Georgia Forest Service

B. M. Lufburrow, State Forester

Forests of Georgia Highlands

Their Importance for Watershed Protection, Recreation and Wood Production

By

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United States Forest Service
Georgia Forest Service and
Georgia Agricultural Experiment Station
Cooperating
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Foreword

Bonnell H. Stone, Blairsville, consulting forester, who has been field representative of state interests in this project, has contributed a foreword to this bulletin as follows:

A cooperative forestry research project was inaugurated in Georgia in 1930 in which the Appalachian Forest Experiment Station of the United States Forest Service, at Asheville; the Georgia State Board of Forestry, and the Georgia Agricultural Experiment Station joined. Georgians will be glad to know that this cooperative project was made possible by a special federal appropriation sponsored by Hon. Wm. J. Harris, Senior United States Senator of Georgia.

From the mountain branch of the Georgia Experiment Station in Union county where the work started, the forest studies are reaching out to the nearby national forests and to other lands where research plots are being established.

The bulletin covers observations made during the first year's survey. The facts herein reported will give an enlarged vision of the value of forests in the mountains of Georgia, not only with respect to their possibilities in producing timber but as to their value for watershed protection and recreation. In fact, when one considers the importance of a water supply for hydroelectric power and the effect of well managed forests on the conservation of water, both for water power and for preventing soil erosion losses, we find that watershed protection is perhaps the major public service rendered by mountain forests. Possibly second in importance in public benefits derived from the mountain forests is the ideal condition forests create for recreation in this highland playground of Georgia. Third in rank of value to the state is perhaps the timber produced by the forests.

The threefold value of the mountain forests emphasizes the great necessity of so managing them as to get the largest benefits to the state. To do this, it is necessary to know what the conditions are and what can be done to improve them. This means research. It is a pleasure to refer here to the keen interest manifested by the director of the Georgia Experiment Station and the state forester in this cooperative undertaking, and to the painstaking work of the personnel of the Appalachian Forest Experiment Station. The first results of forest research embodied in this bulletin, we feel, make a valuable contribution to the development of the State.

BONNEL H. STONE.
Mountain Forests of Georgia

The mountain region of Georgia holds a significant place in the economic geography of the state because of three important considerations: (1) Municipal water supply and hydroelectric power, (2) increasing public demand for recreational facilities, and (3), the continuous requirements for hardwood forest products. The basis for all these considerations is the proper development and management of the mountain forest land. The purpose of this bulletin is to present information pertinent to the nature and composition of the mountain forests of north Georgia, with such facts as are available concerning their proper development and management.

The Appalachian Mountains, which begin in Georgia, extend northward for over 1,000 miles. The portion of these mountains in Georgia is confined to a relatively small area, the greater part occurring within Rabun, Towns, Union and Fannin counties, and in parts of Habersham, White, Lumpkin, Dawson and Gilmer counties. Much of the area in mountain forests is above an elevation of 2,000 feet, where the topography is generally rough, with no extensive level areas or plateaus. The mountain land lying above 2,000 feet is classified according to elevation as shown in Table 1.

### TABLE 1.

<table>
<thead>
<tr>
<th>Elevation</th>
<th>Acres</th>
<th>Per cent of area over 2,000 feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000-2500</td>
<td>352,705</td>
<td>56.40</td>
</tr>
<tr>
<td>2500-3000</td>
<td>177,013</td>
<td>28.31</td>
</tr>
<tr>
<td>3000-3500</td>
<td>79,540</td>
<td>12.72</td>
</tr>
<tr>
<td>3500-4000</td>
<td>13,367</td>
<td>2.14</td>
</tr>
<tr>
<td>4000-4500</td>
<td>2,640</td>
<td>0.42</td>
</tr>
<tr>
<td>4500-5000</td>
<td>87</td>
<td>0.01</td>
</tr>
<tr>
<td>Totals</td>
<td>625,352</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Agriculture in the Mountain Region

For the greater part, farming activities in the mountain region are confined to valleys below an elevation of 2,000 feet. In the past there has been an attempt to farm much land not suited to agricultural crops. This has resulted in abandonment of land with a tendency to retain only the most suitable areas in farms. Table 2 shows the rate at which this abandonment of farms has been going on in three of the most typical mountain counties.

### TABLE 2.

**Abandonment of farm land in Georgia Mountains. Based on reports by United States Bureau of Census.**

<table>
<thead>
<tr>
<th>Year</th>
<th>Rabun</th>
<th>Towns</th>
<th>Union</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900</td>
<td>1,067</td>
<td>665</td>
<td>1,444</td>
<td>3,176</td>
</tr>
<tr>
<td>1910</td>
<td>856</td>
<td>658</td>
<td>1,286</td>
<td>2,800</td>
</tr>
<tr>
<td>1920</td>
<td>745</td>
<td>696</td>
<td>1,170</td>
<td>2,610</td>
</tr>
<tr>
<td>1925</td>
<td>651</td>
<td>660</td>
<td>1,281</td>
<td>2,642</td>
</tr>
</tbody>
</table>

