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IN COOPERATION WITH THE FOREST SERVICE

U. S. DEPARTMENT OF AGRICULTURE

HENRY S. GRAVES, Forester

PRELIMINARY STUDY OF FOREST CONDITIONS IN TENNESSEE

BY R. CLIFFORD HALL
FOREST ASSISTANT, FOREST SERVICE

EXTRACT (A) FROM BULLETIN NO. 10, FOREST STUDIES
IN TENNESSEE

NASHVILLE
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DECEMBER, 1910

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STATE OF TENNESSEE—STATE GEOLOGICAL SURVEY

GEORGE H. ASHLEY, State Geologist

IN COOPERATION WITH THE FOREST SERVICE

U. S. DEPARTMENT OF AGRICULTURE

HENRY S. GRAVES, Forester

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THE STATE GEOLOGICAL SURVEY
OF TEXAS
IN COOPERATION WITH THE FOREST SERVICE
OF THE UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF FOREST RESEARCH

PRELIMINARY STUDY OF
FOREST CONDITIONS IN TEXAS

The study upon which this report is based was undertaken by the Forest Service in coöperation with the State Geological Survey, the work being done under the direction of the Office of State Coöperation in the Forest Service and under the local instructions of the Director of the Survey. By the terms of the coöperative agreement the State is authorized to publish the findings of the investigation.

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VIRGIN FOREST OF HEMLOCK ON UPPER NORTH SLOPE—SEVIER COUNTY.

Preliminary Study of Forest Conditions in Tennessee

The bill establishing the Tennessee State Geological Survey specifies as one of its duties:

"An investigation of the forests, . . . with especial reference to their conservation and development for industrial enterprises."

In accordance with this provision, the Geological Survey secured the coöperation of the Forest Service of the United States Department of Agriculture in a preliminary study of forest conditions in the State, the Forest Service paying one-half of the cost. The object of this study was to determine the forest resources and possibilities of the State, the legislation needed to secure protection and preservation of the forests, and the lines along which more detailed forest investigations can most profitably be carried out. In November and December, 1910, typical sections of each forest region were examined by a representative of the Forest Service, and interviews were obtained with public officials, lumbermen, and others familiar with local conditions. Considerable information was also obtained from reports on private tracts previously examined by the Forest Service.

SUMMARY.

The following is a brief statement of the results of the study and the conclusions drawn:

1. It is estimated that about 35 per cent of the total area of the State is in forest.
2. A large part of this land is best suited for growing timber.
3. It is of utmost importance, especially in the Unaka Range and the Cumberland Plateau, to conserve the forests that cover the steep slopes, not only for their timber supply, but also because of their protective value to the soil and their beneficial influence in regulating stream flow.

4. The forest land of the State is losing its capacity to produce valuable timber on account of forest fires and short-sighted, wasteful methods of cutting. Surface fires, which are very common throughout the State, in addition to burning the humus out of the soil and destroying the leaf mulch, kill young growth and injure larger trees at the butt, so that insects and rot can enter the wood and impair its commercial value. The usual methods of cutting are at fault in that too large a proportion of the tree is not utilized, and at the same time no provision is made for securing future crops. Both fire and repeated culling of the better trees result in the replacement of good timber by a comparatively worthless second growth.

5. Better methods of management should be instituted in order to increase the productiveness of forest land and to afford a permanent supply of raw material for the important wood-using industries of the State. By cutting old timber in such a way as to secure the restocking of the land with valuable species, by stimulating the growth of young timber by thinning out the inferior trees, and by other common-sense measures, the annual growth can be greatly increased and the possible lumber production of the future correspondingly augmented.

6. It is to the best interest of the State to promote the practice of forestry by adopting a progressive forest policy, including the employment of a State Forester, the establishment of a fire protective system, and the creation of State Forests. Such a policy has been adopted in whole or in part by twenty States.

7. The State Forester, in addition to administering the fire protective system and the State Forests, should engage in educational and research work, and in every way possible should assist the citizens of the State to make their woodlands more productive. He could do this by publishing simple and instructive pamphlets on various phases of forest management, by public lectures, by demonstration work on State Forests, and by preparing and superintending the execution of working plans for private forest lands upon request of the owners. It is impossible to overestimate the value of such work in bringing about a general use of more profitable methods of handling timber land.

GENERAL CONDITIONS.

The State of Tennessee presents a great variety of topographic and soil conditions. The eastern portion is mountainous in char-

FLOOD DAMAGE TO RAILWAY ON NOLICHUCKY RIVER, MAY, 1901—UNICOI COUNTY.

acter and extends from the crest of the Appalachian Mountains westward over the western flank and foothill region of the Unakas, or Great Smoky Mountains, the Valley of East Tennessee, and the Cumberland Plateau. The rolling central portion includes the Highland Rim and the Central, or Nashville, Basin. The gently rolling western portion, lying between the narrow western valley of the Tennessee River and the Mississippi bottom lands, is known as the Plateau and Slope of West Tennessee.

The mean annual temperature for the State is about 59 degrees, varying from 57 degrees in the East to 61 degrees in the West. The average absolute annual range of temperature is about 90 degrees. The length of the growing season varies from about 175 days in the East to about 200 days in the West. The average annual precipitation is 50 inches, generally fairly well distributed. Thus climatic conditions are favorable to the growth of trees and other vegetation.

Transportation facilities by water are supplied by three great navigable rivers—the Mississippi, on the western boundary; the Cumberland, in the northern part; and the Tennessee, which crosses the State twice. These furnish about 1,200 miles of navigable waters, while a great many of their tributaries are also suitable for floating timber. In addition, there is a fairly well developed system of railroad transportation, with a mileage of over 3,600 miles.* Few portions of the State, even in the mountainous regions, are more than 25 miles from a railroad, and the greater part of the State is within 15 miles of railroad shipping points.

The larger part of the land in Tennessee is owned by farmers, and for the most part in small tracts, except in the mountainous portions of the State and in the Mississippi bottoms. In these portions larger bodies of land are often held by corporations or individuals, usually either for speculation or exploitation of their forest or mineral wealth. Here surface, timber, and mineral rights are frequently held by different owners. All of the larger bodies of virgin timber are owned by lumber companies. There is still considerable confusion in regard to land titles in the wilder parts of the State.

Taxation of timber lands has had but little influence upon forest management. While the present system is not ideal in principle or method of application, it has not resulted thus far in imposing

* "Statistics of Railways in the United States," Interstate Commerce Commission.

an excessive burden on timber land owners as a class. Consequently there is little or no reason to believe that the cutting of timber has been hastened on account of taxes.

TIMBER INDUSTRIES.

The manufacture of lumber and timber products ranks second among the industries of Tennessee. In 1905 the value of these products amounted to over \$21,500,000, while the capital invested was over \$16,000,000. This is exclusive of planing-mill products, including sash, doors, and blinds, which in 1905 reached a value of over \$4,500,000, with an invested capital of over \$3,000,000. Fuel wood and a large amount of hewn and split material cut for local use would not be accounted for in these figures, although they constitute an important additional drain upon the forest. The consumption of firewood within the State is estimated at 4,730,000 cords for the year 1908. The most important products are rough and finished lumber of all kinds, railroad ties, staves and heading, vehicle stock, handles, poles, mine timbers, posts, and tanbark. The principal commercial timbers are oak, yellow poplar, yellow pine, red gum, chestnut, white pine, hickory, and hemlock.

STUMPAGE VALUES.

The value of standing timber depends on a number of different factors, chief among which are (1) the distance of the tract from market, (2) its accessibility for logging, and (3) the quality of the material. Since these are quite variable, any average figures, such as are given here, are of very general application, and are not suitable for valuing particular tracts. The stumpage values given for Middle and East Tennessee are based upon a distance from the railroad of from 8 to 12 miles, a haul which would be made in one day. In West Tennessee, where much of the timber does not command a price high enough to warrant long hauls, the basis of the figures is a two-trip haul.

White and red* oaks are about equal in value if the red oak is of the best quality. In many cases, however, the red oaks consist of inferior species which have a lower stumpage value. The largest amounts of white oak are produced in the Cumberlandds, where it is worth about \$5 a thousand feet on the stump. Similar timber in the Highland Rim, which also produces considerable white oak,

* All merchantable black oaks are usually termed "red oak."

is worth about \$6 a thousand. The stumpage value of average quality red oak in Middle and East Tennessee is about \$3.

Yellow poplar is obtained from nearly every part of the State and brings from \$3 to \$5 more than white oak.

Yellow ~~White~~ pine is produced mostly in the eastern part of the Cumberland Plateau region, in the Valley of East Tennessee, and along the western borders of the Appalachian Mountains. It is usually worth about \$2 or \$3 a thousand on the stump.

Hemlock, which is obtained from the Cumberlands and Appalachian Mountains, is worth about \$1.50 or \$2 a thousand, including the bark, while white pine with a somewhat similar commercial distribution brings from \$3 to \$4 a thousand.

Chestnut is of commercial importance throughout Middle and East Tennessee, and usually is worth on the stump from \$1 to \$2 a thousand.

The value of hickory is especially uncertain, owing to its great variation in quality and to the fact that a special market and special methods of logging are required. In one large lumbering operation in the Cumberlands the hickory is left standing because of the difficulty of finding a suitable market. In general, it is worth from \$2 to \$5 on the stump. In West Tennessee, where the quality is as a rule not very good, it brings only about \$3, based on a haul of two trips a day.

The West Tennessee "soft woods," such as gum, ash, and cottonwood, are worth from \$2 to \$4 a thousand on the stump. When sold separately, ash and cottonwood are valued somewhat higher than gum. Here there is little true white oak, and all the oaks are usually classed together as to stumpage value, which is about \$6 or \$7. There is little market for beech, and it is of no value unless located directly on the railroad, when it sometimes brings from \$1 to \$2 a thousand.

SAW TIMBER.

In 1909 there were over 2,500 active sawmills in Tennessee. Most of them were of small capacity and operated intermittently, with an average cut of only about 490,000 board feet. Only 33 mills cut over 5,000,000 board feet, and nearly half of these were located in or near Memphis and received a great deal of raw material from other States. The number of small mills is increasing as the larger bodies of timber are cut over and it becomes necessary to lumber small and scattered tracts. There is a great deal

MAP 1—TENNESSEE

SAWMILL STATISTICS, 1909.

Figures show number of active mills within the county.

Dots show the approximate location of mills that sawed over 5,000,000 board feet in 1909.

TABLE 1.—PRODUCTION OF LUMBER, LATH, AND SHINGLES, 1909.
(*Tennessee.*)

LUMBER.	THOUSAND BOARD FEET.	PER CENT.
Oak	546,500	44.6
Yellow poplar	164,826	13.5
Yellow pine	117,135	9.6
Red gum	75,565	6.2
Chestnut	71,962	5.9
Hickory	58,477	4.8
White pine	35,553	2.9
Hemlock	35,593	2.9
Ash	18,709	1.5
Beech	18,341	1.5
Cottonwood	12,380	1.0
Basswood	11,463	.9
Elm	10,688	.9
Cedar	8,927	.7
Cypress	8,709	.7
Maple	8,610	.7
Walnut	4,068	.3
Sycamore	3,512	.3
Tupelo	3,180	.3
Balsam fir	1,489	.1
Birch	1,274	.1
Cherry	874	.1
Spruce	720	.1
All other	5,294	.4
Total	1,223,849	100.0
Lath, M pieces	31,179	
Shingles, M pieces	35,692	

of waste connected with small mills owing to rough methods, wide saw kerf, lack of alignment in the machinery, and unskillful sawyers. However, they are at a great advantage in being able to move at small cost from one wood lot to another, thus saving the expense of hauling the logs. Where timber is so far from the railroad that only select logs could bear the cost of hauling in that form, a portable mill can move in and saw the inferior timber into lumber which can obviously be hauled to market at a much lower cost than in the log. Furthermore, the small mills can dispose of a certain amount of inferior lumber locally that could not be sold in the general market. This kind of lumbering will in time entirely supersede the larger operations. Some of the big sawmills claim a supply sufficient to keep them running for thirty or forty years, but these are very few in number.

Map 1 shows the approximate number of sawmills in each county and the location of the large mills for the year 1909. This map indicates very plainly the widespread character of the industry.

