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# A Guide to the Hitchiti Forest Research Center

by

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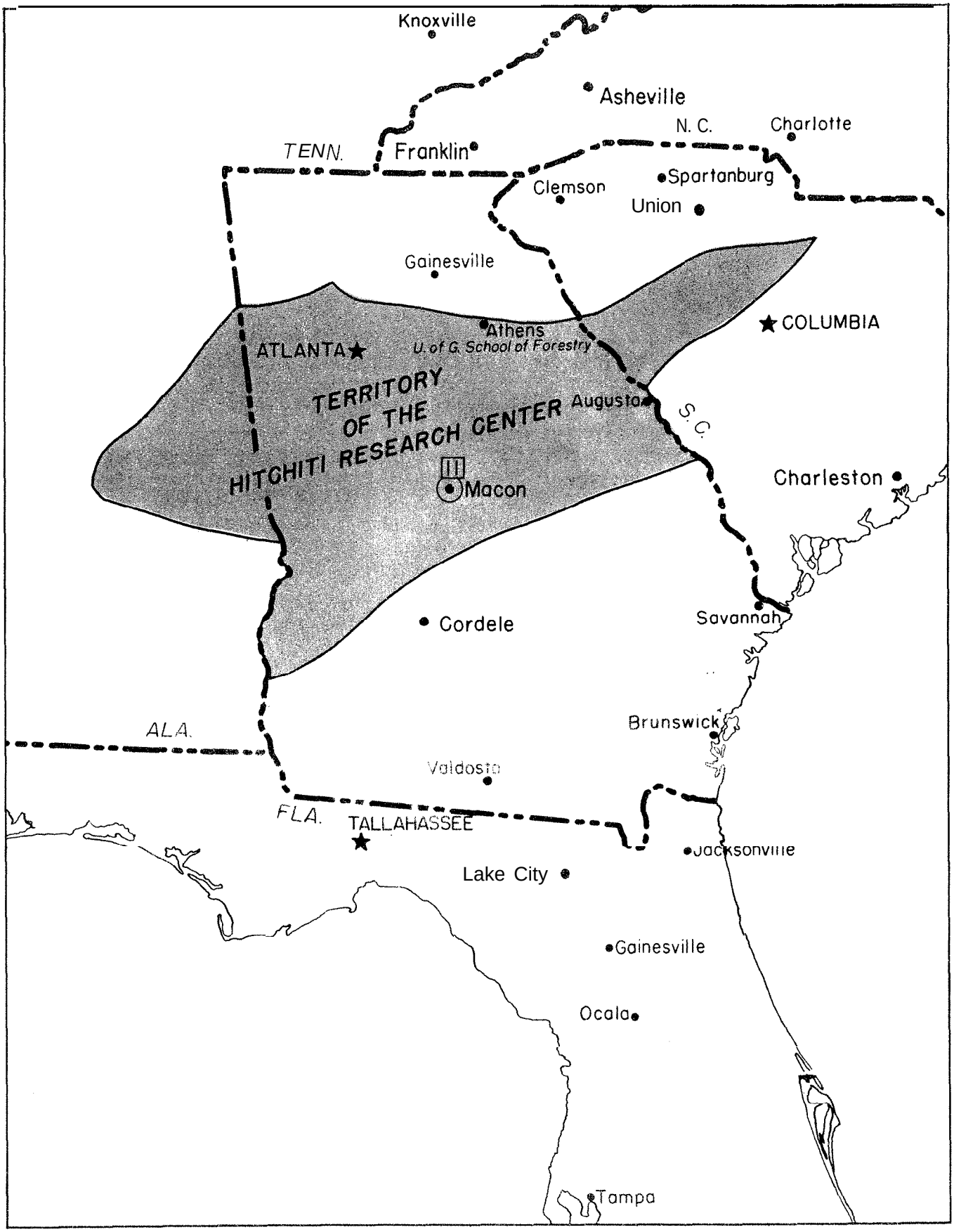



Cover:

About one-third of the forest in the lower Piedmont consists of relatively young pine stands which sprang up in cotton fields that were abandoned because of the boll weevil.