From the above table it appears that 26,271 acres of improved land on 634 farms were abandoned in the three counties between 1900 and 1925. This means that in the 25-year period, 4.5 per cent of the total land area reverted to old fields. The size of the average farm decreased from 141 acres in 1900 to 88 acres in 1925. All these facts point to a growing recognition that certain lands are not suited for farms. There will probably come a time when this land abandonment will cease; when a degree of stabilization will have been reached and only the most suitable land will be retained in farms. However, this remaining desirable farm land within the mountain region is becoming more important each year, particularly for its use in special crops that because of their late season maturity in the mountains can find ready markets in the lower south where similar crops have been harvested earlier in the year. This fact has been recognized by the agricultural interests of the state and
PLATE 1.—Georgia Highlands are the headwaters of many streams important for hydroelectric power. Typical mountain landscape seen from the Neel Gap in Vogel State Park.—Photographed by U. S. Forest Service.

has resulted in the establishment in 1930 of the Georgia Mountain Experiment Station near Blairsville, in Union county. This station has already made a significant start toward carrying out studies that will assist in the betterment of both the agriculture and forestry of the region.

Most of the mountain region will no doubt serve the best interests of the state if it remains in timber, not only for the income from wood products but also as a means of controlling the flow of streams which have their headwaters in the mountains, and for developing its recreational possibilities. According to reports of the United States census report 1920, approximately 84 per cent of the land area of the counties of Rabun, Towns and Union is forest land.

IMPORTANCE OF FORESTS FOR WATERSHED PROTECTION

The southern extremities of the Blue Ridge which include the mountains of northern Georgia are known to have the highest annual rainfall in the eastern United States. For the past 27 years the yearly precipitation has averaged about 70 inches at the weather station located in Clayton, Rabun county. This may be considered an average for the mountain region as a whole. During this period of 27 years, there have been four years when the total rainfall was above 80 inches. During one of these years of exceptionally high precipitation, 1906, the total annual rainfall was about 92 inches. It is in such times that great damage is done by the uncontrolled run-off of rainwater on mountain slopes unprotected by vegetation.

The damage done by floods resulting from heavy rains takes many forms. The soil is removed from unprotected mountain slopes which adds to the difficulty of re-establishing desirable plant growth. Fields in the lower country adjacent to the mountains are sometimes washed away, while others are covered with a layer of gravel and rendered unfit for farming. The finer particles of soil are carried long distances and finally deposited in the quiet waters of power dams, thus reducing their capacity for holding water. The quantity of soil carried by the waters actually adds to the volume of the flood. This heightens flood crests and increases property damage.

Limited information is available as to the part which forests play in reducing the soil carried by flood waters. Examinations made in 1928 by the Appalachian Forest Experiment Station in—
dicate that streams draining the watersheds which have been de-
forested until less than fifteen per cent of the original forest re-
mained, carried in time of flood, one thousand times more sus-
pended matter than did streams whose watersheds remained in
forests.

Adjoining the mountain region of Georgia is an area in south-
ern Tennessee where fumes from the smelters have destroyed the
forest and other vegetation. This region is now one of almost
hopeless devastation. The streams here are practically dry ex-
cept for a few hours after rains when they become swollen tor-
rrents, carrying a heavy load of soil which has been eroded from
the unprotected land. The beneficial influence a forest cover
exerts in controlling the flow and condition of the streams can-
not be overlooked as one of the most important values of the
mountain forests.

One reason for this control of stream flow exerted by forests
is the absorptive capacity of the forest litter, or the layer of
leaves and twigs which collects on the ground under the forest.
This layer is usually in all stages of decay and serves as a
sponge which not only soaks up considerable moisture but
also protects the soil from the beating effects of wind driven
rain, which plays a large part in starting erosion.

Forest litter will absorb a considerable amount of rainfall thus
preventing its rapid run-off, but the greatest effect of the litter
is in keeping the soil itself absorptive through favoring the de-
velopment of a loose, spongy texture within the soil. The pro-
tection resulting from the litter covering the forest floor is one
of the important reasons for keeping forest fires out of the
mountain region.

RECREATION IN NORTHERN GEORGIA

Although watershed protection and timber production are
usually considered the primary benefits to be derived from the
mountain forests, there are other possibilities of drawing an
income from this forested area. The mountains of northern
Georgia occupy a strategic position from a recreational stand-
point. They offer the nearest, most healthful summer play-
ground to the population of the more southern regions. It is the
picturesque background furnished by the mountain forests that
makes the region attractive to tourists and vacationists. The de-
velopment of state forest parks and national forests from the
view point of the tourist will do much toward making the
region popular. According to a recent report to the United
States Senate there were 343,842 hunters and fishermen in
Georgia in 1930. The total number of football and baseball
fans, golf players and tennis players was found to be but 428,-
085, or 84,243 more than the number of hunters and fishermen.
Proper game management, with particular reference to increas-
ing the number of deer, turkey, grouse and game fish will do
much toward attracting a constantly increasing number of
sportsmen into the mountain forests.

Although important, the use of the mountain forests as a
Mecca for sportsmen is only one phase of their recreational
value. The completion and improvement of highways has
brought, and in the future, will bring many people to the moun-
tains largely for the enjoyment of the picturesque and scenic
values of the Blue Ridge country. During 9 months in 1928,
approximately 10,100 people signed the register at Neel Gap in
the Vogel Forest-Park. In 1930, during a similar period, 12,-
590 names were registered at Neel Gap. This increase of over
2,500 visitors took place in spite of the tendency for a smaller
percentage of these visitors to register as the holiday crowds at
the park increased.

