Cutting and hauling of this wood furnishes about 7,100 man-days of labor per year locally.

FIGURE 10. - OLD-GROWTH TIMBER STAND, PARTLY CUT OVER

FIGURE 11. - MINE TIMBERS AND TIES READY FOR LOADING ON MINE CARS

FOREST DRAIN

Although the forest growing stock in the Norris Dam Watershed has been greatly reduced both in quantity and quality in the last hundred years, it still constitutes a valuable and important source of raw material and an opportunity for capital investment and for forest labor. The following account of forest utilization and the drain occasioned thereby is condensed from "Utilization and Drain of Forest Products in the Norris Dam Watershed in 1934", by the Tennessee Valley Authority, Division of Forestry, Knoxville, Tenn. Table 14 shows the estimated production of wood products during 1934 and for each product the merchantable stem volume of living trees used for its production.

TABLE 14. - *Volume of wood products in 1934*

Commodity	Amount produced in 1934	Units of measurement	Drain against living tree inventory [1]		Drain against growing stock [2]	
			Total [3]	Sawtimber material [4]	Total [3]	Sawtimber material [4]
			M cu.ft.	*M bd.ft.*	*M cu. ft.*	*M bd.ft.*
Lumber [5]	19,336,000	Bd. ft.	[6] 4,485	[6] 20,188	[6] 4,263	[6] 19,183
Staves and headings	669,600	Pieces	[6] 365	[6] 1,648	[6] 365	[6] 1,648
Railroad ties	14,689,000	Bd. ft.	[6] 3,492	[6] 15,717	[6] 3,492	[6] 15,717
Mine timbers-hewn	2,880,000	Cu. ft.	1,937	2,905	1,319	2,198
Poles	3,000	Pieces	[6] 72	[6] 350	----	-----
Posts	930,000	Pieces	1,004	[7] 1,622	885	[7] 1,524
Tobacco sticks	2,158,000	Pieces	168	-----	168	-----
Shingles (rived)	1,575,000	Pieces	[6] 133	[6] 600	[6] 121	[6] 546
Pulpwood	6,500	Cords [8]	520	1,167	416	1,167
Tannic acid wood	8,100	Cords [8]	216	906	----	-----
Distillation wood	5,900	Cords [8]	260	801	208	801
Fuelwood	319,800	Cords [8]	[9] 8,536	2,561	[9] 854	2,561
Totals			21,188	48,465	12,091	45,345

[1] All living trees (sound trees, sound culls, and rotten culls).

[2] Drain against chestnut, sound culls, rotten culls, and weed trees is not included.

[3] Including drain from top stems.

[4] Lumber tally. These volumes are included in the total cubic feet figures.

[5] Including sawed mine timbers.

[6] Including incidental drain.

[7] Locust and mulberry are expressed in pieces and cubic feet only.

[8] Standard cords.

[9] Fuelwood from tops of trees cut for other products is included as drain for other commodities and is not included under fuelwood drain.

Forest industries are believed to have been operating at an average rate in 1934, probably higher than in 1931, 1932, and 1933, owing to the general improvement in business and to the initiation of the Tennessee Valley Authority program, but probably lower than in the relatively prosperous decade ending in 1930.

Commodities derived as by-products are charged to the primary use for which the trees were felled. Thus distillation wood obtained from the tops of trees cut for lumber is included as drain from lumber production, and not as drain due to cutting distillation wood.

To compare the annual drain against living trees with the annual growth it is necessary to compute the drain against the species and classes of timber considered as growing stock, which, it should be noted, includes only the sound trees of all species except chestnut and weed trees. The drain against growing stock, so computed, is 12 million cubic feet. The drain against the sawtimber component of this growing stock is 45 million board feet, lumber tally.

LUMBER

In 1934 about 19,336,000 board feet of lumber were manufactured from the sawtimber of the Norris Dam Watershed. In table 15 this total is distributed by species groups. Approximately 28 percent is white oak; 20 percent, yellow poplar, basswood, etc; and 16 percent, red and black oaks. These figures include sawed mine timbers but not ties and staves.

TABLE 15. - *Lumber production by species groups in 1934*

Species group	Production	Percent of total
	Board feet	
White oak	5,331,000	27.5
Yellow poplar, basswood, etc.	3,794,000	19.6
Red and black oaks	3,084,000	15.9
Pines	2,082,000	10.8
Chestnut oak	1,925,000	10.0
Chestnut	1,408,000	7.3
Hickories	618,000	3.2
Beech	468,000	2.4
Hard maple	400,000	2.1
Miscellaneous	226,000	1.2
Total	19,336,000	100.0

The 1934 lumber drain of 20,188,000 board feet, against the living tree inventory, as shown in table 14, is derived by subtracting 469,000 board feet of dead chestnut from the lumber tally, and adding 1,321,000 board feet for material that under current logging practice is left in the woods or used in logging operations, but which as standing timber is included in the sawtimber estimate. Converted into cubic measure, with stemwood in the tops added, it is approximately 4,485,000 cubic feet.