# GUIDE TO THE HITCHITI FOREST RESEARCH CENTER

by

Ernst V. Brender

The Hitchiti Forest Research Center was established in 1946 by the Forest Service, USDA, to find ways and means of producing more wood in the depleted forests of lower Piedmont Georgia, Alabama, and South Carolina. Sixty percent of the 18-1/2 million-acre territory is in forest. The forest consists principally of even-aged stands of loblolly pine on the uplands and a mixture of oaks, hickories, yellow-poplar, and other hardwoods on the moist sites.

An estimated 40,000 people are directly engaged in harvesting and processing the forest products from this area, and 11 percent of the total income is obtained from timber products. The secondary business and industry derived from forest enterprise (such as truck and rail transportation, making paper and plywood and hickory tool-handles, selling axes and tractors) raises the total considerably. But a much greater increase in business and revenue could come from doubling the annual production of the forests--an entirely feasible and practical possibility. The question is, how can it be done most quickly and most cheaply.

The forest research center exists to work on the answers to such questions. It combines biology, economics, soil science, industrial harvesting techniques, and many other specialties. Most of the staff are trained foresters. The main office is in Macon, and the greater share of the experimental work is being done on the 4,735-acre Hitchiti Experimental Forest 18 miles out of Macon.

Originally, the Piedmont was a fertile land of fine oak-hickory forest. Natural springs were numerous; branches, creeks, and streams flowed clear and cool. Intermixed with the oak-hickories were beech, maple, chestnut and shortleaf pine. The forest had reached a climax; many individual trees were 2 to 3 feet in diameter and 120 feet in height. In the understory were dogwood, azalea, huckleberry, and chinquapin (no imported Japanese honeysuckle as yet). Starting about 1773, waves of settlers rapidly advanced from the east coast. Within a 50-year period, the Piedmont was converted from a primeval forest to a farming country. Since those days, 87 percent of the land has been cleared or cultivated one or more times. The original topsoil, which was from 7 to 15 inches deep, has entirely disappeared from many acres. Row cropping, particularly for cotton, caused serious erosion even in the early days. An erodable topsoil and even more erodable subsoil, gully-washing rains of extreme intensity, continual freezing and thawing action in winter, hot summers bringing high soil temperatures and rapid oxidation of humus--all these meant that the delicately balanced land lost its fertility when it was without plant cover., A serious agricultural slump occurred in the late 1880's. With the arrival of the boll

weevil in 1920, land abandonment took place at an unheard-of rate. Pines seeded in naturally on old fields, and it was thus that some of our present-day forests got their start. Land abandonment has continued off and on ever since, until approximately 10 million acres of this territory are in forest again. Deep in the tracts of young pines one comes across massive, wide-armed oaks shading the ruined chimney that marks an old "home place." Mile after mile of former farmland, in unbroken 10-, 20-, and 30-mile stretches has gone back to woods. It is because of this forest that the future of the area is so closely tied to forest production and forest management.