The esthetic values of the mountains and their forest cover
cannot be overestimated as an attractive and healthful recre-
tion ground for visitors. Forest fires would destroy the greater
part of these attractions.

A start in game management was made with the establish-
ment of the Federal Game Preserve in southern Fannin county.
This preserve lies entirely within the Cherokee National Forest
and is about nine miles long in an east and west direction and
eight miles from north to south. Other game refuges, both state
and federal, will be necessary if ample breeding grounds are to
be provided for the satisfactory restocking of the mountain for-
est. Much information not now available will be needed to

1United State Senate Report 1329, 71st Congress, 3rd Session. Re-
port from the Special Committee on Conservation of Wild Life Re-
PLATE 3.—Fine 25 year old stand of oaks on abandoned field, that should be thinned and protected from fire. Such stands offer excellent cover for game.—Photographed by U. S. Forest Service.

efficiently restock the region with game. In addition, an intelligent educational and law enforcement program must be carried out. The potential value of a large game crop should be brought to the attention of the local populace and their cooperation solicited in its protection and proper use.

It is an obvious fact and generally understood in northern Georgia that forest fires if uncontrolled can greatly reduce if not completely destroy possibilities of restocking the region with game. The United States Forest Service, the Georgia Forest Service, and lumber companies are all working on the problem, with the result that the annual fire toll of game is being steadily reduced. The entire populace of the region must consider itself

a part of the fire protection organization if restocking the mountain region to game is to be successful.

While it is not true that forests depend upon game for their existence, it is true that game should be more widely considered as a product of forested areas.

FOREST PRODUCTION IN THE HIGHLANDS

Composition of the Forest—So far as variety and number of plant species are concerned, the flora of the Georgia highland is one of the richest in the entire continent. No less than one hundred and forty species of forest trees alone occur within the region. Approximately one-half of these trees have some commercial significance. Of the commercial trees only seven species are coniferous, the remainder being broadleaf or hardwood species.

The mountain forest is made up of many combinations and mixtures of tree species which is determined largely by the nature of the particular area that is being considered. From a survey of over 33,000 acres made in Union and Towns counties it was found that the areas of mountain forest would be classified briefly as in Table 3:

<table>
<thead>
<tr>
<th>Class</th>
<th>Per cent of total area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cove and stream bottom</td>
<td>3.0</td>
</tr>
<tr>
<td>Lower and middle slope</td>
<td>41.4</td>
</tr>
<tr>
<td>Upper slope and ridge</td>
<td>42.9</td>
</tr>
<tr>
<td>Timbered old fields</td>
<td>11.0</td>
</tr>
<tr>
<td>Open areas</td>
<td>1.7</td>
</tr>
</tbody>
</table>

From these figures it is possible to obtain a broad understanding of certain forest conditions. For instance, it is generally known that timber production is high in coves. Here conditions of soil and moisture are such that rapid growth can take place. From Table 3 it is apparent that the coves and stream bottoms along with the old fields comprise 14 per cent of the forest area. This proportion then is the area of most rapid growth. Lower and middle slopes come next in order of production, while upper slopes and ridges give the poorest growth.
Table 4.—General forest composition.

<table>
<thead>
<tr>
<th>Species</th>
<th>Stream and Cove</th>
<th>Middle and lower slope</th>
<th>Upper slope Ridge &amp; cove</th>
<th>Old field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemlock</td>
<td>16.3</td>
<td>1.4</td>
<td>0.3</td>
<td>0.5</td>
</tr>
<tr>
<td>Yellow poplar</td>
<td>24.0</td>
<td>9.6</td>
<td>1.2</td>
<td>53.6</td>
</tr>
<tr>
<td>White pine</td>
<td>3.7</td>
<td>0.3</td>
<td>1.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Butternut-sycamore</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>1.2</td>
</tr>
<tr>
<td>Walnut &amp; cherry</td>
<td>0.3</td>
<td>0.4</td>
<td>0.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Buckeye</td>
<td>4.6</td>
<td>1.0</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Basswood</td>
<td>6.4</td>
<td>2.6</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Beech-birch maple</td>
<td>1.4</td>
<td>1.3</td>
<td>0.8</td>
<td>0.2</td>
</tr>
<tr>
<td>Ash</td>
<td>1.0</td>
<td>0.4</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Hickories</td>
<td>4.7</td>
<td>4.5</td>
<td>2.4</td>
<td>1.9</td>
</tr>
<tr>
<td>White oak</td>
<td>3.7</td>
<td>6.0</td>
<td>13.6</td>
<td>6.7</td>
</tr>
<tr>
<td>*Red oaks</td>
<td>8.0</td>
<td>20.8</td>
<td>23.1</td>
<td>13.6</td>
</tr>
<tr>
<td>Chestnut</td>
<td>22.0</td>
<td>36.0</td>
<td>12.5</td>
<td>17.9</td>
</tr>
<tr>
<td>Chestnut oak</td>
<td>3.6</td>
<td>14.2</td>
<td>26.7</td>
<td>0.8</td>
</tr>
<tr>
<td>§Yellow pines</td>
<td>0.2</td>
<td>1.4</td>
<td>17.5</td>
<td>2.4</td>
</tr>
</tbody>
</table>

*Includes black, scarlet, and southern red oaks.
§Includes shortleaf, pitch and Virginia pines.