STAVE AND HEADING STOCK

During 1934, there were produced in the Watershed 69,600 rough staves and 600,000 pieces of rough heading, which together contained an actual product volume of about 710,000 board feet. Only the biggest and highest-quality white oak sawtimber trees are suitable for the manufacture of these products, and the production is expected to decline due to the exhaustion of stumpage. The manufacture of staves and heading involves an extremely heavy wastage, since only a small part of the trees meets the strict specifications; they, therefore, caused an actual drain of approximately 1,648,000 board feet from the living tree inventory, or 365,000 cubic feet, including the tops.

RAILROAD TIES

In 1934, about 331,000 railroad crossties, containing a total volume of 13,888,000 board feet, were produced in the Norris Dam Watershed area. In addition, 801,000 board feet of switch ties were produced, which increased the total tie volume to 14,689,000 board feet. The annual drain against the living tree inventory, caused by tie production, is 15,717,000 board feet, including an incidental drain of 7 percent. It is estimated that the entire volume comes from trees of sawtimber size and quality. Of the total number of ties, about 85 percent are white oak, 14 percent are red oak, and 1 percent are locust and pine.

HEWN MINE TIMBERS

The total coal output of the Norris Dam Watershed in 1934 was 6,942,821 tons. In timbering the mines, in addition to the sawed mine timbers included in the lumber production, hewn mine timbers (props, collars, ties, and cap-boards) totalling 3,513,000 cubic feet were consumed---about one-half cubic foot per ton of coal mined. Approximately 80 percent, or 2,880,000 cubic feet, was cut from the forests of the Watershed; the other 20 percent was imported from nearby areas.

Chestnut furnished 49 percent of the hewn mine timbers used in 1934; mixed oaks, 26 percent; yellow poplar, 10 percent; and beech and other species, 15 percent. Approximately only one-third of the chestnut was cut from living trees. It is estimated that only one-fourth of the total drain against the living tree inventory was taken from trees of sawtimber size and quality. This amounted to 2,905,000 board feet. Most of the balance came from high-quality trees below sawtimber size. The total drain from the living tree inventory was 1,937,000 cubic feet, including drain from tops.

POLES

Power- and telephone-line pole replacements in 1934 involved the use of 4,753 poles, of which 3,000 were locally produced chestnut poles. The remaining 1,753 were creosoted southern pine poles and cedar poles imported into the Watershed. It is likely that the supply of live chestnut poles will be depleted in a few years.

The poles had an average volume of 106 board feet, lumber tally. It is estimated that all were cut from living chestnut of sawtimber size and quality. Adding 10 percent for incidental drain gives a drain from the total living tree inventory of 350,000 board feet, or 72,000 cubic feet including tops.

FENCE POSTS

It is estimated that approximately 930,000 new fence posts, with a total volume of about 1,166,000 cubic feet, are cut and placed in use annually in the Norris Dam Watershed.[1] Locust makes up about 43 percent; cedar, 32 percent; chestnut, 21 percent; and mulberry and other species make up the remaining 4 percent.

The cutting of posts involves an annual drain of only approximately 1,004,000 cubic feet from living trees, including tops. Furthermore the greater number of posts are cut from trees below sawtimber size; the remainder are split from trees of sawtimber size, and when converted to board measure equal 1,622,000 board feet. More than 90 percent of the drain is from sound trees. Close utilization is practiced and incidental drain is negligible.

TOBACCO STICKS

Farmers in the Norris Dam Watershed used about 10,792,000 tobacco sticks in 1934. Since about one-fifth of the sticks used are destroyed yearly, there is an annual consumption of about 2,158,000, which contain 112,000 cubic feet; however, because of the waste, 168,000 cubic feet are annually required for this product. About 39 percent of the sticks are oak; 34 percent, yellow poplar; and the remaining 27 percent, hickory, pine, and other species.

HAND-RIVED SHINGLES

About 1,575,000 hand-rived shingles were produced in the unit during 1934 and sold at Norris, Tennessee. Including waste, drain against living trees amounted to 600,000 board feet, or 133,000 cubic feet including the tops. Only large, straight, well-formed trees of sawlog size are used; and practically all of the sapwood, the center, and the knotty portions of the tree boles are wasted. In 1934 red oak comprised about 63 percent of the total production; white oak, 28 percent; and chestnut, 9 percent.