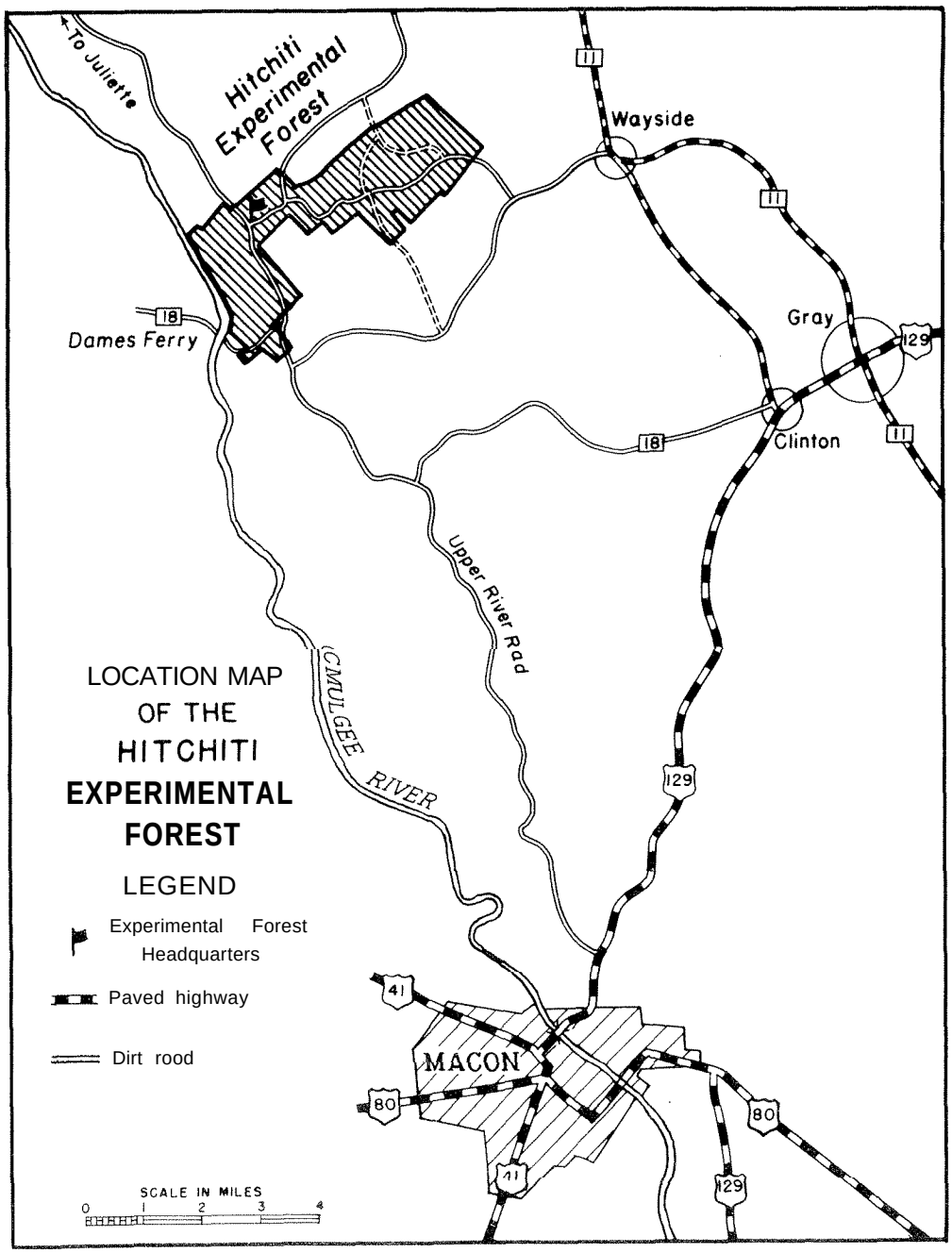



Figure l.--The experimental. forest is 1.8 miles from Macon.

## THE FOREST IN THE RESEARCH CENTER TERRITORY

Some of the better forests of the region are usually found in relatively large tracts of 5,000 acres and more. However, 65 percent of the forest land is in farm ownership of numerous small tracts. These woods are often severely depleted. In consequence, the average growing stock of the forests in this area in 1946 was only 1,800 board feet per acre, of which pine made up 70 percent and the hardwoods 30 percent in volume. During the decade from 1936 to 1946, the pine saw-timber volume decreased 35 percent. It has been estimated that following present logging practices, one acre out of two reverts to low-value hardwoods. Fortunately, the area still has a large area of so-called boll weevil timber, which for the time being forms a backlog of forest capital. Headway is being made in establishing extensive forest plantations which promise to be of importance to the future timber supply. The big challenge is to learn to restore the productivity of the large acreage of depleted woods, and to properly manage the smaller acreage of desirable woods.

## FOREST MANAGEMENT OPPORTUNITIES

The scientific management of the resource which contributes so much to the economy of this area has been very much neglected. It has frequently been pointed out that only about one-third as much usable wood is being grown in this area as the land is capable of producing. Instead of growing 500 board feet per acre annually, we are only growing about 150 board feet; instead of growing one cord per acre, we are only getting one-third cord per acre.