The amount of timber sawed in 1909 is shown by species in Table 1.* The woods classified as "all other" are chiefly buckeye, dogwood, and persimmon.

Waste in the manufacture of lumber is likely to occur both in the woods and in the sawmill. Very often timber is wasted in the woods by leaving high stumps, by cutting logs into such lengths as to leave merchantable timber in the tops, and by leaving trees uncut which ought to be removed. It would sometimes be possible to secure closer utilization by working the tops into ties, slack staves, or other small products for which there may be a market. Of course, in the more inaccessible districts where most of the large operations are carried on, it is usually impossible to handle anything but saw logs at a profit.

There is also great possibility for waste at the mill because of unskillful sawing, or lack of means for using slabs. Lath mills are often run in connection with the larger sawmills, thus utilizing material which would otherwise be wasted. The small mills are at a disadvantage in this respect, since they cannot afford to install the necessary machinery for making such by-products. Mills located in cities can usually dispose of scraps for kindling wood. A great deal of timber would be saved if boards were cut in odd as well as in even lengths.

* Compiled by the Bureau of the Census in coöperation with the Department of Agriculture, Forest Service.

FIG. A.—HEWING RAILROAD TIES—DECATUR COUNTY.

FIG. B.—WHITE OAK BUTT CUT FOR STAVE BOLTS, SHOWING THE MANNER IN WHICH THE SAP BOLTS AND HEART BOLTS WERE SPLIT OUT WITH WEDGES—GILES COUNTY.

RAILROAD TIES.

An important forest industry of Tennessee is the production of cross-ties. This furnishes a large market for timber which is too small and knotty for saw logs. Owing to the abundance of tie timber, there is at present little demand for other woods than white and post oaks, which are best suited for the purpose on account of their hardness and durability in contact with the ground. The best grades of these ties, delivered at the railroad, usually bring from 40 to 50 cents. In West Tennessee "soft woods," such as gum, ash, sycamore, elm, and maple, are bought to a limited extent at about 25 cents a tie. Red oak, beech, and cypress ties usually bring a few cents more. Of course ties of these species, with the exception of cypress, are treated with preservatives before using.

The railroads charge the same freight rate for ties as for lumber; and it is, therefore, usually impossible to sell them at a profit except to the railroad that serves the particular locality in which the timber is located, or to the tie company that buys for that railroad. This has a tendency to keep the price down. Where transportation by water is possible, as in the neighborhood of the Tennessee and Cumberland Rivers, higher prices can usually be obtained. As a general rule, the stumpage value of ties is not more than from 5 to 10 cents each, even for white oak, and a great many are cut and delivered for a return that will scarcely pay wages. In such cases the owners are willing practically to give the timber away in order to get work for themselves or their men at seasons when there is nothing else to do.

There are two principal sources of waste in tie making as commonly carried on: (1) Many trees are cut just at the time when they are putting on the maximum amount of valuable wood. Straight, thrifty trees large enough to make several ties are very easy to work up, and are, therefore, usually cut, although it is much more profitable to allow them to reach larger size before cutting. On the other hand, small trees of poor form, which could often be thinned from overcrowded stands to advantage, are not so easy to work up and are likely to be left by the woodsman. (2) A great deal of wood is wasted in hewing ties, especially if the timber is knotty. Most timber will yield about one-third more ties if they are sawed rather than hewed. Nevertheless, nearly 90 per cent of the ties produced in Tennessee are hewed, since conditions usually make this method the more practicable. Hewed ties are preferred by most of the railroads; and even though no difference in price is made, inspection is likely to be much less rigid, so that a slightly

undersized or defective tie will be accepted if hewed when it would be rejected if sawed. Also it is somewhat less expensive to make and deliver a hewed tie, if the amount of timber wasted is not considered. Sometimes mine props and cordwood can be made from the tops of tie trees, thus saving wood which would otherwise be wasted.

MINE TIMBERS.

One of the principal uses for second-growth timber within the Cumberland Plateau is in connection with the coal mining industry, which is of great importance in that region. Timber of low grade and small size is suitable for props, caps, and mine ties, which are usually either round or split. Red oak and chestnut are the chief woods used for these purposes. Considerable saw timber is also used inside the mines for brattice, rails, and other purposes, and outside for the construction and repair of trestles and tipples. The number of props required varies greatly with the character of the rock covering which forms the roof of the coal seam. An investigation of the amount of timber used by coal mines in Eastern Kentucky showed an average consumption of about $4\frac{1}{2}$ board feet per ton of coal mined. On this basis the amount of timber used in mining coal in Tennessee for the year 1909 would be 27,930,000 board feet. Of course a large part of this timber consists of material too small to make lumber.

OTHER PRODUCTS.

The manufacture of tight cooperage stock, for which white oak is the chief wood required, reaches its greatest importance in the Cumberland Plateau region. Elm and hickory are commonly used for hoops. A high grade of timber is consumed in making tight staves, and a great deal of the tree is wasted, especially if the staves are split out in the woods. In the manufacture of slack staves, on the other hand, close utilization is the rule. Oak, gum, and cottonwood are the chief woods used, and are taken largely from the bottom lands of West Tennessee. Table 2 shows the production of cooperage stock in 1909.*

Boxes and box veneers are also produced in considerable amount. In East Tennessee yellow poplar is used for this purpose, especially

* Compiled by the Bureau of the Census in coöperation with the Department of Agriculture, Forest Service.

TABLE 2.—COOPERAGE STOCK.
Production of Slack Cooperage Stock in Tennessee, 1909.

PRODUCT	TOTAL	Oaks	Red Gum	Cotton-wood	Yellow Poplar	Elm	Ash	Sycamore	Cedar	Bass-wood	Maple	Tupelo	Chest-nut
STAVES (thousands)	67,127	20,906	18,869	15,975	4,685	2,803	1,607	1,249	643	300	90		
HEADING (thousand sets)	3,145	508	431	525	865	247		10	1			438	120
HOOPS (thousands)	13,130	15	50			13,060			5				

Production of Tight Cooperage Stock in Tennessee, 1909.

PRODUCT	TOTAL	Sawed	Bucked and Split	Hewed	Beer and Ale
STAVES (thousands)	35,744	34,345	278	4	1,117
HEADING (sets)	3,694,532	3,615,557			78,975

in making cigar boxes. In West Tennessee gum and cottonwood are extensively used for veneer boxes, while considerable elm is shipped to New Albany for manufacture into baskets. Close utilization is also the rule in this industry.

The production of tannic acid centers in the Valley of East Tennessee, although the neighboring regions are drawn upon for raw material. Hemlock and chestnut oak bark and chestnut wood are the chief native sources. Oak bark is worth about \$9 a cord delivered on the cars, and hemlock bark about \$8. Chestnut wood is bought at from \$3 to \$4 a cord of 5-foot wood delivered on the cars. This industry is beneficial to conservative forest management, since it affords a market for chestnut timber which is too old and defective for lumber and which should be removed for the good of the forest. The bark is also a profitable by-product in the manufacture of chestnut oak and hemlock lumber.

Vehicle stock of all kinds is manufactured extensively from oak and hickory, especially in Middle and West Tennessee. Spokes constitute the most important product of this class. For heavy wagons, white oak is used, while for light wagons and buggies hickory is preferred. Red (willow) oak is also cut in West Tennessee for cane-cart spokes. As a rule, timber from 14 to 22 inches in diameter is preferred for these purposes. The billets from which the spokes are turned are either split in the woods or sawed from bolts at the mill. While the split billets make a better grade of spokes, there is more waste in making them, since fewer cuts are taken from the tree. Even at best there is a great deal of waste in the use of hickory owing to the discrimination against heartwood and bird-peck wood.

Another special use for hickory is the manufacture of tool handles, which constitute an important product in many parts of Middle and West Tennessee. Among other minor products made from hickory are skewers, picker sticks, and weaver frames.

The production of red cedar for pencil wood, piling, and posts centers in the Central Basin, more particularly in Wilson and Rutherford Counties. Other important red-cedar counties are Marshall, Giles, Bedford, and, in part, Maury and Fentress. Red-cedar lumber of average quality is worth about \$35 a thousand feet at the railroad, while the best grades run as high as \$50. The average stumpage value is about \$20 for saw logs. Pencil factories are located at Murfreesboro, Lebanon, and Nashville. The supply of wood suitable for this purpose is so scarce that these factories buy

logs from old cedar barns and fence rails, in some cases paying as high as 10 cents a rail in addition to putting up a new wire fence. Piling and posts of different sizes are also produced in large numbers. About 20 cents is paid for a 7-foot post 3 to 5 inches in diameter at the top. Black locust is also cut for fence posts in many parts of the State.

The strong demand for chestnut poles makes a wide market for straight second-growth timber of this species, which is valuable for the purpose on account of its light weight and durability. The poles are probably produced in greatest quantity on the western side of the Cumberland Plateau. Prices vary greatly with the size.

Pulp wood is a minor product of East Tennessee. Hemlock wood is worth about \$4 a cord delivered on the cars, and is shipped to Canton, N. C. Poplar, basswood, and cucumber tree are worth about \$5.50 a cord for pulp wood, and ash, black gum, and soft maple about \$1 less, all delivered on the cars. These woods go to Bristol for manufacture.

There is also a general market for dogwood and persimmon for shuttle blocks. The price paid for dogwood delivered at the railroad is from \$7 to \$8 a cord of 5-foot wood 5 inches and up in diameter, and for persimmon, which usually comes in larger sticks, from \$5.50 to \$7 a cord.

FOREST REGIONS.

The character of the forest growth and the distribution of woodland depend chiefly on topography, soil, and other physiographic influences. Accordingly, the State may be divided into forest regions based on physiographic divisions. These divisions are the Unaka Range, or Great Smoky Mountain Belt, the Valley of East Tennessee, the Cumberland Plateau, the Highland Rim, the Central Basin, and the West Tennessee Plateau and Bottom Lands. The accompanying map shows the approximate location of the forest regions, and also of the areas within which the largest bodies of timber occur. The following descriptions are based on information in the files of the Forest Service, supplemented by brief studies made during the present examination in typical portions of each region. They are, therefore, lacking in many details which would be brought out by a longer and more thorough investigation.

MAP 2—TENNESSEE

FOREST REGIONS.

- I. UNAKA RANGE.
- II. VALLEY OF EAST TENNESSEE.
- III. CUMBERLAND PLATEAU.
- IV. HIGHLAND RIM.
- V. CENTRAL BASIN.
- VI. WEST TENNESSEE PLATEAU AND BOTTOM LANDS.

UNAKA RANGE.

The Unakas constitute a region about 2,000 square miles in extent in the form of a belt averaging 13 miles wide, which extends northeast and southwest and forms the eastern border of the State. The general elevation varies from 1,500 to 5,000 feet, but some of the higher peaks reach over 6,000 feet above sea level. The country is drained westerly by swift mountain streams tributary to the Tennessee River, some of the larger of which rise in North Carolina and cut through the range in deep and narrow valleys. There is very little level land and practically no swamps. Small farms are found along the streams and in the broader coves, mostly in the western part of the region, but the greater part of the land is too steep for cultivation.

This region is crossed at four points by railroad lines, which connect with the north and south trunk lines extending through the Valley of East Tennessee. It is also penetrated by several logging railroads. There are, however, portions of the high ridge along the North Carolina line which are still very inaccessible. Such portions are usually covered with virgin timber, although sometimes the best of the poplar and walnut has been cut and floated out at flood seasons. A considerable proportion of the land is held in large bodies, principally by lumber companies. The smaller holdings are confined chiefly to the foothills and valleys which are most accessible and best adapted for farming.

The chief industry throughout the region is lumbering, although copper mining is of local importance in the southeastern corner (Polk County). In addition to the small portable sawmills occasionally found in the more accessible parts, there are about five lumbering operations in virgin timber, with large sawmills supplied by logging railroads. A large amount of hemlock, poplar, oak, and other lumber is produced. Minor products include chestnut oak and hemlock tanbark; chestnut and, to some extent, chestnut oak extract wood; and, in the northeastern part of the region, pulpwood made from the smaller sizes of poplar, cucumber, basswood, and hemlock. Other woods are sometimes cut for special purposes, such as sugar maple, beech, and birch for bobbins, and dogwood and persimmon for shuttle blocks. Some white oak cross-ties are also produced.