PULPWOOD

In 1934 the Norris Dam Watershed contributed 6,500 standard cords of peeled pulpwood to the two nearby mills. Yellow poplar made up almost half of the total volume; soft maple, sweet gum, basswood, and black gum were the other species used in large quantities. About one-third came from trees of sawtimber size and two-thirds from smaller trees. Pulpwood cutting involved a drain against the living tree inventory of 520,000 cubic feet, of which 80 percent was from sound trees. It included about 1,167,000 board feet of sawtimber material.

---

[1] Including 1,200 highway guard-rail posts.

TANNIC ACID WOOD

In 1934 the unit furnished nearby extract plants with 8,100 standard cords of chestnut. About 70 percent of this volume came from trees of sawtimber size. It is estimated that only one-third, or 216,000 cubic feet, including topwood, came from living trees. This included 906,000 board feet of sawtimber material.

DISTILLATION WOOD

The unit produced 5,900 standard cords of distillation wood in 1934. Approximately 45 percent came from sawmill waste and the salvaged tops and limbs of trees cut for lumber, ties, etc., which has already been accounted for in the drain of these products. Approximately 260,000 cubic feet (including 801,000 board feet from trees of sawtimber size and quality) was independent drain against the living tree inventory. Approximately 80 percent of the total volume came from sound trees and 20 percent from culls. Oak comprises 75 percent of the wood used; hickory, 10 percent; beech, 5 percent; and other nonpulping woods, excepting cedar and chestnut, make up the remaining 10 percent.

FUELWOOD

A greater volume of wood is consumed in this unit for fuel than for any other purpose. According to the study made by the Tennessee Valley Authority, the Norris Dam Watershed community consumes annually about 319,800 cords, or 25,866,000 cubic feet of fuelwood. Of this total 8,536,000 cubic feet, or 33 percent, constitute drain against the living tree inventory; 17,330,000 cubic feet, or 67 percent, come from dead trees (chestnut and other species) and from the tops of trees cut for other products. Chestnut makes up 48 percent of the total; chestnut oak, 21 percent; other oaks, 9 percent; hickory, 13 percent; and pine, 9 percent.

DRAIN FROM CHESTNUT

In the preceding discussion of drain, dead chestnut has been excluded. Dead chestnut contains a volume of about 128 million cubic feet and live chestnut 58 million cubic feet, making a total of 186 million cubic feet. There is an annual consumption of both live and dead chestnut of about 15 million cubic feet, of which fuelwood accounts for 83 percent, mine timbers 9 percent, extract wood 4 percent, and other products 4 percent.

At the present rate of drain there is a sufficient quantity of chestnut to last about 12 years. The wood is deteriorating rapidly, however, and should be utilized as fast as markets can be found if much of it is to be salvaged. [1]

---

[1] E. H. Frothingham, Timber Growing and Logging Practice in the Southern Appalachian Region. U. S. D. A. Tech. Bull. 250, page 52.

COMPARISON OF GROWTH AND DRAIN

The total annual growth of live sound trees[1] other than weed species and chestnut is about 16 million cubic feet,[2] of which the sawtimber component is 49 million board feet, lumber tally.[3] The 1934 drain against this growing stock, including the cut of all commodities, is 12 million cubic feet; or for sawtimber alone, 45 million board feet, lumber tally.

If the quality of the product were not considered or the possibility of the site taken into account, this surplus of 4 million cubic feet of growth over drain would indicate a satisfactory situation, in that a considerable part of the growth would seem to be available for both the expansion of forest industries and the building up of the growing stock. Analysis of the situation, however, shows depleted growing stock; too small a proportion of the annual growth in high grade timber for which there is a ready market with good financial returns; and too large a proportion in either unmerchantable or low grade trees suitable only for low-priced commodities.

Figure 12 shows the relation of growth to drain in the various size-classes of trees.

Five million cubic feet of the annual growth can be roughly allocated to trees that will be at least 5 inches in diameter breast high and below sawlog-size at the end of one year; 6 million to trees that will be sawlog-size but less than 19 inches in diameter; and 5 million to trees that will be 19 inches or larger in diameter. The actual volume of trees moving from one size class to another is considered as growth. The annual net drain of 12 million cubic feet is taken from the growing stock approximately as follows: 2 million cubic feet from trees under sawlog size; 7 million from sawlog-size trees less than 19 inches in diameter; and 3 million from sawlog-size trees 19 inches or larger in diameter. Forest industries are over-cutting the medium-size trees by about a million cubic feet annually, and are cutting less than the growth in the small and large trees. The appraisal of this situation, an interpretation of its significance, and recommendations designed to improve the situation are taken up in the next section of this report.

---

[1] See glossary for definitions.

[2] Estimate in table 13 --- 15,822,000 cubic feet.