This low growth rate is, in part, the result of liquidating cutting practices. It is also due to lack of appreciation of what the timber-growing possibilities are in this territory. Some of it must also be attributed to invasion of our forests by weed species, such as low-value hardwoods, shrubs, and vines. Still other losses are due to natural enemies of the forest, such as insects and diseases. And finally, wildfires destroy millions of seedlings, thousands of saplings, poles, and sometimes saw-timber trees.

We want to find what method of harvesting timber is best suited for perpetuating pine. Under which method will the most volume be grown, the greatest net-returned be reaped? What is the optimum spacing for pine trees throughout the life of the stand--for growing pulpwood--for growing saw timber? What measures are necessary to control weed species? Can we stimulate seed production, and can we create a receptive seedbed for germinating pine? How can these measures be applied economically? Which management practices are best for farm woodland owners? Can we select superior strains of pine, can we develop superior hybrids? These and many more problems need to be solved.

# THE RESEARCH PROGRAM

## Management of Loblolly Pine

Comparison of management systems on 40-acre compartments

Survey study of reproduction (growth, damage, mortality) in shelterwood stands

Survival, growth and development of residual saplings on areas clear cut and planted

## Stand Improvement in Loblolly Pine

Relationship of growth to stand density, site, and age in thinned and unthinned stands

Bud and branch pruning

## Regeneration

Site preparation for hardwood control before planting clear-cut areas

Field tests of hybrid pines

Seed production by stand characteristics

Behavior and control of honeysuckle

## Silvics

Prescribed burning as a silvicultural tool and its effect upon soils

## Financial Aspects

Farm woodlot management (4 woodlots)

Relation of harvesting costs to tree size, volume cut per acre, topography, etc.

Determining conversion values of trees for alternate uses

Development of log and tree grades

Forest valuation (proposed), growth studies, land use, etc.

## THE FOREST LABORATORY

The field laboratory on which many of the studies of this research center are conducted is the 4,735-acre Hitchiti Experimental Forest. It is situated along the east banks of the Ocmulgee River, 18 miles north of Macon, Georgia. The forest derives its name from a tribe of Indians who formerly lived in the area.

### Climate and Soils of the Experimental Forest

#### Climate

The climate in the lower Piedmont is well suited to the growth of pine timber. The mean annual rainfall on the forest is about 48 inches. However, spring droughts of 4 weeks' duration may be expected in one out of every 5 years. Mean annual temperature is 63 degrees F., with extremes ranging from 6 degrees F. to 105 degrees F. The growing season lasts 7-1/2 months.

#### Topography

The topography is typical of lands bordering the major streams in the lower Piedmont. It is characterized by deep, narrow valleys, rounded ridges, and steep slopes. The lowest elevation on the experimental forest is 328 feet; the highest point on the plateau is 532 feet above sea level.

#### Soils

The soils occurring on this forest are representative of those of the principal watersheds of the lower Piedmont. They are found in the following proportions:

| Soil series | Percent occurrence |
|---|---|
| Lloyd and Davidson | 31 |
| Vance | 27 |
| Madison and Cecil | 20 |
| Wilkes and Louisburg | 12 |
| Alluvial and Colluvial | 9 |
| Miscellaneous | 1 |

The Lloyd and Davidson soils are dark, chocolate-colored soils. They are fertile and well drained. They are not as erodable as some of the other Piedmont soils. The Vance soils are light colored, with compact subsoils which retard root penetration and water movement. These soils are subject to severe erosion. The Madison and Cecil soils are the well-known, picturesque, red clay hills of Georgia. They are deep soils of good structure, well drained, and moderately productive. They are highly susceptible to erosion under agricultural abuse, The Wilkes and Louis-

burg soils are shallow, undeveloped soils, with frequent outcrops of parent rocks. They are agriculturally unproductive soils. Alluvial and Colluvial soils occur as narrow branch bottoms and in depressions. There are no extensive flood plains on the experimental forest.