The forests cover nearly all the rough, steep mountain slopes and higher coves of the region. Virgin timber, however, is confined to the most inaccessible sections, the largest bodies occurring in the

eastern parts of Sevier, Blount, and Monroe Counties. The cut-over lands are covered by irregular, uneven-aged stands of defective and suppressed old trees mixed with young growth. Even-aged, second-growth forests are found only in the vicinity of old iron furnaces or on old fields where clear cutting took place. The most important commercial timbers are yellow poplar, hemlock, and chestnut, although a great variety of valuable hardwoods as well as white pine and spruce are also found. Altitude and exposure are of great importance in determining the character of the forest. Two broad types may be distinguished—coves and slopes. While the slope type comprises a much larger proportion of the territory, the coves are of greater commercial importance, since they contain by far the heavier stands and better quality of timber. A survey of a tract of 110,000 acres in Polk and Monroe Counties shows 12 per cent of the total area to be cove land.

Coves.—The cove type includes the sheltered belts along drainage lines and the hollows at headwaters of creeks and branches. The soil is deep and fertile, with a constant and even supply of moisture. Yellow poplar and hemlock are the characteristic trees of the type, the former comprising from 3 to 10 per cent of the stand and the latter from 25 to 50 per cent. The associated species include chestnut, birch, basswood, hickory, white pine, maple, red and white oaks, buckeye, and cherry. At the higher elevations the proportion of hemlock, birch, maple, and cherry increases at the expense of yellow poplar, oak, and chestnut. Yellow poplar, chestnut, and white pine occur as dominant trees singly or in small groups, their crowns reaching above the tops of the other trees. In virgin stands the ground is usually covered with a deep humus and a good accumulation of litter, since ground fires are not frequent in this type because of the moisture. A scattering undergrowth is usually found, chiefly of hornbeam, holly, beech, dogwood, and witch hazel. Reproduction of oak and chestnut takes place where light is admitted through openings in the crown cover; while scattered seedlings of the more tolerant trees, such as hemlock, birch, basswood, beech, and maple, are found here and there under the older trees. Because of the fertility of the soil and the prevalence of a good moisture supply, the trees are of good form, with long, straight trunks, clear of branches to a great height. Virgin stands in this type will average from 8,000 to 10,000 board feet to the acre over extensive areas, while individual acres will, in some cases, yield from 20,000 to 35,000 feet. Thrifty second-growth

WHITE AND CHESTNUT OAK ON WEST SLOPE—POLK COUNTY.

stands are rare. When the cut-over lands have not been used for farming, as is sometimes possible, they have usually been so severely burned that natural tree reproduction is inferior in amount and quality.

Slopes.—The long, undulating slopes and narrow ridges are covered with many local forest types in which different species predominate. At the lower elevations, chestnut, chestnut oak, black, scarlet, and white oaks, hickory, and sometimes scrub and short-leaf pines, are the chief trees. Chestnut is very often the predominating tree, preferring northerly slopes; while scarlet, or chestnut, or white oak sometimes predominate, especially on southern exposures. White pine also grows on the northerly slopes at the lower elevations. Scarlet oak is most commonly found along the foot-hills just above the limestone outcrops. At higher elevations (above 2,000 feet on Little River) pitch pine is found on the more exposed southern slopes in patches that mark the poorer situations. Here white oak is largely confined to the warmer sites, such as the lower, less exposed ridges and the flatter south slopes. Chestnut oak is also found on such situations, and is abundant on nearly all the ridges and upper slopes of medium elevation. At the higher elevations, especially on slopes with northern and eastern exposures, beech, cherry, basswood, and buckeye are the most important hardwoods. Spruce begins to appear at elevations as low as 4,000 feet, on shallow, stony soil, but reaches its best development above 5,000 feet. It is associated with beech, yellow birch, and maple, and at the very highest elevations with balsam.

The direction toward which the slope faces has a great influence upon the size of the trees and the amount of merchantable timber as well as upon the composition of the stand. The south and west slopes receive the direct rays of the sun during the hottest part of the day, as well as the full force of the prevailing winds of summer. They are, therefore, more subject to drought, to wind break, and, since growth starts earlier in the spring, to frost damage, than the more sheltered north and east slopes. The soil is also thinner and less fertile, due partly to the action of the wind in blowing the leaves up the slopes and over the ridges so that they cannot decompose and enrich the soil. Consequently, the timber is smallest and of poorest quality on south slopes, and usually consists of trees best able to endure such unfavorable conditions, among which chestnut oak is most abundant, with chestnut next. White and black oak, hickory, short-leaf pine, sourwood, and black gum are also typical

of such situations. On the other hand, the north slopes are characterized by a greater variety of species, and the sheltered lower portions are classed with the cove lands. The more exposed ridges are usually covered with a stunted, scrubby growth of the hardiest trees and shrubs.

There is considerable damage to timber from fires, especially on the drier, southwest slopes. The burned-over land often becomes covered with briars, laurel, rhododendron, and other shrubs, which choke out tree reproduction. Fires are set purposely by cattlemen to improve grazing, and accidentally by hunters and campers. Cut-over lands are always in danger from fire because of the slash left after lumbering. Sometimes the impetus gained by a fire on such lands will carry it into virgin stands which would not ordinarily be in danger. For this reason lumber companies often make an effort to keep fire out of their cut-over lands.

VALLEY OF EAST TENNESSEE.

That portion of the Great Appalachian Valley within the State forms the Valley of East Tennessee, a belt lying west of the Unakas with an average width of 50 miles, a general elevation of 1,000 feet, and an area of 9,200 square miles. It is made up of a series of minor valleys and low ridges which rise from 300 to 500 feet above the stream levels. The long, northeast-southwest valleys are underlaid by limestone and shale. The intervening ridges formed by sandstone strata are either narrow and sharp-crested or mountainous in character; while the cherty dolomite ridges are broad, with rounded or level tops. The entire region is drained southwestward by the Tennessee River and its tributaries. These become smaller and swifter above Knoxville, where the general slope is somewhat steeper. The railroad transportation facilities are very good, with two trunk lines south of Knoxville and one north. Most of the land is held in farms of moderate size, although there are also a few large tracts owned by individuals or corporations.

This is a well-settled region in which agriculture is the chief industry. The timber is of relatively small commercial importance, since the virgin stands have long been cut off and little has been done to encourage and protect second growth. Nevertheless, there are many portable mills producing inferior grades of lumber, chiefly for local use, and a considerable amount of wood is cut for fuel and extract purposes. Cross-ties and chestnut poles are also produced. Within the region are several cities where various manufacturing

FIG. A.—EFFECT OF SURFACE FIRES ON CHESTNUT—MONROE COUNTY.

FIG. B.—EROSION OF CLEARED LAND—BLOUNT COUNTY.

industries center which use timber both from this and adjoining regions. In addition to planing mills, furniture and box factories, there are tannic acid plants using both wood and bark, handle and spoke factories, and other wood-using industries. Practically all of the higher grade timber comes from the mountains.

The forests are very broken in distribution, being largely confined to the crests and steeper slopes of the ridges; many of the broader ridge tops, as well as the valleys, are in cultivation. The stands are, for the most part, uneven-aged, except on old fields and on tracts which have been cut clear for charcoal or fuel. The trees are generally from 7 to 18 inches in diameter, with the exception of an occasional old chestnut or other tree which is considered too hollow or decayed to be worth cutting. The silvicultural condition of the forest is poor owing to the prevalence of fire, the grazing of hogs, and the continued culling out of the best trees.

The forest may be divided into two original types—ridge and slope; and one temporary type—old field. The ridge type includes the ridge tops and the upper south slopes, while the slope type is found on north slopes and the more fertile and sheltered southern exposures. Chestnut oak and chestnut are the characteristic trees of the ridge type, although black and Spanish oaks sometimes predominate, especially on high flats. Other common trees of this type are scarlet and post oaks, pignut hickory, black gum, and short-leaf and scrub pines. The slope type is characterized by red oak, white oak, and yellow poplar, with which are associated chestnut, hickory, maple, butternut, an occasional walnut, and many other hardwoods.

The old-field forests are usually found on lower slopes or on ridge tops which were once cleared for agricultural purposes. The first woody growth on old fields is usually pine, sassafras, and persimmon; but later the composition becomes more similar to the original type, except that there is in most cases a much higher proportion of short-leaf and scrub pines. Sometimes the pine reproduces in practically pure stands, while it very often forms groups covering from 20 to 50 per cent of the area. In the original types, pine is confined to the poorer situations and rarely occupies more than from 10 to 15 per cent of the ground. The proportion of short-leaf to scrub pine on the old fields varies greatly, and seems to be determined chiefly by the proximity of seed trees of one or the other species. Possibly a little over one-half of the old-field pine in the southern counties consists of the more valuable short-leaf pine, while in the northern counties about three-fourths is scrub pine.

Red cedar is also a common conifer in the various types of this region, chiefly on limestone land.

A local type of some importance in the northern part of the region might be called "short-leaf pine flats." The soil is a dry, loamy sand, sometimes mixed with clay, and the ground cover is either entirely absent or consists of a thin layer of grass, weeds, and leaves. Dense groups of sumach, sassafras, huckleberry, and blackberry form an irregularly scattered underbrush. Short-leaf pine and black oaks, including scarlet and Spanish, and occasionally a willow oak and some scrub pine, are the chief trees. These are associated with a scattering of other hardwoods and an occasional loblolly pine in moister situations. Short-leaf pine predominates and is the most valuable tree. While the pine is sometimes pure, it is common to find pine and hardwoods mixed, either by groups or as single trees.

CUMBERLAND PLATEAU.

The Cumberland Plateau is a high table-land, 5,000 square miles in extent and 2,000 feet in elevation, which lies west of the Valley of East Tennessee and is separated from it by a fairly regular line of precipitous sandstone cliffs. The western boundary, which is also marked by sandstone cliffs, is much more irregular, following a series of projecting headlands inclosing rich coves. The surface of the table-land is cut by numerous ravines and deep valleys, and is especially well dissected toward the north and west. Most of the northern part is drained in a northerly direction by tributaries of the Cumberland. South of Cumberland County the drainage is tributary to the Tennessee River. There are no navigable rivers in the region, but facilities for railroad transportation are fair. The central part is crossed by the Tennessee Central Railroad, while the Cincinnati Southern extends across the plateau north of Hariman, and then runs southwest from this point just beyond and parallel to the eastern escarpment. It is also penetrated by branches of the Nashville, Chattanooga and St. Louis Railway from the south and west. Probably about half of the land is concentrated in large holdings of value chiefly for coal or timber, or for both.

Lumbering and coal mining are the chief industries. Agriculture is of minor importance at present. In addition to saw timber, important forest products are cross-ties, chestnut poles, spokes, handles, extract wood, and tanbark. The largest lumbering oper-

GROWTH OF ABOUT FIFTEEN YEARS ON OLD FIELD ON LOWER SLOPE; CHIEFLY
POPLAR, WITH SOME OAK—SCOTT COUNTY.

ations are found in the north and northwest portion of the region, where private logging railroads have been constructed. Small operations, usually conducted with portable mills, are numerous and widespread. Throughout the region are small and scattered tracts of practically virgin timber which have been held for one reason or another. The larger bodies and those containing timber of the best quality are found in the northern part in Pickett, Overton, Fentress, and Scott Counties.

There are four distinct types of forest land in this region—coves, slopes, plateau ridges, and plateau swales. Of these, the cove and slope types are the most important from the commercial standpoint.

The proportion of land in each type varies greatly in different sections of the region. A careful survey of a large and fairly typical tract on the waters of Rocky River showed about one-sixth of the area to be cove and slope land, one-third plateau swales, and one-half plateau ridges. On the other hand, in a well-dissected section farther north nearly a third of the area consisted of cove land, while practically all of the rest was of the slope type.