[3] International 1/4 inch log rule, which closely approximates green lumber tally.

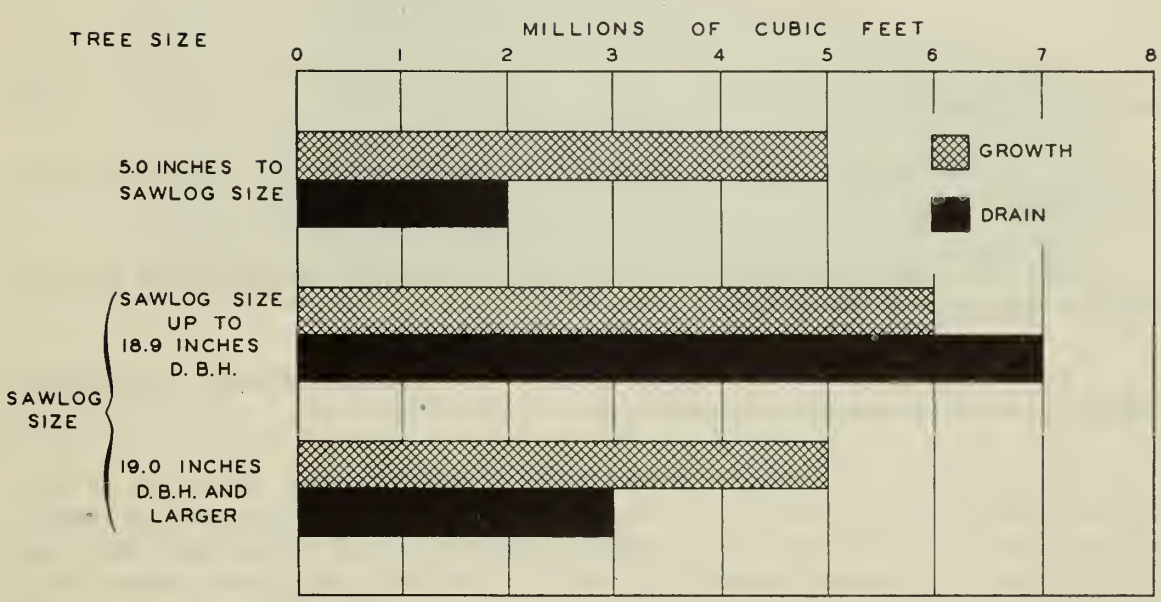

FIGURE 12. - APPROXIMATE NET ANNUAL GROWTH AND DRAIN OF LIVE SOUND TREES OTHER THAN WEED SPECIES AND CHESTNUT (The growth figures include the volume of trees moving from one size class to another.)

MEASURES TO IMPROVE THE SITUATION

Although the forest still plays an important part in the lives of the people of the Watershed, it is deteriorated to the extent that it is contributing only a fraction of what it could if properly managed. Several fundamental improvements are suggested.

REHABILITATION OF THE GROWING STOCK

The forest growing stock of the Norris Dam Watershed is deficient in at least three ways:

1. - The stands contain a high percentage of defective and unmerchantable trees.

2. - The average number of trees per acre is considerably below the productive capacity of the site.

3. - The number of the larger trees in the stands has been reduced considerably below a desirable porportion.

In the forest as a whole, defective and inferior trees now make up over one-fourth of the total number of stems. This unfavorable situation has resulted from forest fires, fungi, from logging practices, and occasional sleet and wind storms. By always leaving the poorer trees and taking the better ones, logging practices, especially, have contributed to this situation. In uncut stands many of the trees are old, over-mature, and are constantly deteriorating. Weed trees, worthless for industrial use, are also found throughout the area. Sound forest management requires that the space occupied by cull and weed trees be made available for sound trees of the more valuable species.

As the result of many decades of over-cutting and harvesting the best and largest trees, leaving the smallest and least desirable, the volumes of the growing stock in the several size-classes have become badly unbalanced. Too small a proportion of the growing stock is in the larger trees.

A desirable distribution of basal area in a well-managed, sustained-yield, hardwood forest is shown in figure 13: small timber about 20 percent; medium timber, 30 percent; and large timber, 50 percent. Under such a distribution of basal area an adequate proportion of the annual growth is laid down on large, high-quality trees.

In contrast to this the stands[1] in the area at present show the following basal area proportions (as indicated in figure 14): small timber, 41 percent; medium timber, 39 percent; and large timber, 20 percent. With so large a proportion of the stand volume in the smaller trees, the average annual growth is necessarily low in quality, and can return but a fraction of the financial realization possible were more of the growth in larger trees.

---

[1] Forest area, exclusive of reproduction and clear-cut conditions.