From these figures it is obvious that 24 per cent or nearly one-fourth of the total board foot volume in coves and stream bottoms is yellow poplar. This species, with hemlock and chestnut, contains 62 per cent of all merchantable timber on such areas. Other valuable species such as white pine, buckeye, and basswood are found most frequently in coves, although taken together they furnish only about 15 per cent of the merchantable timber in the cove and stream bottom type.

On middle and lower slopes chestnut furnishes the greatest amount of merchantable timber of any one species. It is followed in order of importance by the red oaks, chestnut oak and yellow poplar. Together, these species contain 81 per cent of all merchantable timber in the type. Such species as walnut,
cherry, beech, birch, maple, and the hickories appear to have about the same representation on middle and lower slopes that they have in the cove and stream bottom type.

Chestnut oak is the leading species on the ridges and upper slopes. Here it provides slightly over one-fourth of the merchantable standing timber. The red oaks are present in nearly equal amounts. The yellow pines show a sudden increase over their occurrence at lower elevations, being third in order of importance. White oak takes fourth place, contributing approximately 14 per cent of the merchantable saw timber. Chestnut contains only 12.5 per cent of the board feet volume on this site. The oaks and chestnuts, together with yellow pine, comprise 93 per cent of all merchantable timber on ridges and upper slopes.

On old fields it is found that yellow poplar makes up over half of the timber volume. A very important characteristic of this species is its ability to seed old fields and rapidly establish a forest stand.

The direction in which a mountain slope faces also has a great influence upon the forest composition. For instance, on south and west slopes, white, black, scarlet and chestnut oaks are found much more frequently than on north and east slopes of the same elevation. In the first case, they form over three-fourths of the merchantable stand, while on north and east facing localities, less than one-half of the forest stand is made up of these species. Certain trees, such as post oak and southern red oak occur most frequently on dry south and west slopes, thereby indicating their ability to occupy the poorest of sites.

Unfortunately, chestnut occupies a very prominent place in the stand and its unavoidable death by the chestnut blight will remove a rapidly growing and high-grade timber tree from the forest. The figures in Table 4 show the stands as they were before the chestnut blight became wide spread in the Georgia mountains. In the summer of 1930 it was found that an average of 40 per cent of the chestnut trees 4 inches in diameter and larger were blight killed. However, the percentage of dead trees varied considerably with elevation. Apparently the blight is not as severe at higher altitudes. At an elevation of 2,900 feet above sea level 25 per cent of the trees were dead. Between 2,000 and 2,300 feet the mortality due to blight was found to be about 60 per cent.

FOREST GROWTH RATE

Because of the very favorable climatic conditions a high growth rate might be expected in the mountain forests. During a field study of two months' duration the most rapid growth discovered was made by a stand of yellow poplar (see plate 4) in the Sosebee cove near Wolf Pen Gap, Union county. Conditions in this cove are excellent for the growth of yellow poplar.

PLATE 4.—Exceptionally fast growing stand of yellow poplar in Sosebee Cove, Union county, Georgia. The timber is 55 years of age.—Photographed by U. S. Forest Service.
A half acre in one of the best stocked portions of this stand was measured in 1923 when the timber was 48 years of age. At that time it contained 15,646 board feet of lumber in trees 12 inches and larger at breast height. This stand was again measured in 1930 and found to contain 17,946 board feet in trees with a diameter of 12 inches and larger. The difference in volume of 2,300 board feet was grown on the half-acre in 7 years or at the rate of 328 feet per year. Provided good forestry practice could produce a large area with as good stocking as existed on this half-acre, the yearly growth would have averaged 656 board feet per acre for the 7 years between 1923 and 1930. However, such growth is unusual and will occur only on limited areas.

**Growth Rate of Different Species.**

No doubt on suitable sites yellow poplar is the fastest growing hardwood found in northern Georgia. For instance, Chart 2, which is based on the best available data, shows that at 50 years of age yellow poplar has an average breast high diameter of nearly 13 inches; while scarlet oak, its nearest competitor among the hardwoods, has reached a diameter of only about 8 inches.

Chart 2 shows the average diameter growth by species of all classes of trees except those which are badly decayed. No data were obtained for chestnut, since it probably will not play a large part in the forest stands of the immediate future.

From Chart 2 it is apparent that scarlet and black oak grow more rapidly than any of the other oaks except in early life. Southern red oak has a rapid early growth but is soon surpassed by scarlet and black until at 100 years of age it has a diameter about equal to that of white oak. Post oak, of course, is the slowest grower.

In old fields, shortleaf pine also grows very rapidly. Its growth on these sites, as shown in Chart 2, is slightly greater than that of yellow poplar.

**Volume Production on Cut-Over Mountain Slopes**

The figures in Table 5 show the average number of trees per acre that were found on cut over forested slopes of average stocking between the elevations of 2,000 and 2,500 feet. Nearly 60 per cent of the land area above 2,000 feet lies between these elevations and is therefore of particular importance from the standpoint of forest growth. By measuring the growth rings of wood cores taken from the standing trees an estimate was made of the wood production for the past 20 years. These growth figures are presented in Table 6.

Data in Table 5 and Table 6 are based on 16 half acre sample plots representing typical conditions.
Table 5.—Average number of trees per acre. Slopes of average stocking. Elevations 2,000 to 2,500 feet.