Coves.—The cove lands consist of the better portions of the valley slopes and hollows well below the level of the plateau. The characteristic soil is a deep, moist loam, rocky or stony, upon which is a layer of humus, often several inches in depth. The underbrush varies in density and usually consists of rhododendron, laurel, red bay, witch hazel, persimmon, dogwood, and viburnum. The characteristic and dominant trees of the type are white oak, yellow poplar, and chestnut. Beech and sugar maple are also very numerous. Among the associated species are hickory, black oak, red oak, chestnut oak, buckeye, red maple, basswood (linn), ash, elm, and an occasional walnut, cucumber, and cherry. Hemlock is also found, sometimes singly, but usually in groups, and sometimes with white pine. The chief difference between this type and the true Appalachian cove type lies in the smaller proportion of hemlock and the larger amount of white oak. Reproduction is fairly good, although shade conditions in the typical older stands favor seedlings of tolerant species, such as sugar maple and, to a less extent, hickory and ash. Oaks, red maple, and yellow poplar come up in the natural openings of the forest. Yellow poplar reproduces best, however, on abandoned fields, where it sometimes forms an almost pure stand.

The characteristic timber of this type is straight, tall, clean, and of excellent quality. Virgin stands yield on the average about 8,000 board feet per acre.

Slopes.—The slope type includes south and upper north slopes, and is intermediate, both in situation and quality, between the cove and plateau types. The characteristic trees are chestnut oak, black, scarlet, and white oaks, and hickory. Usually either chestnut oak or one of the black oaks predominates. Chestnut, black gum, and short-leaf pine are also common, the pine usually in groups. The quality and amount of timber is somewhat inferior to that found in the coves, virgin stands yielding only about 6,000 board feet per acre.

Plateau Swales.—The plateau swales are the lower portions of the table-land, including the flat lands and shallow depressions along drainage lines that lie below the general level of the ridges. The soil is of good depth, especially if the land receives the wash from the slopes, and it is fairly moist because the water does not drain off rapidly. Black, white, Spanish, and scarlet oaks, with a varying proportion of hickory, predominate in this type. Black gum, post and chestnut oaks, chestnut, and short-leaf pine are also sometimes included in the mixture. The swampy bottoms, which are of very limited extent, contain thickets of red maple, black gum, and sweet gum, often with an undergrowth in which large holly trees are conspicuous. The timber does not grow as high as that of the coves and is not so clear and free from defects. The yield per acre of virgin timber averages about 4,000 feet.

Plateau Ridges.—These are the highest and most exposed portions of the table-land, with thin, sandy, unproductive soil. They are covered with a short and stunted growth of inferior hardwoods, such as post, black jack, scarlet, and chestnut oaks, sand hickory, and black gum, with some scrubby chestnut. Scrub pine, and sometimes short-leaf, grow on this land in mixture with the hardwoods or in pure stands. The timber is not only short-boled and limby, but is usually badly injured by insect and fungus enemies, partly owing to the frequency with which fires occur. The stand is open and at best yields only about 2,000 board feet per acre.

HIGHLAND RIM.

The Highland Rim is a high, broad shelf surrounding the Central Basin, with an area of 9,300 square miles and average elevation of 950 feet above sea level. It is a rolling country, with broad valleys and rounded hills. The underlying rock is chiefly limestone. There is great variety in the quality of the soil, perhaps the poorest being found on the cherty formations that immediately surround

SLOPE TYPE OF CUMBERLAND PLATEAU; CHIEFLY WHITE, BLACK, AND SPANISH OAKS—SCOTT COUNTY.

the Central Basin. The drainage system is well developed, and there is very little swamp land. The greater part of the land drains south and west toward the Tennessee River, although a section on the north is included in the basin of the Cumberland.

In addition to the Cumberland and Tennessee, which are both navigable rivers, there is a good system of railroad transportation, so that few places are more than 12 miles from shipping points. The most inaccessible portion is found in Wayne County, in the southwest corner of the region. By far the larger part of the land is in farm holdings of moderate size.

The chief industry is agriculture, although lumbering and mining for phosphate and iron are also of local importance. Lumber, cross-ties, spokes, and handles are the most important forest products. Most of the lumbering operations are on a small scale, since, with the exception of a few of the more inaccessible counties, the merchantable timber is distributed in a very scattered manner in farm wood lots and small tracts. There is very little virgin timber left, the principal bodies lying about halfway between the railroad and the Tennessee River, in Wayne, Lawrence, and Perry Counties, and in the northeast corner of the region, in Pickett and Overton Counties.

There is a great diversity in the character of the forests of this region, but they may be roughly grouped into slope and ridge types. A cove type, very similar to that described for the Cumberlands, is also found in this region at the base of the Cumberland Plateau, along the margin of the Central Basin and in the southwestern counties along the Tennessee River. There is more or less land which was once cleared, but which proved either too poor or too steep for farming and is now reverting to forest or has already done so. The stands are uneven-aged except in the neighborhood of old iron furnaces, which were once very common in the western part of the region. Here the forest was cut clean for charcoal, and even-aged stands have resulted, covering extensive areas.

Slopes.—The soil of the slopes, which, as a rule, are moderately steep, is somewhat better than that of the ridges, but most of the agricultural soils have been cleared and put under cultivation. The type is characterized by a mixture in which the oaks predominate, especially black, red, Spanish, and white oaks. Hickory is also a very constant constituent of the stand. A great many other hardwoods are included, the most important of which are chestnut, yellow poplar, black gum, and ash. Beech is also found on the lower slopes, and sycamore along the streams.

Ridges.—The ridges are either narrow and rounded or broad and flat, but are characterized by a thin, sandy, unproductive soil, often strewn with chert fragments. Scarlet, black jack, and post oaks, and hickory are the common ridge trees, constituting a type similar to the Cumberland Plateau ridges, but on the whole of somewhat better quality. In the southern part of the region, especially in Wayne and Perry Counties, there are occasional belts of short-leaf pine, either pure or associated with scattering post and black jack oaks. The quality of the pine is much better than that of the hardwoods of this type.

CENTRAL BASIN.

The Central Basin, an oval depression 5,400 square miles in area, about 400 feet below the level of the surrounding Rim, is, on the whole, a gently rolling region underlaid by limestone and possessing very fertile soils. The outer portions of the region are somewhat rougher. The drainage is toward the north, south, and west through the Cumberland, Duck, and Elk Rivers, the two latter being tributaries of the Tennessee. Numerous railroads radiate from Nashville, affording, together with the Cumberland River, good means of transportation. The principal wagon roads are macadamized. With the exception of a few large estates, the land is held in small farms.

The chief industry of the region is agriculture. A few select saw logs are shipped from various points, principally to the veneer factories; while small mills, often run by threshing-machine engines, saw a little lumber for local use. The red-cedar industry centers at Murfreesboro, where there is a pencil-wood factory which depends principally upon this region for its supply. This species also supplies the market with a great many fence posts and small poles.

The forest is largely confined to small, ornamental groves and to belts or patches of timber on broken land along the creeks and on the poorer hillsides and ridges. The groves are, as a rule, located near or about the farmhouses on good agricultural land. The ground is usually covered with blue grass, with no tree reproduction. These remnants of the original forest are preserved for their natural beauty, for shade about the house, or to protect the cattle from the sun in the heat of summer. Stands of this type are usually composed of mature or overmature trees, which are often wide-spreading and limby. Many of these old trees, especially the elm,

FIG. A.—SLOPE TYPE OF THE HIGHLAND RIM; OAK, POPLAR, AND CHERRY—
STEWART COUNTY.

FIG. B.—RIDGE TYPE OF THE HIGHLAND RIM; WHITE OAK, BLACK OAK, AND
HICKORY—STEWART COUNTY.

are dying out, sometimes as a result of changes in drainage conditions. The most common species are white, cow, chinquapin, and bur oak, hard maple, ash, walnut, sycamore, elm, buckeye, and butternut.

The scattering bodies of timber on broken land near creeks are composed of about the same species that are included in the pastured groves. On the hills and ridges, however, many other hardwoods are represented, including chestnut and other oaks, beech, sugar maple, and hickory. Red cedar is sometimes found in mixture with these hardwoods and sometimes in pure groups. It is especially characteristic of thin-soiled, stony, limestone hillsides.

The abandoned fields show a great variety of tree growth. Sassafras, persimmon, hickory, patches of black locust, groups of poplar on moister situations, and red cedar in dense thickets, or scattered singly, may frequently be met with all on the same farm.

WEST TENNESSEE PLATEAU AND BOTTOM LANDS.

The country between the Tennessee and Mississippi Rivers may be considered as one forest region, although it includes two physiographic divisions and part of a third. The Plateau and Slope lands comprise an area of about 8,850 square miles, and the bottom lands of the Tennessee and Mississippi Rivers nearly 1,500 square miles. The region is mostly under 600 feet in elevation, the uplands rising from 200 to 400 feet above the stream bottoms. The greater part of the region is a low, rolling upland, with a short slope on the Tennessee side, and a long, gentle, westward slope to the bluffs that border the Mississippi bottom lands. The underlying rock seldom outcrops and is covered by a deep mantle of unconsolidated deposits of clay, loam, and sand. The soil of the bottoms is alluvial in origin and of great fertility, although not always available for agriculture because of insufficient drainage and danger of overflow. The upland soils vary considerably in quality, the more fertile loams covering the western half of the plateau. They are, as a rule, compact and wash badly even on very moderate slopes. In addition to the two navigable rivers that bound the region, a network of railroads affords good transportation facilities. The farms are mostly small, averaging about 100 acres, while the large holdings are practically confined to portions of the Mississippi bottom lands.

This is primarily an agricultural country, with cotton as the chief money crop. Lumbering on a large scale is carried on only in the bottom lands of the Mississippi. The principal forest products are

lumber, cross-ties, box veneers, cooperage stock, and spokes. The greater part of the timber cut comes from the bottom lands.

Uplands.—The upland forests are of two types—one in which post oak is the characteristic tree, and another in which the better oaks predominate. The post oak type is found on the higher ridges and upper slopes of the hilly sections and on sandy, sterile flats. It is particularly characteristic of the soil type described by the United States Soil Survey as Lexington sandy loam. With post oak are most commonly associated black jack, scarlet and Spanish oaks, and pignut hickory. The trees are small-sized and short-boled, averaging from 6 to 14 inches in diameter and yielding little timber of value. In the southwestern counties of Hardin and McNairy the type is occasionally interspersed with stands of short-leaf pine.

On the lower ridges and slopes and on gently rolling lands of the soil type described as Memphis silt loam a better group of hardwoods prevails. The principal species are white, Spanish, and black oaks, pignut and mockernut hickories, and scattered chestnuts. Along drainage lines, tulip poplar, sweet gum, beech, and sycamore are also found. The stands are uneven-aged, and the trees generally run from 8 to 16 inches in diameter. This type is naturally productive, but has suffered from unsystematic cutting and general neglect.

Bottom Lands.—The bottom-land forests reach their greatest extent and importance on the broad flood plain of the Mississippi, but also occur on the various rivers and creeks that drain the uplands. The virgin stands are dense, with tall, clear trees which form an unbroken canopy of foliage. The typical tree is red gum, which makes up about 50 per cent of the forest. Oak, ash, cottonwood, hickory, cypress, elm, sycamore, soft maple, and tupelo gum are the common associates. The black-oak group is represented by red, swamp Spanish, and some few pin and willow oaks. Cow oak is the chief bottom-land white oak. Among the hickories are included the bottom shellbark, shagbark, and mockernut. Cottonwood is an important constituent of the forest on the Mississippi bottoms, especially on low, sandy land of recent origin; while on the bottoms of the smaller streams the oaks are of greater importance. Some beech is found on low ridges and is one of the few bottom-land timbers for which there is almost no market. There is usually a scattered underwood of hawthorn, holly, dogwood, and young growth of gum, hickory, hackberry, and other trees.

Few virgin forests of this type remain, the most extensive of

PASTURED WOOD LOT, UPLAND TYPE OF WEST TENNESSEE PLATEAU; SPANISH
BLACK, AND WHITE OAKS—HARDEMAN COUNTY.

which are on the Mississippi bottoms in the northwestern part of the region. Such forests have an average stand of from 10,000 to 12,000 board feet per acre. The gum, oak, and cottonwood timber is of excellent quality; but the cypress is very defective, running at least 50 per cent "pecky." Growth is very rapid on cut-over lands, and the fire damage is small on account of the wet character of the situation. This is not, however, a permanent type, since most of the land will eventually be reclaimed for agricultural purposes.