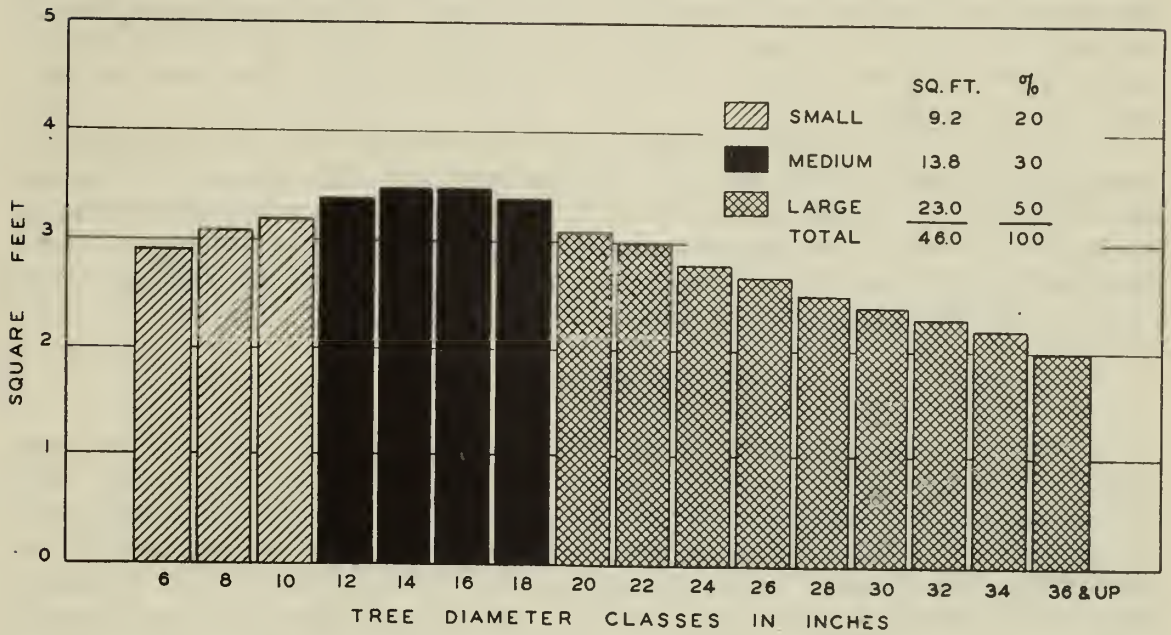

FIGURE 13. - DESIRABLE BASAL AREA PER ACRE FOR A MANAGED STAND

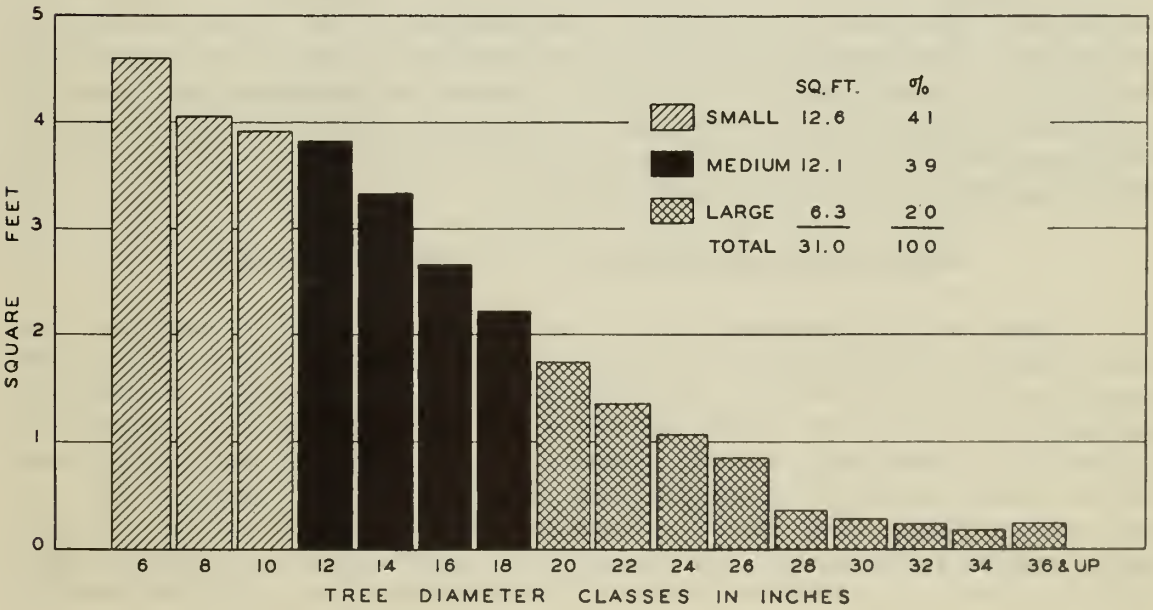

FIGURE 14.- PRESENT BASAL AREA PER ACRE OF THE ESTABLISHED STANDS

Obviously three things stand out as necessary to bring about a marked improvement in the growing stock: (1) the defective, over-mature, malformed, and weed trees should be removed from the stand; (2) the number of sound, valuable trees per acre must be increased; and (3) the large tree component of the growing stock should be built up in order to bring about a better balance in size classes.