Various degrees of erosion are found on all of these soils. On 20 percent of the area the topsoil is completely gone. An additional 70 percent retains only a thin layer of topsoil. Gullies are numerous and traces of the old cotton-field furrows are visible here and there throughout the forest.

## The Timber Stand

Practically the entire forest is second-growth, 11 percent becoming established during the War between the States, 32 percent originating during the depression years of the late 1880's up to World War I, and 34 percent coming in since the arrival of the boll weevil in 1920.

The principal types are loblolly-shortleaf, and loblolly-hardwoods, The loblolly makes up 85 percent of the pine overstory, shortleaf 15 percent, Overstory hardwoods in -these stands are confined more or less to stream banks, gullies, and old house places . Understory hardwoods are encroaching on 40 percent of the upland pine forest area. This invasion of hardwoods ties in with the age of the pine overstory, with exposure and degree of slope and the drainage pattern of the land, Roughly, about 10 percent of the fores-t is classified as hardwood stands, where the hardwoods make up over 80 percent of the dominant canopy.

The pine stands are mostly even-aged, where the trees on a given acre vary no more than 10 years in age., Only about 8 percent of the pine stands are many-aged in character, where seedlings, saplings, poles, and saw timber occur intermixed on a given area. Of the even-aged stands about 70 percent are fairly well stocked with either seedlings, saplings, poles, or saw timber, and 30 percent -are definitely understocked, The average volume is about 4,000 board feet per acre, with a range from 800 to 22,000 board feet, On this forest, indications are that the average yearly growth of merchantable stands exceeds 500 board feet per acre, or one cord per acre. And still this forest is not yet fully productive . Many stands are understocked, and the quality of many -trees is poor . The full production potential has not yet been reached .

## Loblolly Pine Management Studies on the Experimental Forest

The research program on this experimental forest emphasizes investigations on how to manage loblolly pine for various owner objectives, such as growing maximum volume in the form of pulpwood and small sawlogs as against growing quality timber, like poles and piling, or high grade lumber.

The silvicultural as well as the economic aspects associated with these objectives are being evaluated. Under silvicultural aspects are included two broad systems of managing loblolly pine--the selection system or many-aged management, versus even-aged management.

Figure 2. --To gauge results of various cutting methods on compartments, all trees 6 inches in diameter and larger are measured at 5- and 10- year intervals.

## Many-aged Management

Under many-aged management, a harvest cut is made at 5-year intervals (fig. 2), removing the growth that accrues during that period, in such a manner as to bring about an all-aged or selection type of forest on each acre.

## Even-aged Management

Under even-aged management, different harvesting methods are being explored (fig. 3).

1. Clear cutting and planting: The entire crop, saw timber, and pulpwood, is being removed at a given rotation age, (tentatively set at 40 years) and the area is immediately planted to pine.

2. Seed tree method: All merchantable trees, saw timber, and pulpwood, are harvested when the stands are 50 to 60 years old, with the exception of 6 good seed trees per acre which are left for the purpose of restocking the area.

3. Shelterwood cutting: By this method 22 large seed trees or 40 small seed trees are left per acre to restock the area. These residual. trees are removed when an adequate stand of seedlings is established.

Economic Aspects

These tests are made on logging chances of about 40 acres each so that the economics of harvesting a timber crop by these systems and methods of management can be evaluated.

Levels of Cultural Practices

In order to get maximum volume or highest quality, a stand has to be tended, Certain cultural practices must be applied throughout the life of the stand, Such practices include seedbed preparation, release cuttings, hardwood control, thinnings, and improvement cuttings.

Two levels of cultural care are given the stands under each method of management. One is a high level which is intended to assure success of the management method employed. The other is a moderate level designed to provide the best success possible at reasonable cost and does not include any treatment that will. not pay for itself now. The purpose of these two levels is to determine whether additional expenditures above the absolute essentials will pay off in terms of added yields.

The loblolly pine management study area is shown in Figure 3 of this report, A more detailed description of studies, treatments, and results follows.