FOREST PROBLEMS.

UNAKA RANGE AND CUMBERLAND PLATEAU.

While the forest types in the Unaka Range, the more mountainous ridges of the Valley of East Tennessee, and the Cumberland Plateau differ somewhat, the problems of forest management are in general very similar. In contrast to the rest of the State, they are essentially timber-exporting regions and should always remain so. Moreover, they constitute an important part of what is known as the southern Appalachian region, which is bound to be the chief source of the future hardwood supply of the United States. The other regions in the United States from which hardwood lumber is obtained are nearly all agricultural in character and must eventually be used primarily for that purpose. While the soil of the Unaka Range is in many cases fertile, the mountain sides are so steep that farming is not practicable and timber is bound to be the chief crop. The Cumberlands, on the other hand, have certain agricultural possibilities. The level plateau land may eventually be farmed with profit by the liberal use of fertilizers and other intensive methods, when market conditions warrant the expense. Nevertheless, there probably will always be much more absolute forest land than is necessary to supply the local demand for timber and wood.

The fact that the Cumberland and Tennessee Rivers head in these regions also gives them peculiar importance. The forests of the mountain slopes should be maintained to check the run-off and to regulate stream flow. Their preservation is essential for the successful utilization of water power and effectual artificial storage. The protective function of the forest cover is of especial importance in the Unaka Range because of the great height of the slopes. These problems are discussed in detail in the "Report of the Secre-

tary of Agriculture on the Southern Appalachian and White Mountain Watersheds,"* and need not be enlarged upon here.

The small proportion of virgin timber which remains is very inaccessible and must be logged at considerable expense. The private companies who own this timber regard it as necessary to cut all the trees that can be handled at a profit, in order to pay the cost of constructing the logging railroad and other fixed expenses. Accordingly, they do not intend to cut conservatively nor to protect the young growth for a second crop.

The greater part of the land is already heavily cut over. Many small tracts have also been cleared for farming, worn out in a few years, and then abandoned. In the more inaccessible sections the usual practice is to kill the large trees by girdling and to leave them standing. On these abandoned farm lands even-aged stands have sometimes started as a result of seeding from neighboring trees.

The growth of woody vegetation is so vigorous that cut-over lands which have not been plowed seldom become bare and totally unprotected against erosion, even in spite of fire and other adverse influences. The chief danger from washing is along old skid roads which follow drainage lines, and thus give a foothold for the destructive action of water. In a few cases this danger has been guarded against by piling slash in the skid roads after the last logs have been hauled down, in order to check washing until vegetation has had a chance to establish itself. Little is done to prevent fires on cut-over land, except when necessary to protect fences and virgin timber. The effect of the repeated burning is to prevent the reestablishment of a valuable forest growth. An inferior growth of sprouts comes up from the burned stumps, and the development of hardy, but valueless, shrubs is encouraged. The most valuable trees, such as yellow poplar, chestnut, and white pine, are the most sensitive to fire injury. Such a growth as persists in spite of repeated burning, while it often is sufficient to prevent the soil from washing off of the steep slopes, does not have the effect in regulating run-off that a better forest growth possesses. There is not as good shade, the spongy layers of humus and leaf litter are destroyed, and the capacity of the soil to absorb moisture is reduced.

As soon as the fire risk is reduced to a minimum, other measures can be taken to improve the forests and make timber growing profitable. The composition and rate of growth can be improved by thinning out the inferior species and poorer individuals from

* United States Senate Document 91.

FIG. A.—A ROUGH, LIMBY CHESTNUT OAK TOPPED AT 23 INCHES, WASTING TWO STANDARD TIES—SULLIVAN COUNTY.

FIG. B.—WASTE IN CUTTING STAVE BOLTS; TOP, 28.3 INCHES IN DIAMETER, LEFT ON ACCOUNT OF KNOTS AND WATER SOAK—GILES COUNTY.

crowded stands. In making final cuttings, certain principles can be observed that will insure a second crop from the young trees in the shortest possible time, as well as reproduction from seed and sprouts. In these regions the chief object of management will be the production of saw timber, although many other products will also be obtained. For this purpose yellow poplar and chestnut are the most promising in the Unaka Range, while white oak may be included with these in the Cumberlands. Short-leaf pine will also be a very valuable tree on the driest soils of the Cumberland Plateau lands where valuable hardwoods will not thrive. Hickory is likewise important, especially in the Cumberlands. While the best hickory timber grows on upper north slopes in mixture with oak, the younger growth is of fair quality in almost all situations. Reproduction is good and growth rapid enough to make it well adapted to management and an important tree for the future. Excellent fuel can be obtained from the smaller trees cut out in thinning, while the larger timber is of especial value in the manufacture of vehicles.

A large amount of woodland in the Cumberlands is underlaid by workable coal. This land should be managed for the production of mine timbers, in order to render the mines independent of the general market for their supply. At present there is very little method in the selection of timber for use in the mines, this usually being left to the contractor. Consequently, the most convenient trees are cut without regard to the effect on the forest. Usually the slopes nearest the mines are devastated, while more remote bodies of timber belonging to the same property are deteriorating from decay and overcrowding. Whether the land is owned by the mining company or merely leased, it would be profitable to all concerned to institute improved methods of cutting so as to conserve the supply and improve the condition of the forest. Owners of coal lands should see to it that provisions to this end are inserted in mining leases. A few of the more progressive companies have already taken steps in the right direction. The fact that small-sized trees of all kinds can be utilized gives an exceptionally good opportunity to thin out the forest in such a way as to increase the growth and improve the quality of the timber produced. Just how this can best be accomplished would be an important subject for investigation by a State Forester.

One of the most important problems before the State is the affording of adequate fire protection to forest land, and this problem

is especially vital in these timbered regions. Legislative and other means toward this end will be discussed in another part of this report. The State should also inaugurate studies of the rate of growth and silvicultural requirements under local conditions of the more important species, in order to show the probable results that can be obtained in growing timber and the best methods to use. An investigation of short-leaf pine and the conditions under which it reproduces would be of great practical value, especially in the Cumberlands. A study of second-growth chestnut and yellow poplar in Tennessee has already been started by the State Geologist in coöperation with the Forest Service for the purpose of determining the most practicable methods of management. A study of the management of coal lands for mine timbers, to find the methods that are most suitable and the probable yield in each type, is greatly needed in the Cumberland Plateau.

VALLEY OF EAST TENNESSEE AND HIGHLAND RIM.

While these regions are separated by the Cumberland Plateau, the character and distribution of the forests and the broad problems of forest management are similar, if the more mountainous ridges of the Valley of East Tennessee be excepted. Both contain a considerable proportion of absolute forest land, possibly one-fourth of the total area. Forestry will, however, always be subordinate to farming. The forest is broken in distribution and owned mainly by farmers. It is largely depleted of valuable timber, and its productive capacity has deteriorated because of fires, indiscriminate grazing, and repeated culling of the best trees.

A considerable proportion of the timber produced in the future will be used directly upon the farm. There is also a good general market for nearly all classes of forest products in the numerous towns and cities. Management can, therefore, be on a rather intensive basis, and the farmer can well afford to use his spare time in keeping his woodland in the best possible condition. He can usually find ways of using on his own place the material that he thins out, even if no other market can be found for it. Unfortunately, the improvement of farm wood lots ordinarily receives little consideration. Trees are cut because they are handy and suit the purpose, even if it would be much more profitable in the long run to leave them and use instead inferior or overmature trees that might be a little more difficult to get at or work up. It is also a common mistake to try to combine timber and grass production, with poor

results in both directions. Grass will grow but very sparsely under trees which are close enough together to produce good timber, so that pasture land should be cleared except for a few scattered, wind-firm, shade trees. On the other hand, woodlands should be kept fairly dense, and no attempt should be made to graze them heavily. It is especially necessary to keep out all live stock during a period when it is desired to establish a young growth of trees. Hogs are particularly destructive in such a period, since they devour the seed of nut-bearing species and root up many young seedlings.

All of these questions, however, require further investigation under the special conditions that prevail in different sections. Also a great deal of educational work is needed in order to acquaint the people with the fundamental principles of forest management. More accurate information should be obtained in regard to the growth and requirements of the important species, such as chestnut, yellow poplar, Spanish oak, black oak, hickory, and short-leaf pine. Methods of thinning and otherwise improving the even-aged stands on furnace lands in the western part of the Highland Rim should also be studied.

CENTRAL BASIN.

Although the Central Basin does not contain nearly enough land which can profitably be devoted to raising timber to supply its own needs, it nevertheless presents certain problems in forest management that are of local importance. Many of the small pasture and ornamental groves are dying out because of the old age of the trees, or changes in drainage, or other conditions. The usual sod of blue grass, the trampling of stock, and close pasturage, prevent natural restocking with young trees. This might be secured by breaking up the sod and excluding stock. Such treatment is not usually advisable, however, since satisfactory results can be obtained by planting in small groups and leaving the greater part of the grass undisturbed. Of course, all seedlings must be fenced for protection until they are large enough so that stock will not injure them. In regard to the present stand, the cutting must be made with a view to keeping as many of the older trees as long as possible. The strengthening of decrepit old trees by mechanical means, as well as pruning, may often be justified because of their ornamental value. Such measures, however, belong to the field of arboriculture rather than of forestry.

The very limited area that can be used as wood lots should be made to yield as many posts and other farm timbers as possible. The principal problems connected with wood-lot management are similar to those that have already been mentioned for the Valley of East Tennessee and the Highland Rim. In many cases it may be necessary to plant young trees in order to secure a full growing stock. The natural locust groves may often be made more productive by judicious thinning. There should be a good profit in growing red cedar on stony hill sides that are not of much value for other purposes, since fence posts can probably be grown in open stands in twenty-five years. Information on methods of management of red cedar for pencil wood may be obtained from Circular 102 of the United States Forest Service.

WEST TENNESSEE PLATEAU AND BOTTOM LANDS.

The management of farm wood lots is the chief problem of the uplands here, as in the other agricultural districts. Also the problem of the best use of land presents itself in another form. In this case woodland is being unwisely cleared by negro farmers in order to secure fresh land for cotton. Since the soil is compact and there is a strong tendency to form gullies even on moderate slopes, considerable land which should be retained in forest is ruined in this way.

As the bottom lands are drained and protected, the forests there will eventually be reduced to small farm wood lots in the lowest and poorest situations. Since this drainage work goes on slowly, it will be possible on many tracts to obtain one or several crops of timber before it is completed, especially as most of the bottom-land trees are very rapid growers. In order to obtain the greatest increment in both volume and quality on such forest lands, it is necessary in the original cutting to use a higher diameter limit than if no future cutting were in view. Also it is often possible in the case of dense stands of moderate-sized trees to thin them out in the first cutting thereby stimulating greatly the growth of those that remain and procuring large timber for the next cutting. Cottonwood is especially adapted to such treatment. It is also wise to remove old decadent trees that take up a great deal of room and hinder the development of young poles and saplings, even if there is no profit in handling them. One company has adopted this policy of conservative cutting, using a diameter limit of 24 inches on the stump for gum, but such far-sighted methods are not general. Of course

WASTE IN LOGGING; A WHITE OAK STUMP 3 FEET HIGH—PERRY COUNTY.

there would be no inducement for a timber operator, owning only the stumpage rights, to adopt such a policy unless some special arrangement were made for this by the landowner.

FOREST POLICY FOR THE STATE.

NECESSITY FOR ACTION.

It was not possible with the time and funds available for the preliminary study upon which this report is based to estimate the amount of standing timber or determine how soon a scarcity of the supply is likely to be felt. However, it is already becoming difficult for consumers of high-grade lumber to get enough raw material for their uses. All indications point to a continued supplanting of higher grade timber, with lower grades as far as this is possible, and to a period of scarcity and restricted production in the not far distant future. Eventually the annual cut will have to adjust itself to the annual growth of timber on the forest lands of the State.