To reach the objectives stated above, there must be a broad educational campaign designed to introduce better forest practices, an extension of Federal and State aid in organized fire protection and in the construction of forest roads, and a movement to encourage markets for low grade commodities in order that the region's needs for income and work may be satisfied without a continued rapid utilization of the larger trees.

FORESTRY EXTENSION WORK

Since the forest stands of the Watershed are almost entirely privately owned and in the hands of many owners, the majority of whom neglect their forests and are not skilled in even the elements of good forest management, an intensive and expanded campaign of forestry education seems basic before any marked improvement in the situation is to be expected. This extension work will probably be most successful if it follows closely the plans used in agricultural extension work. Personal contacts with individual owners, demonstration areas, sample marking, etc., besides building up a consciousness and appreciation of good forest practice and its possibilities, will actually train individual owners in thinnings, improvement cuttings, and other steps in sound forest management.

INCREASED FIRE PROTECTION

Although, as a result of successful forestry education, it is to be expected that there will be a greater understanding of the harmful effects of forest fires and a greater demand for protection, this alone will hardly suffice. In addition, there should be a material increase in the amount and intensity of public aid, both State and Federal, in fire protection. Freedom from fires will check the formation of cull trees, and will facilitate restocking of the blanks and thin places in the forest stands.

DEVELOPMENT OF MARKET FOR ALL FOREST PRODUCTS

Education of the owners in the principles of forest management, and public aid in fire protection, will not be sufficient, however, to place the forest operations in the most favorable position for the future. To build up the large tree component of the stands and to give the stands an opportunity to produce a larger part of their annual yield as high-grade material on trees of the larger diameters, a greater demand should be developed for the low-grade commodities. Fuel, tannic acid extract, distillation materials, woodpulp, posts, and mine timbers are all low quality products; and two-thirds of these materials can be cut from cull trees, which are present in sufficient quantity

to allow considerable expansion in output if a larger market for these products could be found. It is estimated that the volume of wood suitable for the above uses in undesirable living trees alone is 93 million cubic feet, and in dead sound chestnut 128 million cubic feet; but the present demand for these products is not great enough to supply satisfactory income to the owners or sufficient opportunity for labor, and thus fails to meet the economic and social requirements of the area. Under present market demand, it is scarcely to be expected that private owners will (or can) greatly improve their cutting practices.

While there is a possibility that the present industries now established in or near the Norris Dam Watershed may be able to absorb somewhat larger quantities of this low-grade material from the region, to make any real progress it appears desirable to encourage both the expansion of present plants and the establishment of new industries that can use this class of wood. In its plan for the disposal of surplus electric power, the T.V.A. has an opportunity to develop and encourage such industries as pulp mills, wood chemical plants, tannic acid plants, handle and low cost furniture factories, toy and novelty mills, and similar installations that would provide an outlet for the classes of material which should be removed from the forest stands.

These new industries need not be located in the Norris Dam Watershed, but may be strategically placed where they can draw their raw materials from several forest units. Improved transportation facilities will greatly facilitate the effectiveness of outside industries in utilizing the Watershed's surplus forest growth.

Important as it is, the present contribution of the depreciated forests to the wealth and social welfare of the region is no true measure of what it might be if the forest resources were wisely managed and fully utilized.

Assuming no increase in the present cut of the growing stock, if protection from fire is given, a cutting practice designed to reproduce the best species is followed, the cull-tree component of the stand removed, and a greater percentage of the larger trees left to grow high quality material, it seems not unreasonable to expect that after 10 years of such management the total annual increment might be increased as much as 50 percent. Thus, after a decade of good management, the annual growth would be increased to 24 million cubic feet, which would then justify doubling the volume of the annual cut from sound trees and would raise its market value even more. Continued progress thereafter in the improvement of the growing stock, coupled with careful cutting practice and ready markets, could do much to put the forest industries of the Norris Dam Watershed on a sound and permanently prosperous basis.

GLOSSARY OF TERMS USED

AGRICULTURAL LAND CLASSES

OLD CROPLAND: Land cultivated more than three years and on which a farm crop was raised within two years prior to the date of survey. Orchards are included.