<table>
<thead>
<tr>
<th>Species</th>
<th>White Oak</th>
<th>Black Oak</th>
<th>Scarlet Oak</th>
<th>Chestnut Oak</th>
<th>Southern Red Oak</th>
<th>All other species</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>6.7</td>
<td>3.6</td>
<td>1.4</td>
<td>3.6</td>
<td>2.1</td>
<td>7.7</td>
<td>25.1</td>
</tr>
<tr>
<td>6</td>
<td>6.7</td>
<td>7.9</td>
<td>2.6</td>
<td>2.8</td>
<td>1.8</td>
<td>4.6</td>
<td>26.4</td>
</tr>
<tr>
<td>7</td>
<td>8.1</td>
<td>6.6</td>
<td>3.2</td>
<td>2.0</td>
<td>1.3</td>
<td>3.3</td>
<td>22.3</td>
</tr>
<tr>
<td>8</td>
<td>5.0</td>
<td>5.1</td>
<td>3.3</td>
<td>2.7</td>
<td>2.0</td>
<td>3.4</td>
<td>21.5</td>
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<tr>
<td>9</td>
<td>5.0</td>
<td>7.5</td>
<td>3.2</td>
<td>2.0</td>
<td>0.9</td>
<td>1.1</td>
<td>11.6</td>
</tr>
<tr>
<td>10</td>
<td>3.2</td>
<td>2.2</td>
<td>0.8</td>
<td>2.1</td>
<td>0.8</td>
<td>1.0</td>
<td>10.1</td>
</tr>
<tr>
<td>11</td>
<td>1.9</td>
<td>1.7</td>
<td>1.5</td>
<td>1.1</td>
<td>0.4</td>
<td>0.5</td>
<td>7.1</td>
</tr>
<tr>
<td>12</td>
<td>2.1</td>
<td>2.0</td>
<td>0.7</td>
<td>1.0</td>
<td>0.3</td>
<td>0.2</td>
<td>5.6</td>
</tr>
<tr>
<td>13</td>
<td>0.4</td>
<td>1.6</td>
<td>0.3</td>
<td>1.2</td>
<td>0.6</td>
<td>2.4</td>
<td>5.9</td>
</tr>
<tr>
<td>14</td>
<td>0.5</td>
<td>1.2</td>
<td>0.3</td>
<td>1.1</td>
<td>0.8</td>
<td>1.1</td>
<td>3.7</td>
</tr>
<tr>
<td>15</td>
<td>0.1</td>
<td>0.3</td>
<td>0.7</td>
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<td>0.1</td>
<td>0.1</td>
<td>0.5</td>
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<tr>
<td>28</td>
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<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Totals</td>
<td>37.8</td>
<td>35.4</td>
<td>16.9</td>
<td>19.4</td>
<td>9.7</td>
<td>26.2</td>
<td>145.4</td>
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</table>

Trees 12 inches d.b.h. and over*:

<table>
<thead>
<tr>
<th>Age, Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>2</td>
</tr>
</tbody>
</table>

Table 6.—Average yearly growth per acre 1910-1930. Slopes of average stocking, 2,000-2,500 feet elevation.

<table>
<thead>
<tr>
<th>Species</th>
<th>Board feet by International log rule, &quot;Merchantable cubic feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>All species</td>
<td>89</td>
</tr>
<tr>
<td>Major species*</td>
<td>73</td>
</tr>
</tbody>
</table>

*White oak, black oak, scarlet oak, chestnut oak, and southern red oak.
Board foot volumes include those trees which were 12 inches in diameter and larger in 1910 and also those which reached this size between 1910 and 1930. Merchantable cubic foot volumes include trees which were four inches in diameter in 1910 and in addition those which reached this size between 1910 and 1930.

These growth figures give an indication of the present wood production which is taking place on a widespread type of mountain forest. Without doubt the potential wood-producing capacity of these forests is much greater than that indicated by the growth figures. Past cuttings followed by fires have so far reduced the number of desirable trees per acre that production is much less than it would be if the land were fully stocked.

Growth of virgin forests.

Foresters and lumbermen know that as a tree approaches old age its rate of growth becomes slower. This is shown by an investigation of the volume production in the remaining virgin forests of northern Georgia as compared with the growth on well-stocked cut-over slopes. The latter has already been discussed.

According to the best information available the average acre of forested mountain slope previously described produced 1,780 board feet in the 20 years between 1910 and 1930. As shown in Table 6 this amounts to a yearly growth of 89 board feet per acre. The stands upon which these figures are based contained an average of 985 board feet to the acre in 1910. The yearly growth rate during the 20-year period averaged 9.0 per cent.

Examinations of the virgin forests showed that in the same period growth had amounted to 1,632 board feet per acre or about 81 board feet annually for all species. As nearly as can be determined these virgin stands contained an average of 3,314 board feet per acre in 1910. Using this figure as a basis the annual growth rate for the virgin forests has been only 2.5 per cent for the past 20 years. This indicates that these old growth stands have passed the period of highest annual volume production.

In general it cannot be said that present forest growth is rapid either in the virgin forests or in cut-over areas. This is largely due to over-maturity in the case of virgin forests and to past treatment as already indicated in the case of cut-over areas.

Wood Production on Old Fields.

Old field forests are usually well stocked and they frequently produce merchantable crops of wood in a comparatively short time.