The exhaustion of the virgin timber is not in itself a disadvantage. It is even necessary that mature and decadent timber be cut out to prevent loss and to allow younger trees room for development. The great evil lies in the fact that little or no attention is paid to securing and fostering a valuable second growth. There is a great deal of land in the rougher parts of Tennessee that will yield little or nothing in any other crop than forest trees. Yet in the face of the growing scarcity of timber, these lands are being allowed to become unproductive through neglect. If timber lands are to remain in a productive state, they must be treated intelligently. No one expects to grow any other crop without attention, and yet no other crop matures so slowly as the forest crop or requires so long a time for the rectifying of mistakes in management.

The forest land of Tennessee is practically all held by private individuals, and by far the greater part will continue to be so held. If forestry is to be practiced, it must, therefore, be by these private owners. Most of them will do little or nothing along this line unless the State shows them the need and advantage and assists them in using proper methods. In addition, the State should help in giving the landowners protection from fire. There is now a fire law on the statute books which provides penalties for setting forest fires carelessly or willfully, but it lacks an appropriation to make it effective.

In this connection it should be remembered that the Appalachian

Bill which has recently become a law appropriates the sum of \$200,000 from the Federal Treasury to enable the Secretary of Agriculture to coöperate with the States, when requested to do so, in organizing and maintaining a system of fire protection on private or State forest lands situated upon the watersheds of navigable rivers. The amount expended in any State cannot exceed the amount appropriated by that State for the same purpose in the same fiscal year. No agreement will be made, however, with any State that has not provided by law for a system of fire protection. In order, therefore, that Tennessee may take advantage of this provision and obtain a share of the appropriation, the State should undertake at once the organization and support of such protective system.

In addition to mere legislation, an educational campaign to show the damage that results from surface fires in woodland is greatly needed and will do much to protect the forests from this danger. It is now recognized by many States that it is to their advantage to promote better methods of forestry just as they are encouraging improvement in agriculture. Sixteen States employ one or more trained foresters in such work, and some of these have also State forest reserves.

The need of educating the owners to increase the productiveness of their woodland is especially important in Tennessee. It is estimated that about 35 per cent of the total area of the State, or 9,300,000 acres, is in woodland. The average annual growth per acre of forest throughout the State is probably not over 100 board feet. Through the application of forestry this should be more than doubled. If, however, it were increased by only 10 board feet, this would mean that the annual timber production of the State would be greater by 93,000,000 board feet. At the low rate of \$15 per thousand, this is equivalent to an increased annual income from timber products of \$1,395,000, to be distributed among the land-owners and those who furnish the labor and materials for marketing these products. Such a gain might be very easily obtained on second-growth lands by giving them a little attention and protection; and as soon as better methods become general, the increase should be much greater. Since culled lands in which old growth still predominates has practically no annual increment, their productiveness can be increased even more by the introduction of proper forest management. The State could well afford to invest an annual appropriation of \$20,000 or \$30,000 in order to increase the annual income from forest products by over a million dollars.

PROPOSED LEGISLATION.

The legislation in regard to forestry now on the statute books is of a very scattered nature. In addition to the fire law, it consists chiefly in giving investigative functions to three different departments—the State Geological Survey, the Department of Game, Fish, and Forestry, and the Commissioner of Agriculture. It is time to consider what legislation is needed in order to unify and round out a consistent and complete forest law. It is believed that forestry education and forest fire protection are of sufficient importance to warrant the creation of a new department or State Board of Forestry. Accordingly, a plan of legislation is outlined upon this basis. In case it does not seem practicable to adopt this policy, it would be of great advantage to make a special appropriation for the continuation of forest investigations under the direction of the State Geological Survey, either independently or in coöperation with the Federal Forest Service.

The proposed Board of Forestry should be so constituted that it will be free from politics and fitted to take charge of scientific and educational work. Therefore, it is suggested that the board consist of the Governor, the State Commissioner of Agriculture, State Geologist, State Game Warden, Director of the Tennessee Agricultural Experiment Station, and two timber land owners, to be appointed by the Governor, one of whom shall be a manufacturing lumberman. The members should serve without compensation except for necessary expenses.

This board should direct the promotion of the forest interests of the State, and should make a biennial report to the Legislature showing the nature and extent of the work accomplished. It should employ a State Forester, who should be a graduate of a reputable forest school, and a man of experience and ability in his profession. His duties should include (1) the organization of a fire protective force and the administration of the fire laws; (2) the administration of State forests for demonstration and experimental purposes; (3) educational work, such as lecturing on forestry and related subjects before farmers' institutes and other public meetings, and the publication of bulletins; and (4) scientific investigations with a view to increasing the knowledge of the forest resources of the State and to finding out the methods of forest management best suited to local conditions in different sections.

(1) The forestry law of 1907 provides for a system of fire protection under the office of the State Game Warden, giving the

County, Special, and Deputy Game Wardens the duties of forest fire wardens. They are authorized to take charge of fire fighting, to summon assistance, to inspect railroad rights of way, and to arrest, without warrant, offenders against the fire laws. The law has failed in effectiveness because no provision was made for funds to pay the expenses of fire fighting. Also no arrangement was made for posting warning notices; and, therefore, the provisions of the law are not generally known. It is believed that better results would be obtained by not trying to burden the game wardens with this additional work, which has little relation to their regular duties, and for which they may or may not be fitted. Therefore it is recommended that the State Forester be made State Fire Warden, and that he be empowered to request the Board of Supervisors of each county to appoint, with his approval, a county fire warden, or to appoint one himself should the County Board fail to take action. The county wardens should be subject to removal by the State Forester. The powers and duties conferred upon the game wardens by the law of 1907 should be transferred, with some modifications and additions, to the fire wardens thus provided for, who should likewise be given the powers of sheriffs in enforcing the forest laws of the State. The county wardens should be required to report each fire to the State Forester on suitable forms, to post warning notices, and to patrol in dangerous seasons if directed to do so by the State Forester. If the State Forester deems it advisable, deputy wardens should be appointed by the county warden, with the approval of the State Forester, to work under his direction, with the same powers and duties. The State Forester should also have authority to appoint special wardens, to serve voluntarily without pay, or with compensation from private owners. This would enable suitable employees of parties interested in fire protection to secure the powers of wardens and to coöperate in fire protection without expense to the State or county.

It should further be provided that whenever the State Forester becomes convinced that a dangerously dry time exists, and that it is imprudent to set fire on any land, he shall cause a notice to this effect to be posted in three public places in each county concerned, and that any person setting a fire upon any land in that county after the posting of such notices shall be guilty of a misdemeanor. This provision should not apply to camp fires built in safe places and extinguished before leaving, or to log piles, stumps, and brush located at least a quarter of a mile from other combustible material.

However, the escape of fire from such camp fires, log piles, stumps, or brush should be *prima facie* evidence that the burning was unsafe and in violation of the statute.

Section 11* of the present law provides that "nothing contained in this Act shall take away or impair the right to damages or other legal remedy which the party injured may now have under the laws of this State." This would be strengthened by adding the provision that the liability of persons or corporations for all damages shall include the injury to young growth resulting from fires, and that, upon request of the court, the State Forester shall make an examination and give an expert opinion as to the amount of damages to forest growth. It should also be provided that in a prosecution for the willful or negligent setting fire to forests, it shall be within the discretion of the court to take evidence as to the cost of fighting the fire which the accused is charged with setting, and to assess such costs as part of the penalty if the person or persons charged with the offense shall be found guilty.

The railroads should be required to post in stations warning notices, furnished by the State Forester, calling attention to the fire laws. Section 14 of the 1907 law, which provides that logging locomotives must be furnished with spark arresters, is unjust in that it discriminates against a particular class. This provision should be extended to cover all locomotives and engines operating in or near forest land not burning oil for fuel.

(2) The forestry law of 1907 authorizes the State Game Warden to collect statistics in regard to forest conditions, to investigate the suitability of public lands for forest reserve purposes, to take charge of such reserves as might be created, and to accept gifts of land for forest reserves. These duties lie naturally within the province of the State Board of Forestry, and should be transferred to that board, to be administered by the State Forester under its direction. Further authority should be given the board to make rules and regulations for the State forests, including the right to sell timber. In the case of sales amounting to over \$100 in value, advertisement for bids should be required.

The sections† in regard to forest reserves should be so modified as to permit the use of mineral land for this purpose, the mineral rights to be retained by the original owner, if the land is acquired by purchase or gift. Section 23 makes it necessary for a nonresi-

* Acts of 1907, Chapter 397.

† Sections 21 and 22.

dent of the State to obtain the services of a warden as guide in case he wishes to camp within the State forest reserves. This section should be repealed, since regulations safeguarding the camping privilege can best be made by the State Board of Forestry, which should be given the necessary authority.

The State now owns two tracts of land suitable for forest reserve purposes—the Brushy Mountain tract, in Morgan County, and the Herbert Domain, in Cumberland and the adjoining counties on the southwest. The former is about 12,000 acres in area, and includes 3,000 acres of practically virgin timber. The Herbert Domain covers between 10,000 and 11,000 acres, but the timber probably does not exceed the amount that is likely to be needed for the development of coal mines on the property. Both of these tracts should be handled so as to produce as much timber as possible in the long run. The Board of Prison Commissioners, which now controls these lands, has no authority to sell timber or practice forestry. It is recommended that the surface and timber on these tracts be turned over to the Board of Forestry to administer as State forests. Thus an opportunity may be given to start at once valuable object lessons in the practice for forestry, as well as experimental investigations. It would also make it possible to stop the loss now incurred by the State through the decay of overmature timber, which cannot be sold under existing statutes. It is further recommended that the Board of Forestry be authorized to purchase land for State forest purposes, at a rate not to exceed \$5 an acre. This authority would probably not be exercised for the present, at least, owing to lack of sufficient funds at the disposal of the board, but would be desirable in case any small tract is needed in connection with the administration of lands now owned by the State and made State forests in accordance with these recommendations.

(3) The need for educational work by the State Forester, particularly in regard to fire protection and the introduction of conservative methods of forest management, has already been clearly brought out. Special emphasis should be laid on the damage done in stock-raising sections by the practice of burning the woods every year in order to keep down the brush and to get new grass earlier in the spring. Not only does the forest growth deteriorate under such treatment, but the more nutritious annuals and winter grasses are gradually replaced by tougher perennials, so that the grazing

interests eventually suffer. Since much serious injury results from these causes, it should certainly be within the power of the landowner to regulate or prevent grazing on his own property. This is not possible in the counties which have not secured the passage by the Legislature of a law prohibiting stock from running at large. These are, for the most part, in the more thinly populated districts with large areas of woodland. The permanent welfare of such counties requires the passage of stock laws. Educational work along this line, supplemented by an investigation to demonstrate the injurious effect of annual fires on the quality of the grasses, would be an important duty of a State Forester.

The State Forester should be give authority to assist private owners at their request, also by making plans for conservative management of woodlands and advising in regard to the execution of such plans, provided that the applicant in each case pays at least the expenses of the field work that may be necessary. A careful record should be kept of the results secured by such working plans, which would furnish practical examples of what may be accomplished by rational management of woodlands.

(4) The State Forester should, of course, take charge of the investigation of forest problems within the State. The most important subjects for investigation in the different regions have already been mentioned. In connection with such studies, it should be possible to make detailed forest surveys and estimates of some of the typical timber counties as a start toward a forest type map and description of the State. The map work should be done in considerable detail, showing cleared land and types of forest. If this were done independently of other work, it would cost about \$400 to map and estimate a county. It is recommended, however, that if such surveys are undertaken at all, it be in connection with investigations of special problems. The State Forester should be authorized to cooperate with the Federal Government and with other branches of the State Government in scientific investigations, when this can be done to the advantage of the State.

The expense of carrying out the forest policy outlined naturally divides itself into two parts—the cost of the State Forester's office in educational, scientific, and administrative work, and the cost of fire protection. The first should be met by a State appropriation of \$10,000 annually. This should be supplemented by a State forest fund, into which all receipts from the sale of timber on the State forests and fines for violations of the forestry laws would be paid.

This fund should be used in the protection, improvement, and extension of the State forests. In emergency cases the State Forester should have the right to draw upon it for fighting fire in a county which has exhausted its annual allowance for this purpose.