NEWLY CLEARED CROPLAND: Land converted from forest to cropland within three years prior to date of survey, as indicated by stumps or deadened trees on the land. Orchards are included.

IDLE CROPLAND: Cultivated land that has not been used for two years or more, but that has not reached the abandoned stage.

ABANDONED CROPLAND: Land formerly cultivated but showing distinct evidence of having been abandoned for agricultural crop production; no attempt is being made to maintain it as improved pasture. Forest growth is not yet established.

IMPROVED PASTURE: Cleared or open land under fence used primarily for grazing; an attempt has been made to maintain a sod.

FOREST CONDITIONS [1]

OLD GROWTH: Stands composed predominantly of sawtimber trees that have the characteristics of the original mature trees found in the region.

Uncut: Stands from which less than 10 percent of the old-growth sawtimber has been cut.

Partly cut: Stands from which 10 percent or more of the old-growth sawtimber has been cut, leaving at least 1,000 board feet per acre.

SECOND GROWTH: Stands that have succeeded the original old growth, as a result of forest cutting or other causes.

Sawlog-size, uncut: Stands from which less than 10 percent of the sawtimber has been cut, leaving at least 600 board feet per acre.

Sawlog-size, partly cut: (1) Stands other than cedar, from which 10 percent or more of the sawtimber has been cut, leaving at least 400 board feet per acre; and (2) cedar stands, regardless of the cutting, that contain at least 200 linear feet per acre of boles suitable for sawtimber.

---

[1] Cedar type stands have been placed in the following conditions only: (1) second growth, sawlog-size, partly cut; (2) second growth, under-sawlog-size, uncut; (3) reproduction; and (4) clear-cut.

Under-sawlog-size, uncut: (1) Stands other than cedar, composed predominantly of under-sawlog-size trees at least 1.0 inch in diameter, less than 10 percent of which have been cut (sawtimber present amounts to less than 600 board feet per acre); and (2) cedar stands, regardless of the cutting, that contain less than 200 linear feet per acre of boles suitable for sawtimber.

Under-sawlog-size, partly-cut: Stands composed predominantly of under-sawlog-size trees at least 1.0 inch in diameter, 10 percent or more of which have been cut. The volume of sawtimber present is less than 600 board feet per acre.

Reproduction: Areas of second growth not falling into any of the other classes, and bearing more than 80 seedlings per acre less than 1.0 inch in diameter at $4\frac{1}{2}$ feet from the ground.

CLEAR-CUT: Cut-over areas on which an insufficient quantity of young growth has come in to classify them as second growth.

NON-COMMODITY: Forest land that will grow only brush or scrubby trees unfit for commercial use.

FOREST TYPES

HARDWOOD: Pure or mixed stands of yellow poplar, chestnut, chestnut oak, hickories, black oak, forked-leaf white oak, scarlet oak, and other hardwoods; stands of hardwoods and pine mixed in which hardwoods make up at least 75 percent of the sawtimber volume, if sawlog-size stands, or 75 percent of the dominant and codominant stems, if under-sawlog-size stands; and stands of hardwoods and cedar mixed in which the hardwoods make up more than 50 percent of the sawtimber volume, if sawlog-size stands, or 50 percent of the dominant and codominant stems, if under-sawlog-size stands.

PINE-HARDWOOD: Stands of hardwoods and pine mixed in which neither the hardwoods nor the pine alone make up 75 percent of the sawtimber volume, if sawlog-size stands, or 75 percent of the dominant and codominant stems, if under-sawlog-size stands.

PINE: Stands of pine and hardwoods mixed in which pine makes up at least 75 percent of the sawtimber volume, if sawlog-size stands, or 75 percent of the dominant and codominant stems, if under-sawlog-size stands; and stands of pine and cedar mixed, in which pine makes up more than 50 percent of the sawtimber volume, if sawlog-size stands, or 50 percent of the dominant and codominant stems, if under-sawlog-size stands.

CEDAR: Stands in which cedar makes up at least 50 percent of the sawtimber volume, if sawlog-size stands, or 50 percent of the dominant and codominant stems, if under-sawlog-size stands.