The rapid growth made by shortleaf pine on old fields has already been mentioned. Plate 6 illustrates a stand of this
character located in Union county at an elevation of approximately 2,000 feet. The age of this stand was found to be 40 years and the growing conditions average for shortleaf pine. The following tabulation shows for the stand the volume per acre by 10-year intervals, the average yearly growth for the past 20 years and also for the entire life of the stand.

<table>
<thead>
<tr>
<th>Product</th>
<th>Volume per acre by decades</th>
<th>Average annual growth per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cords— Peeled wood</td>
<td>1910</td>
<td>1920</td>
</tr>
<tr>
<td>Board feet</td>
<td>15.7</td>
<td>28.2</td>
</tr>
</tbody>
</table>

NOTE: Cordwood volumes include all trees five inches in diameter at breast height and larger. Board foot volumes include all trees 12 inches in diameter at breast height and larger. This table is based on increment cores from 50 trees.

From the above table it is obvious that the merchantable growth of the pine for the last twenty years has been somewhat faster than the average growth for the entire life of the stand. This is largely because the growth during the period 1910-30 has been concentrated on trees of merchantable size, while growth during early life was made by trees too small for pulpwood, many of which have died through suppression by faster growing trees.

The rate of growth on an old field stand of poplar 36 years of age was studied for comparison with shortleaf pine. The site was slightly above average for poplar and the yield was found to be 31 cords per acre of wood exclusive of bark in trees of the five-inch diameter class and larger. There were 4,000 board feet of lumber per acre in trees 12 inches in diameter at breast height and larger. This represents an average annual growth for the entire life of the stand of about 0.86 cord of peeled wood, or 112 board feet of saw-timber.

Compare the yields made by these pine and poplar stands with the production of a well stocked old field of mixed hardwoods located at a similar elevation. The site, or the conditions for growth, was found to be about average for Appalachian hardwoods and the age of the stand was approximately the same as that of the pine and poplar. The average yearly growth of this stand for its entire life was found to be one-half cord of rough wood (with bark) to the acre, or a little less than one-half the growth made by the pine stand.
This comparison illustrates one of the fundamental differences that exist between the growth of pine and hardwood stands. Where both types of forest are growing under average favorable conditions for their particular requirements, the pine will produce a larger wood crop at an earlier age than will the mixed hardwoods. Since there is a considerable demand for pine as pulpwood, this rapid growth makes it a particularly desirable species for old fields at the lower altitudes. For saw-timber production, shortleaf pine is to be preferred to any of the other native pines such as pitch or scrub (Virginia) pine. Although for the first 30 or 40 years these grow at about the same rate as shortleaf pine, they do not sustain rapid growth into saw-timber sizes. Scrub or Virginia pine has a tendency to hold its dead limbs on the trunk, thus producing knots and low-grade lumber. A stand of this species is shown in plate 7. Compare this picture with the shortleaf pine of about the same age shown in Plate 6.

However, Virginia pine has exhibited an unusual ability to seed in and reforest abandoned fields at the lower elevations. In this respect it has surpassed all other pines. There is evidence to support the opinion that the area occupied by this species is increasing. Due to its rapid early growth and wide use as pulpwood, this species may be expected to furnish an appreciable percentage of the income from forested areas immediately adjacent to the cultivated lands of the lower valleys.

Old fields located in high, moist coves are ideal sites for yellow poplar. The rapid growth made by this species has already been mentioned and it should be favored above all others in cove sites, whether old field or not.

Saw-timber production in the more mature hardwood stands found in old fields is occasionally very high. The growing conditions are about average for Appalachian hardwoods. The majority of the trees are black oak, which is one of the fastest growing of the hardwood species. In 1930 an 80-year-old stand contained an average of 38 trees per acre of 12 inches breast high diameter and larger. These contained an average of 333 board feet per tree, or about 12,650 board feet to the acre. Since the stand is 80 years of age, the yearly growth has averaged 158 board feet to the acre.

Summary of forest growth.
On the basis of such observations as have been described, it is estimated that the average yearly growth of all species on cut-over mountain slopes is about 89 board feet per acre, as compared with 81 board feet for virgin stands. The annual production of peeled wood in well-stocked old field stands of shortleaf pine averages slightly over one cord per acre, while well-stocked stands of poplar produce slightly under one cord of peeled wood per acre.

Mixed hardwoods growing in old fields produce annually an average of about one-half cord of wood per acre for stands under saw-log size. Older stands of hardwood may grow about 158 board feet to the acre each year.

Time required to grow special products.
From Chart 2 it is possible to estimate the average length of time required by the various species to grow trees of proper sizes for special products such as pulpwood, posts, ties and poles. This has been done in Table 7. It should be clearly understood that the various periods required to reach certain specified sizes are averages and are based on all the fairly sound trees examined in the woods. A small proportion of the trees in each stand will reach the specified size 10 to 15 years sooner than the majority. Likewise a certain proportion will take longer to reach the desired size than is shown in Table 7.

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>Diameter of tree breast high in inches</th>
<th>Number of years by species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulpwood fence</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>Fence posts</td>
<td>7</td>
<td>42</td>
</tr>
<tr>
<td>Ties and poles</td>
<td>11</td>
<td>69</td>
</tr>
<tr>
<td>Sawlogs</td>
<td>12</td>
<td>45</td>
</tr>
</tbody>
</table>

*Old field.
However, from this table a growth comparison of the various species is possible. For instance, shortleaf pine and yellow poplar produce sawlogs 30 years earlier than scarlet oak, which is the fastest growing oak in the mountain forests. It requires about five years longer for black oak to reach sawlog size than scarlet oak. Southern red oak, white oak, and post oak take, on the average, over 100 years to produce a sawlog tree 12 inches in diameter at breast height. Post oak rarely reaches a size suitable for saw-timber.