The cost of the general fire protective system should be shared equally between the State and the individual counties in which the money is spent. This division prevents the placing of too great a burden on more thinly populated counties, and is perfectly fair, since the protection of the forests benefits indirectly the entire State as well as the individual counties. To secure promptness in payment of fire fighters, the State should pay the accounts and collect one-half from the county in which they were incurred. The rate of compensation for fighting fire is fixed in the present law at \$3 a day. This is unnecessarily high, and might be an inducement to set fires in order to get employment in putting them out. It is recommended that the rate be changed to 20 cents an hour, and that the county and deputy wardens be paid at the rate of 25 cents an hour for time actually employed in patrolling, fighting fire, posting notices, making reports, or doing other official work. They should also be reimbursed for reasonable expenses for necessary equipment and transportation. All accounts, including those for wages, should be approved by the State Forester before payment. The amount to be spent for fire protection in any county in any one year might be limited to \$200, and in the entire State to \$10,000. On this basis the total cost to the State of the forest policy recommended would not exceed \$15,000 per year, and the cost to any one county would not exceed \$100 per year, while the maximum total expense per year would be \$20,000. This expenditure is to be regarded as an investment, the returns to come in the saving of loss through fire, in the increased productivity of the woodlands, and in the maintenance of wood-using industries.

APPENDIX I.

LIST OF TREE SPECIES NATIVE TO TENNESSEE.

The following list of tree species native to Tennessee is compiled from Sudworth's Check List (Forest Service Bulletin 17), supplemented by the observations of the author and of W. W. Ashe, of the Forest Service. After the scientific name, first the accepted common name according to the Check List, is given, and then any local names that are commonly used within the State. In case the spe-

cies is not listed in the Check List, merely local names are given. The letters E, M, and W indicate the divisions of the State within which the species occur, whether East, Middle, or West Tennessee.

<i>Pinus strobus</i> , Linn.	White pine	E
<i>Pinus taeda</i> Linn.	Loblolly pine Old-field pine	E
<i>Pinus rigida</i> Mill.	Pitch pine	E
<i>Pinus virginiana</i> Mill.	Scrub pine Black pine Nigger pine	E M
<i>Pinus pungens</i> Michx, f.	Table-mountain pine	E M
<i>Pinus echinata</i> Mill.	Short-leaf pine Yellow pine	E M W
<i>Picea mariana</i> (Mill.) B. S. P.	Black spruce Balsam	E
<i>Picea rubens</i> Sargent	Red spruce Balsam	E
<i>Tsuga canadensis</i> (Linn.) Carr	Hemlock Spruce pine	E M
<i>Tsuga caroliniana</i> Engelm.	Carolina hemlock Spruce pine	E
<i>Abies fraseri</i> (Pursh) Lindl.	Fraser fir She Balsam	E
<i>Taxodium distichum</i> (Linn.) Rich.	Bald cypress	W
<i>Taxodium distichum imbricarium</i> (Nutt.) Sarg.	Pond cypress	W
<i>Thuja occidentalis</i> Linn.	Arborvitæ White cedar	E
<i>Juniperus virginiana</i> Linn.	Red Juniper Red cedar	E M W
<i>Juglans cinerea</i> Linn.	Butternut White walnut	E M W
<i>Juglans nigra</i> Linn.	Black walnut	E M W
<i>Hicoria pecan</i> (Marsh) Britton	Pecan (hickory)	W
<i>Hicoria minima</i> (Marsh) Britton	Bitternut (hickory) Pignut hickory	E M W
<i>Hicoria aquatica</i> (Michx. f.) Britton	Water hickory Bitter pecan	W
<i>Hicoria ovata</i> (Mill.) Britton	Shagbark (hickory)	E M W

<i>Hicoria carolinae-septentrionalis</i> Ashe	Shagbark hickory	E
<i>Hicoria laciniosa</i> (Michx. f.) Sargent	Shellbark (hickory) Kingnut	M W
<i>Hicoria alba</i> (Linn.) Britton	Mockernut (hickory) White hickory	E M W
<i>Hicoria glabra</i> (Mill.) Britton	Pignut (hickory) Black hickory	E M W
<i>Hicoria odorata</i> (Marsh.) Sargent	Small pignut (hickory) Black hickory	E M W
<i>Hicoria villosa</i> (Sarg.) Ashe	Pale-leaf hickory Sand hickory	E M W
<i>Salix nigra</i> Marsh.	Black willow	E M W
<i>Salix wardi</i> Bebb.	Ward willow	M
<i>Salix amygdaloides</i> Anderss	Almond-leaf willow	W
<i>Salix discolor</i> Muehl.	Glaucous willow	W
<i>Populus grandidentata</i> Michx.	Large-tooth Aspen Poplar	E
<i>Populus heterophylla</i> Linn.	Swamp cottonwood Black cottonwood	W
<i>Populus deltoides</i> Marsh.	(Common) Cottonwood	E M W
<i>Betula nigra</i> Linn.	River birch	E M W
<i>Betula lutea</i> Michx. f.	Yellow birch	E
<i>Betula lenta</i> Linn.	Sweet birch Black birch	E M
<i>Ostrya virginiana</i> (Mill.) Koch	Hornbeam Ironwood	E M W
<i>Carpinus caroliniana</i> Walt.	Blue beech	E M W
<i>Fagus atropunicea</i> (Marsh.) Sudworth	Beech	E M W
<i>Castanea pumila</i> (Linn.) Mill.	Chinquapin	E M W
<i>Castanea dentata</i> (Marsh.) Borkh.	Chestnut	E M W
<i>Quercus alba</i> Linn.	White oak	E M W
<i>Quercus Minor</i> (Marsh.) Sarg.	Post oak	E M W
<i>Quercus macrocarpa</i> Michx.	Bur oak Overcup oak	M W
<i>Quercus lyrata</i> Walt.	Overcup oak Bur oak	M W
<i>Quercus prinus</i> Linn.	Chestnut oak	E M W
<i>Quercus acuminata</i> (Michx.) Houba	Chinquapin oak	E M W
<i>Quercus platanoidea</i> (Lam.) Sudworth	Swamp white oak	E

<i>Quercus michauxii</i> Nutt.	Cow oak	E M W
	Bur oak	
<i>Quercus rubra</i> Linn.	Red oak	E M
	Water oak	
<i>Quercus texana</i> Buckl.	Texan oak	M W
	Red oak	
<i>Quercus coccinea</i> Muenchh.	Scarlet oak	E M
	Spotted oak	
<i>Quercus velutina</i> Lam.	Yellow oak	E M W
	Black oak	
<i>Quercus digitata</i> (Marsh) Sudworth	Spanish oak	E M W
	Red oak	
<i>Quercus palustris</i> Muenchh.	Pin oak	M W
<i>Quercus marilandica</i> Muenchh.	Black jack	E M W
<i>Quercus nigra</i> Linn.	Water oak	M W
<i>Quercus imbricaria</i> Michx.	Shingle oak	M W
<i>Quercus phellos</i> Linn.	Willow oak	M W
<i>Quercus pagodaefolia</i> Ashe	Swamp Spanish oak	
	Red oak	M W
	Yellow-bottom oak	
<i>Ulmus crassifolia</i> Nutt.	Cedar elm	E M
<i>Ulmus pubescens</i> Walt.	Slippery elm	E M W
	Red elm	
<i>Ulmus serotina</i> Sargent	Bluff elm	E M
<i>Ulmus americana</i> Linn.	White elm	E M W
<i>Ulmus racemosa</i> Thomas	Cork elm	M W
<i>Ulmus alata</i> Michx.	Wing elm	E M W
<i>Planera aquatica</i> (Walt.) Gmel.	Planertree	W
<i>Celtis occidentalis</i> Linn.	Hackberry	E M W
<i>Celtis georgiana</i> Small	Georgia hackberry	M
<i>Celtis mississippiensis</i> Bosc.	Sugarberry	E M W
	Hackberry	
<i>Celtis smallii</i> Beadle	Hackberry	E
<i>Morus rubra</i> Linn.	Red mulberry	E M W
<i>Magnolia glauca</i> Linn.	Sweet magnolia	E M W
	Swamp magnolia	
<i>Magnolia acuminata</i> Linn.	Cucumber tree	E M
<i>Magnolia macrophylla</i> Michx.	Large-leaf umbrella	E M
<i>Magnolia tripetala</i> Linn.	Umbrella tree	E M

<i>Magnolia fraseri</i> Walt.	Fraser umbrella	E
	Indian physic	
<i>Liriodendron tulipifera</i> Linn.	Tulip tree	E M W
	Yellow poplar	
	White wood	
<i>Asimina triloba</i> (Linn.) Dunal.	Pawpaw	E M W
<i>Sassafras sassafras</i> (Linn.) Karst.	Sassafras	E M W
<i>Hamamelis virginiana</i> Linn.	Witch hazel	E M W
<i>Liquidambar styraciflua</i> Linn.	(Red or) Sweet gum	E M W
<i>Platanus occidentalis</i> Linn.	Sycamore	E M W
	Buttonwood	
<i>Pyrus coronaria</i> Linn.	Sweet crab	E M W
<i>Pyrus ioensis</i> (Wood) Bailey	Iowa crab	M W
<i>Pyrus angustifolia</i> Michx.	Narrow-leaf crab	E M
<i>Pyrus americana</i> (Marsh.) de C.	Mountain ash	E
<i>Amelanchier canadensis</i> (Linn.) Medic.	Serviceberry	E M W
	Shad-bush	
<i>Crataegus punctata</i> Jacq.	Dotted haw	E M W
<i>Crataegus cordata</i> (Mill.) Ait.	Washington haw	E M W
<i>Crataegus viridis</i> Linn.	Green haw	M W
<i>Prunus americana</i> Marsh.	Wild plum	E M W
<i>Prunus hortulana</i> Bailey	Garden wild plum	M W
<i>Prunus angustifolia</i> Marsh.	Chickasaw plum	E M W
<i>Prunus pennsylvanica</i> Linn. f.	Wild red cherry	E
<i>Prunus virginiana</i> Linn.	Choke cherry	E M W
<i>Prunus serotina</i> Ehrh.	Black cherry	E M W
<i>Cercis canadensis</i> Linn.	Redbud	E M W
	Judas tree	
<i>Gleditsia triacanthos</i> Linn.	Honey locust	E M W
<i>Gleditsia aquatica</i> Marsh.	Water locust	M W
<i>Gymnocladus dioica</i> (Linn.) Koch.	Coffeetree	M W
<i>Cladrastis lutea</i> (Michx. f.) Koch.	Yellow wood	E M
<i>Robinia pseudacacia</i> Linn.	Locust	E M W
<i>Robinia viscosa</i> Vent.	Clammy locust	E
<i>Ptelia trifoliata</i> Linn.	Hoptree	E M W
<i>Cotinus cotinoides</i> (Nutt.) Britton	American smoketree	E
<i>Rhus hirta</i> (Linn.) Sudworth	Staghorn sumach	E M

<i>Rhus copallina</i> Linn.	Dwarf sumach	E M W
<i>Rhus vernix</i> Linn.	Poison sumach	E M W
<i>Ilex opaca</i> Ait.	American holly	E M W
<i>Ilex decidua</i> Walt.	Deciduous holly	E M W
<i>Ilex monticola</i> Gray	Mountain holly	E
<i>Euonymus atropurpureus</i> Jacq.	Waaahoo Burning bush	E M W
<i>Acer spicatum</i> Lam.	Mountain maple Low maple	E
<i>Acer pennsylvanicum</i> Linn.	Striped maple	E
<i>Acer saccharum</i> Marsh.	Sugar maple Sugar tree	E M W
<i>Acer saccharum rugelii</i> Rhed.	Sugar maple	E
<i>Acer saccharum nigrum</i> (Michx. f.) Britton	Black maple	E M W
<i>Acer saccharum leucoderme</i> (Small) Sudworth	White-bark maple Sugar maple	E
<i>Acer saccharinum</i> Linn.	Silver maple Soft maple	E M W
<i>Acer rubrum</i> Linn.	Red maple Soft maple	E M W
<i>Acer rubrum tridens</i> Wood	Red maple	E M
<i>Acer negundo</i> Linn.	Boxelder	E M W
<i>Aesculus glabra</i> Willd.	Ohio buckeye	E M W
<i>Aesculus octandra</i> Marsh.	Yellow buckeye	E M W
<i>Aesculus austrina</i> Small	Buckeye	W
<i>Rhamnus caroliniana</i> Walt.	Yellow burkthorn	E M W
<i>Tilia americana</i> Linn.	Basswood Linn	E M W
<i>Tilia heterophylla</i> Vent.	White basswood Linn	E M
<i>Tilia eburnea</i> Ashe	Linn basswood	E
<i>Aralia spinosa</i> Linn.	Angelica tree Hercules Club	E M W
<i>Cornus florida</i> Linn.	(Flowering) Dogwood	E M W
<i>Cornus alternifolia</i> Linn. f.	Blue dogwood	E
<i>Nyssa silvatica</i> Marsh.	Black gum	E M W
<i>Nyssa aquatica</i> Linn.	Cotton gum Tupelo	W