SPECIES GROUPS
(*cubic volume composition*)

The percentage of the volume of each group accounted for by the species in the group is about as follows:

Yellow poplar, basswood, etc. - yellow poplar, 68%; cucumber magnolia, 14%; basswood, 12%; buckeye, 5%; red gum, 1%.
Soft maples - red maple, 100%.
Other pulping hardwoods - black gum, 87%; butternut, 8%; mountain magnolia, umbrella magnolia, and miscellaneous species, 5%.
Shortleaf and pitch pines - shortleaf pine, 83%; pitch pine, 17%.
Other pines - white pine and mountain pine, less than 1%; remainder, Virginia pine.
Hemlock - hemlock, 100%.
Red oaks - black oak, 39%; northern red oak, 23%; scarlet oak, 35%; southern red, shingle, pin, and shumard oaks, 3%.
Forked-leaf white oak - forked-leaf white oak, 100%.
Chestnut oak - chestnut oak, 100%.
Other white oaks - chinquapin oak, 57%; post oak, 41%; swamp white oak, 2%.
Hickories - hickories, 100%.
Beech - beech, 100%.
Hard maple - sugar maple, 100%.
Black walnut and cherry - black walnut, 86%; black cherry, 14%.
Ashes - practically all white ash.
Birches - sweet birch, 94%; yellow birch, 6%.
Post species - black locust, 84%; sassafras, 13%; mulberry, 3%.
Dogwood and persimmon - dogwood, 65%; persimmon, 35%.
Other nonpulping hardwoods - sycamore, 36%; elms, 46%; honey locust, hackberry, and coffee-tree, 18%.
Cedar - cedar, 100%.
Chestnut - live chestnut, 100%.

TREE CLASSES

SAWLOG-SIZE TREE: A tree with a D.B.H. as follows: hardwood, at least 11 inches; pine or hemlock, at least 9 inches; cedar, at least 7 inches.

SAWTIMBER TREE: (1) A sawlog-size cedar with at least 6 feet of usable bole length; and (2) a sawlog-size tree other than cedar, with a sound butt log at least 12 feet in length, or if the butt log is cull, with at least 50 percent of its gross volume in sound sawtimber material (except trees of large diameter or valuable species that would justify being cut for a shorter log or for less than 50 percent of the gross volume).

SOUND TREE: A sawtimber tree, or an under-sawlog-size tree that gives promise, with additional growth, of becoming a sawtimber tree.

SOUND CULL TREE: A sawlog-size tree that is not, or an under-sawlog-size tree that will not become, a sawtimber tree, owing to form, crook, knots, extreme limbiness, or other similar defects.

ROTTEN CULL TREE: A tree in which the volume of decayed wood is more than 50 percent, if a sawlog-size tree, or sufficient, if an under-sawlog-size tree, to indicate the liklihood of its future loss from the stand.

MISCELLANEOUS

D. B. H. (*diameter-breast-height of trees*): Diameter, outside of bark, 4½ feet from the ground.

TWO-INCH DIAMETER CLASSES: Trees ranging from 5.0 inches to 6.9 inches in D.B.H. are placed in the 6-inch class; corresponding limits apply to the other diameter classes.

SCRIBNER LOG RULE: In computing present volume and growth, the formula for a 16-foot log with a 1/4 inch saw-kerf allowance was used, $V = .79D^2-2D-4$, derived by Donald Bruce and Francis X. Schumacher from the values of the original Scribner log rule.

NORRIS DAM WATERSHED

MAP TO ACCOMPANY REPORT OF

FOREST SURVEY - SOUTHERN FOREST EXPERIMENT STATION

1936

SCALE STATUTE MILES 0 10 20 30

LEGEND

- FOREST LAND
- NONFOREST LAND
- UNIT BOUNDARY
- COUNTY BOUNDARY
- STEAM RAILROADS
- HIGHWAYS
- TOWNS & VILLAGES
- COUNTY SEATS

FOREST LAND AND BOUNDARIES AS SHOWN WERE OBTAINED FROM A MAP PREPARED BY THE FORESTRY DIVISION OF THE TENNESSEE VALLEY AUTHORITY JULY 1935

N

W VA
VA
KY
VA
KY
TENN
VIRGINIA
TENNESSEE
MCDOWELL
BUCHANAN
DICKENSON
TAZEWELL
SMITH
LETCHER
HARLAN
WISE
SCOTT
STONE GAP
DUNGANNON
RUSSELL
WASHINGTON
BRISTOL
KINGSPORT
HAWKINS
SULLIVAN
WHITLEY
LEE
CLAIBORNE
SCOTT
CAMPBELL
LAFOLLETTE
CAMPBELL
NORRIS DAM
NORRIS
UNION
KNOX
ANDERSON
GRAINGER
HAWKINS
KNOXVILLE

RELATION OF NORRIS DAM WATERSHED TO THE TENNESSEE RIVER BASIN

KENTUCKY
TENNESSEE
TENNESSEE RIVER BASIN
ALABAMA
GEORGIA

RDA 3-21-38

SOUTHERN FOREST EXPERIMENT STATION NEW ORLEANS, LA.

Southern Forest Survey

Forest Resources of the Norris Dam Watershed

LIBRARY
GREAT SMOKY MOUNTAINS
NATIONAL PARK