Scarlet oak and black oak reach a size suitable for cross ties and poles at an age of 70-75 years. Southern red and white oak require nearly 100 years to reach the same diameter, while post oak commonly takes over 100 years to produce trees of pole or tie size.

TREATMENT OF FORESTS

In formulating a proper system of management for mountain forests the first consideration is to determine how these forests can best serve the interests of the state. However, no matter what the particular use in mind—watershed protection, recreation and game management or the production of wood products—certainly a well stocked rapidly growing forest is the first essential. Such a forest cannot be maintained without adequate fire protection. This protection will be assured when each individual citizen of the state recognizes the significance which the forests have upon his personal affairs and well being, and when he is willing to exert every possible effort to reduce forest fires to a minimum.

As has already been pointed out in this bulletin much of the forested land in the Georgia highland is not well stocked and for many reasons is not producing the amount of forest products of which it is capable. In a number of ways the forest land owner may improve the stocking and vigor of his timber lands.

Immediate harvest of chestnut advisable

One of the outstanding immediate problems of the mountain forests deals with the harvesting of chestnut. No doubt this valuable tree is doomed by the chestnut blight. Because this disease started in New York and spread south over the range of chestnut, the mountain forests of Georgia were among the last to be infected.

In 1930 approximately half of the chestnut stand was still alive. Mere killing by the blight does not mean that the dead trees are useless. The disease itself does not weaken or destroy the wood in any way. However, when the tree is nearly dead, wood decaying fungi become established in the blight killed portions of the sapwood. After about two years rot becomes well established in the sapwood and this decay is spread by the burrowing insects. Within four or five years after the death of the tree, the sapwood and bark is almost completely rotted away. During this time a certain amount of checking has been going on which often renders the tree undesirable for anything but acid or fuelwood. The boring of timber worms also reduces the quality of lumber which can be sawed from blight killed trees.

It has been shown in Table 4 that from 12 to 36 per cent of board foot volume of the mountain forest stands is chestnut. Unless cut immediately much of the value represented by this species will be lost.

Whenever possible, suitable living trees and those not badly damaged by rot or insects should be cut for lumber. Poles, piling, ties, mine props and posts can be obtained from a chestnut stand not too long dead. Cordwood for the tannin extract and pulp industries can be cut from trees which have been dead for 20 years. However, the work of utmost importance is the immediate harvest of all living and recently dead trees for the higher quality material which can be obtained from them. 

Cordwood cuttings an aid to forest improvement.

In many cases an area of natural woodland can be made more productive by cutting undesirable species and poorly formed or slow-growing trees of desirable species. By removing poor trees better individuals are favored and allowed to reach their full development with less competition. This results in more rapid growth of the best timber and therefore a reduction in the time required to reach merchantable size.

A test of such an operation by means of a fuelwood cutting.
was made by the Appalachian Forest Experiment Station in the
fall of 1930, on the timber tract of the Georgia Mountain Ex-
periment Station. A half acre plot was established in a stand
consisting for the most part of white, southern red, scarlet and
black oak. In mixture with these more valuable species was
found post oak, black gum, sourwood and several other inferior
varieties. The ages of the trees in this stand varied from 40 to
120 years.

The cutting removed crooked and decayed trees and also such
species as sourwood, black gum, and post oak. Fairly good trees
which were crowding the best trees in the stand were also re-
moved. In this particular case it was considered advisable to
favor southern red, white, and scarlet oak since the largest and
most rapidly growing trees on the area consisted of these species.

The stand before thinning contained 330 trees per acre, rang-
ing from 2 to 14 inches in breast high diameter. The cutting
removed 196 trees per acre, leaving 134 of the best trees. The
general character of the remaining stand is shown in Plate 8.

The cutting yielded 22 cords of 2 foot wood per acre at a cost
of $1.48 per cord. After paying 50 cents a cord for hauling
three and one-half miles to the nearest market, the improvement
cutting would pay for itself at the customary price of $2 a cord.
Looking at this example in a different way and allowing noth-
ing for stumping or taxes, the cutting paid wages at the rate of
$1.48 a cord, after charges for hauling to market were deducted.

Although the profits from this operation are negligible it
must be remembered that a stand of 130 trees per acre of the
most desirable species still remains. These trees need no longer
compete with their inferior neighbors for light, moisture and
plant food. There is every reason to expect that they will now
reach tie, pole, or sawlog size much sooner than if the improve-
ment cutting had not been made. Just what this difference in
time actually is will be determined by future measurements of
the stand in comparison with a similar nearby area which was
measured but not thinned.

When making cordwood cuttings in the mixed hardwood
forest, landowners should consider the possibilities of improving
the stand that it may give the greatest possible returns in the
future.

Thinnings for pulpwood in old field stands of
pine and yellow poplar.

It has already been pointed out that pine and yellow poplar
grow very rapidly, particularly on old fields. Under average
growing conditions and where the land is fully stocked with
trees, pulpwood thinnings can be made between 25 and 30 years
of age.