<i>Vaccinium arboreum</i> Marsh.	Tree huckleberry	E M W
<i>Oxydendron arboreum</i> (Linn.) de C.	Sourwood	E M W
	Sorrel tree	
<i>Kalmia latifolia</i> Linn.	Mountain laurel	E
<i>Rhododendron maximum</i> Linn.	Great rhododendron	E
	Rosebay	
	Great laurel	
<i>Bumelia lanuginosa</i> (Michx.) Pers.	Shittimwood	W
	Gum elastic	
<i>Diospyros virginiana</i> Linn.	Persimmon	E M W
<i>Mohrodendron carolinum</i> (Linn.) Britton	Silverbell tree	E M W
<i>Fraxinus quadrangulata</i> Michx.	Blue ash	E M W
<i>Fraxinus americana</i> Linn.	White ash	E M W
<i>Fraxinus biltmoreana</i> Beadle	Biltmore ash	E
<i>Fraxinus pennsylvanica</i> Marsh.	Red ash	E M
<i>Fraxinus profunda</i> Bush	Pumpkin ash	M W
<i>Fraxinus lanceolata</i> Borkh.	Green ash	E M W
<i>Catalpa speciosa</i> Warder	Hardy catalpa	M W
<i>Viburnum lentago</i> Linn.	Sheepberry	E
<i>Viburnum prunifolium</i> Linn.	Nannyberry	E M

APPENDIX II.

GROWTH OF WHITE AND CHESTNUT OAKS.

The following extracts from Forest Service circulars contain information in regard to the growth of white and chestnut oaks, based on measurements obtained, for the most part, in Tennessee. They are reprinted here on account of the scientific and practical value of the tables.

WHITE OAK.*

The most important feature of the growth of white oak, as well as the most significant characteristic of the tree, is its inherent persistence. The growth of white oak is comparatively slow. Young trees are often outstripped and suppressed by other species. They will, however, grow slowly, but persistently, for many years under adverse conditions.

In white oak the duration of vigorous growth is greater than in any of its associates except yellow poplar and possibly chestnut. It retains its vigor and resistant qualities to an advanced age. For these reasons white oak in the long

* Circular 105, "White Oak in the Southern Appalachians."

run overcomes and replaces in the mature virgin stands the black and red oaks, which have such a marked advantage over it in early life. As a rule, in virgin woods, the proportion of white oak increases steadily in the older-age classes. It often forms the bulk of the mature timber in stands where but 10 per cent of the young growth is white oak.

The very slow rate of growth of white oak seedlings under virgin forest, as well as their persistence under adverse conditions, is shown in the last column of Table 1. It is based upon measurements of seventy-seven white oak seedlings in virgin coves in the Holston Mountains of Northeastern Tennessee. The forest in this case was exceptionally dense, and the rate of growth is undoubtedly much lower than the average on virgin lands in the region as a whole. The growth of white oak seedlings, however, is slower than that of seedlings of most of the important timber trees associated with it. Under similar site conditions, young black and red oak will almost invariably outstrip white oak.

The rate of growth in height of white oak sprouts under virgin woods is given in the three middle columns for the cove and slope types of the Cumberland Mountains and for the cove type of the Holston Mountains.

TABLE 1.—HEIGHT OF YOUNG WHITE OAK AT DIFFERENT AGES IN EASTERN TENNESSEE.

AGE	CUMBERLAND MOUNTAINS		HOLSTON MOUNTAINS	
	Sprout		Sprout	Seedlings
	Cove	Slope	Cove	Cove
<i>Years</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>
1.....	13.0	12.5	10.0	4.0
2.....	40.0	26.0	16.5	5.5
3.....	57.0	39.5	21.0	6.8
4.....	70.0	48.2	24.0	8.0
5.....	82.0	56.0	26.7	9.0
6.....	.....	.....	29.0	10.0
7.....	.....	.....	31.0	10.8
8.....	.....	.....	33.0	11.7
9.....	.....	.....	35.0	12.4
10.....	.....	.....	36.6	13.0

The sprouts measured upon the cove lands of the Holston Mountains were growing under an old stand of unusual density, which accounts for their comparatively slow rate of growth. These figures can be compared directly with those for the rate of growth of white oak seedlings, which were obtained from exactly the same coves. By such comparison it is seen that under the same conditions as to soil, moisture, and light, the sprouts of white oak grow about three times as fast during the first ten years as the seedlings.

The rate of growth of young white oak sprouts, while vigorous, is considerably less rapid than that of chestnut and of black oak and red oak. Instances are frequently found in the oak belt of Central and Western Tennessee and Kentucky where white oak sprouts have been outstripped in growth and badly suppressed by black and red oak sprouts of the same age.

Table 2 shows the growth in diameter of virgin white oak up to 21 inches. It is based on measurements of 509 trees taken in Jackson County, Ky., but represents the average rate of diameter growth of white oak throughout the Southern Appalachian region.

TABLE 2.—HEIGHT AND DIAMETER OF VIRGIN WHITE OAK AT DIFFERENT AGES.

AGE	Height	Diameter breast high
<i>Years</i>	<i>Feet</i>	<i>Inches</i>
20	11	1.1
30	18	2.2
40	25	3.2
50	31	4.2
60	38	5.3
70	44	6.3
80	49	7.4
90	55	8.5
100	60	9.7
110	65	11.0
120	69	12.3
130	72	13.5
140	74	14.7
150	76	15.4
160	79	16.8
170	82	17.8
180	84	18.9
190	85	19.9
200	87	21.0

The development of second-growth white oak after logging, with much better light conditions, is considerably faster than that of virgin timber. Measurements of second-growth white oak were obtained in Decatur County, Tenn., on lands which were cut clean for charcoal from fifty to sixty years ago. The rate of growth of this young timber in height, diameter, and volume is given in Tables 3 and 4.

TABLE 3.—RELATION OF HEIGHT AND DIAMETER TO AGE OF SECOND-GROWTH WHITE OAK IN DECATUR COUNTY, TENN.

AGE	Height	Diameter breast high
<i>Years</i>	<i>Feet</i>	<i>Inches</i>
5	6	0.2
10	12	1.0
15	19	2.0
20	25	3.3
25	31	4.6
30	37	5.9
35	44	7.1
40	50	8.3
45	56	9.4
50	61	10.3
55	66	11.2
60	70	11.7
65	73	12.2
70	74	12.6
75	75	12.9
80	76	13.2
85	77	13.4
90	78	13.6

TABLE 4.—VOLUME *a* OF SECOND-GROWTH WHITE OAK OF ALL TYPES, DECATUR COUNTY, TENN.

Diameter breast high	All types	Diameter breast high	All types
<i>Inches</i>	<i>Board feet</i>	<i>Inches</i>	<i>Board feet</i>
10	24	15	106
11	34	16	130
12	47	17	155
13	65	18	180
14	85		

a Logs scaled by Doyle's rule.

The better soil and moisture conditions found on the cove and slope lands produce more rapid growth in height and diameter than on the ridges, and much more rapid volume increment.

CHESTNUT OAK.*

The rate of growth of chestnut oak is slower both in height and diameter than that of any of the associated oaks. This and its intolerance account for its being so largely excluded from the shady coves. Table 5 shows the development in diameter, total height, and clear length of trees in the virgin forest of the slope type in Polk and Monroe Counties, Tenn. The growth, as shown in this table, seems, on comparison with measurements made in other portions of the region of slope, ridge, and cove trees, to represent about the average rate of growth for virgin timber throughout the region. Second-growth trees and trees which have had more favorable light conditions in culled forests would show much more rapid diameter increment at least.

TABLE 5.—TOTAL HEIGHT, CLEAR LENGTH, AND DIAMETER GROWTH OF VIRGIN CHESTNUT OAK IN POLK AND MONROE COUNTIES, TENN.

Age	Diameter breast high	Total height	Clear length	Age	Diameter breast high	Total height	Clear length
<i>Years</i>	<i>Inches</i>	<i>Feet</i>	<i>Feet</i>	<i>Years</i>	<i>Inches</i>	<i>Feet</i>	<i>Feet</i>
20	1.2	12	5	120	12.0	63	24
30	2.4	19	8	130	13.0	65	24
40	3.4	25	11	140	13.9	67	25
50	4.3	31	13	150	14.9	69	25
60	5.4	36	15	160	15.8	70	26
70	6.5	41	17	170	16.7	72	26
80	7.7	47	19	180	17.5	73	26
90	8.8	52	21	190	18.4	74	27
100	10.0	57	22	200	19.3	75	27
110	10.9	60	23				

* Circular 135, "Chestnut Oak in the Southern Appalachians."

Table 6 contains average figures for the rate of growth of seedling sprouts and seedlings of chestnut oak for the first ten years in virgin woods. Two localities were studied—the Cumberland Mountains, of Claiborne County, Tenn., and the Holston Mountains, in Sullivan County, Tenn. Separate averages were made for each locality by types.

TABLE 6.—HEIGHT GROWTH OF YOUNG CHESTNUT OAK.

AGE	Cumberland Mountains, slope, and ridge, seedling coppice (101 trees)	HOLSTON MOUNTAINS			
		Slope and ridge, seedling coppice (90 trees)	Slope, root suckers (29 trees)	Cove	
				Seedling coppice (43 trees)	Seedlings (30 trees)
	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>
1 year	13	12	6	9	5
2 years	30	22	7	21	7
3 years	46	38	8	33	8
4 years	62	61	9	44	9
5 years	76	75	9	53	10
6 years	89	.....	10	59	11
7 years	100	.....	10	64	12
8 years .....	.....	.....	11	.....	13
9 years .....	.....	.....	11	.....	13
10 years .....	.....	.....	12	.....	14

From this table the rate of growth of seedlings and seedling sprouts of chestnut oak in the same locality and type can be directly compared. Such comparisons show the rate of growth of seedling coppice in height to be from three to five times as rapid as that of seedlings. The rate of growth of root suckers is seen to run slightly less than that of seedlings.

The following tabular statement, made from measurements taken in different portions of Tennessee and North Carolina, shows the average height, clear length, and diameter breast high of old chestnut oak growing under different conditions. Each measurement is averaged from a number of trees in the same locality, growing under the same conditions, but, except in the ridge trees measured in Jackson and McDowell Counties, N. C., only averages of mature trees above 20 inches are included.

County and State	Trees growing in coves			Trees growing on slopes			Trees growing on ridges		
	Average height	Average clear length	Average diameter	Average height	Average clear length	Average diameter	Average height	Average clear length	Average diameter
	<i>Feet</i>	<i>Feet</i>	<i>Inches</i>	<i>Feet</i>	<i>Feet</i>	<i>Inches</i>	<i>Feet</i>	<i>Feet</i>	<i>Inches</i>
Sullivan County, Tenn.....	102	42	32	77	35	31	.....	.....	.....
Claiborne County, Tenn.....	90	45	32	60	30	24	59	19	22
Perry County, Tenn.....	85	40	23	75	30	23	51	20	23
Jackson and McDowell Counties, N. C.....	81	34	24	.....	.....	.....	a 21	7	6

a Includes trees with diameters less than 20 inches.

The relation of total height to clear length, showing the extent of self-pruning, is also observable. The relative length of crown on the several types is exhibited, and the greater sizes attained in the cove type than in the slope or ridge type.

The largest dimensions are attained along and west of the Allegheny and Cumberland Mountains, in West Virginia, Kentucky, and Tennessee. Individual specimens occasionally reach a height of 115 and 118 feet, and maximum diameters of 50 and 52 inches.

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