Past experience has shown that in thinning pines the best re-
sults are obtained by cutting from 45 to 50 per cent of the total
number of trees. The cutting should remove all trees which are
completely overtopped and also those which are hindering the
growth of the best individuals. In stands of these ages the re-
mainning trees should be well separated, that is, there should be
at least 2 to 3 feet of space between their crowns to provide
enough room for unhindered future growth. Such cuttings com-
ing between 25 and 30 years of age will yield from 5 to 12 cords
of four-foot pulpwood to the acre, depending largely on the de-
gree of stocking. The remaining trees are free to grow unhind-
ered and will reach sawlog size much faster than would be the
case if left to grow under natural conditions. Such a cutting
will allow a second thinning 10 to 15 years later.
The above applies to old field pine particularly. Very little is known regarding the best methods of thinning yellow poplar. In general, stands of this species are not so dense as those of pine and if equal degrees of thinning are practiced the yield will be somewhat below that of pine. However, the same general rules as suggested for pine should be followed in thinning poplar.

In 1929 a better than average stand of yellow poplar 41 years old was thinned at Cranberry, N. C. 31 per cent of the trees were cut including all those which were overtopped, or of poor form. The cutting also removed a few good trees which were crowding the best individuals in the stand. This cutting yielded 15 cords per acre in pulpwood and left standing 164 trees to grow for the final crop of sawtimber. A heavier cutting than this would be advisable in stands which are nearing sawlog maturity.

Summary of Thinning Practices.

To summarize, a general thinning plan for well-stocked stands of shortleaf pine and yellow poplar may be outlined as follows:

1. First thinning to be made at 25 to 30 years of age. The cut should remove 45 to 50 per cent of the trees.
2. Second thinning to be made at 40 to 45 years of age when all trees should be cut except 125 to 150 trees per acre. These remaining trees should be chosen for their good form and high quality. Being freed from competition with poorer trees they will approach sawtimber size rapidly and form the final crop.

Relative merits of tree species.

The decision as to which species should be favored in making improvement cuttings will depend largely on the particular stand under consideration. In many cases the most desirable species may make up only a small part of the stand, so that it is necessary to weigh carefully the relative merits of the species making up the remainder or the stand, in deciding which trees to remove. In mixed oak stands between the elevations of 1800 and 2800 feet, white oak, southern red oak, and black oak have shown themselves to be more valuable for the production of forest products than have scarlet oak or post oak. Northern red oak, where it occurs, is a valuable species and should be given every opportunity to establish itself. This species favors high north coves where it exhibits an unusual ability to prolong a rapid growth to great ages.

On rich, moist soils black cherry, black walnut, cucumber magnolia and white ash are species with a relatively high commercial value. Black cherry particularly has shown itself to be a vigorous and rapid growing tree in the Georgia mountains and will probably always be valued for high grade furniture wood. Basswood may also be considered a valuable species where it occurs.

Unquestionably on soils favorable for its growth, yellow poplar has the highest general rating of any tree in the mountain region. The tree is valuable for pulpwood and poplar sawlogs are much in demand. The species is a vigorous grower, has few enemies and is relatively free from defects.

Black locust is a rapid grower and makes a desirable tree when the saplings are not completely destroyed by the locust borer. Black locust is of high value for posts and small poles because of the durability of its wood in contact with the soil. It is an easy tree to propagate and is becoming important for planting on wornout lands, to prevent further depletion of the soil through erosion.

Chestnut has probably lost its importance as a valuable tree in the mountain forest because of the increasing prevalence of the blight. Shagbark, mockernut and pignut hickories have a potential value on moist, fertile soils. On poorer sites these species grow slowly and are of doubtful durability.

Of the dry site oaks, chestnut oak is the most desirable. It bears abundant seed and reproduces itself under relatively unfavorable conditions. The tree is useful for saw-logs, for railroad ties and for tanbark.

As already pointed out, yellow pines, and particularly Virginia pine, are important from a pulpwood standpoint. This species is rapidly taking over abandoned fields many of which remain in the possession of small landowners. In many ways
the handling of stands of Virginia pine is becoming a farm woodland problem.

White pine is seeding in under the hardwood stands on lower slopes adjacent to many mountain streams. This is true particularly on areas which have had the advantage of many years of protection from fires. Due to its greater tolerance of shade and other inherent characteristics, white pine has a greater ability than any other native pine to seed in and become established under a hardwood overstory. Increment borings made in white pine seed trees when compared with borings made in hardwood trees of the same size occurring on the same area, show that this pine has a much greater growth than any of its associates with the possible exception of the yellow poplar. In all cases where it occurs, the young growth of white pine under a hardwood stand should be favored by removing or deadening the poorest of the hardwood overstory.

A number of small tree species common to mountain forests have no particular commercial value at present. These are sourwood, silverbell, sassafras, serviceberry and hawthorn. On the other hand, persimmon and dogwood have special usage because of the character of their wood and it is possible that the demand for these two species may increase.

Red maple, buckeye and black gum are increasing in importance for paper pulp. It is difficult to predict to what extent the demand for special wood products will increase. It is quite possible that some species, not now considered of importance, will become of high commercial value for special uses. The present demand for black gum and closely-related species, by the southern pulp industry is an example. With increasing changes in the demand for special wood products other little-used species may become important. When the demand becomes large enough these species must be given their proper place in the management of the hardwood stands.