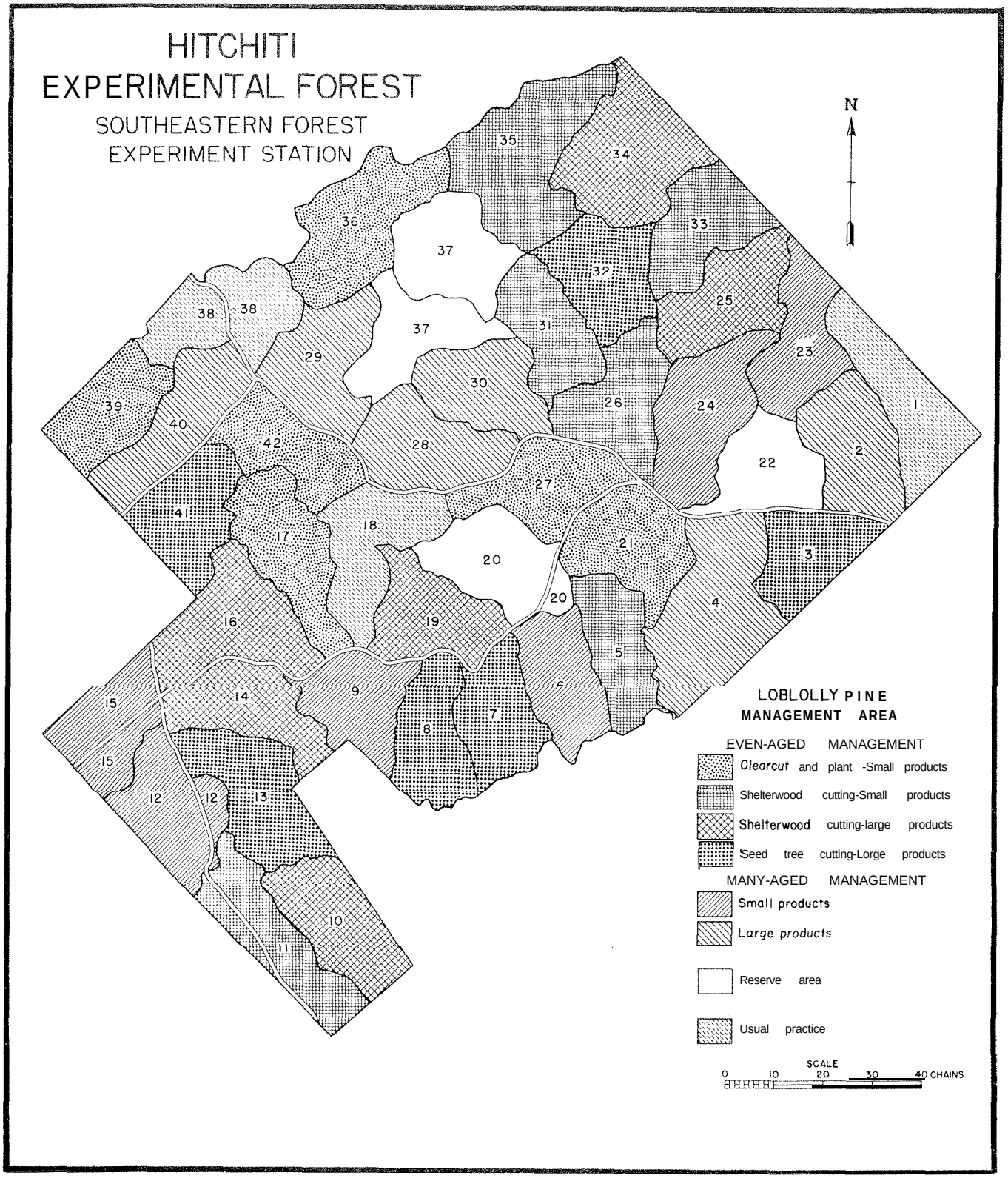



Figure 3.--A major study on the experimental forest is a long-time comparison of different management system on compartments of about 40 acres each.

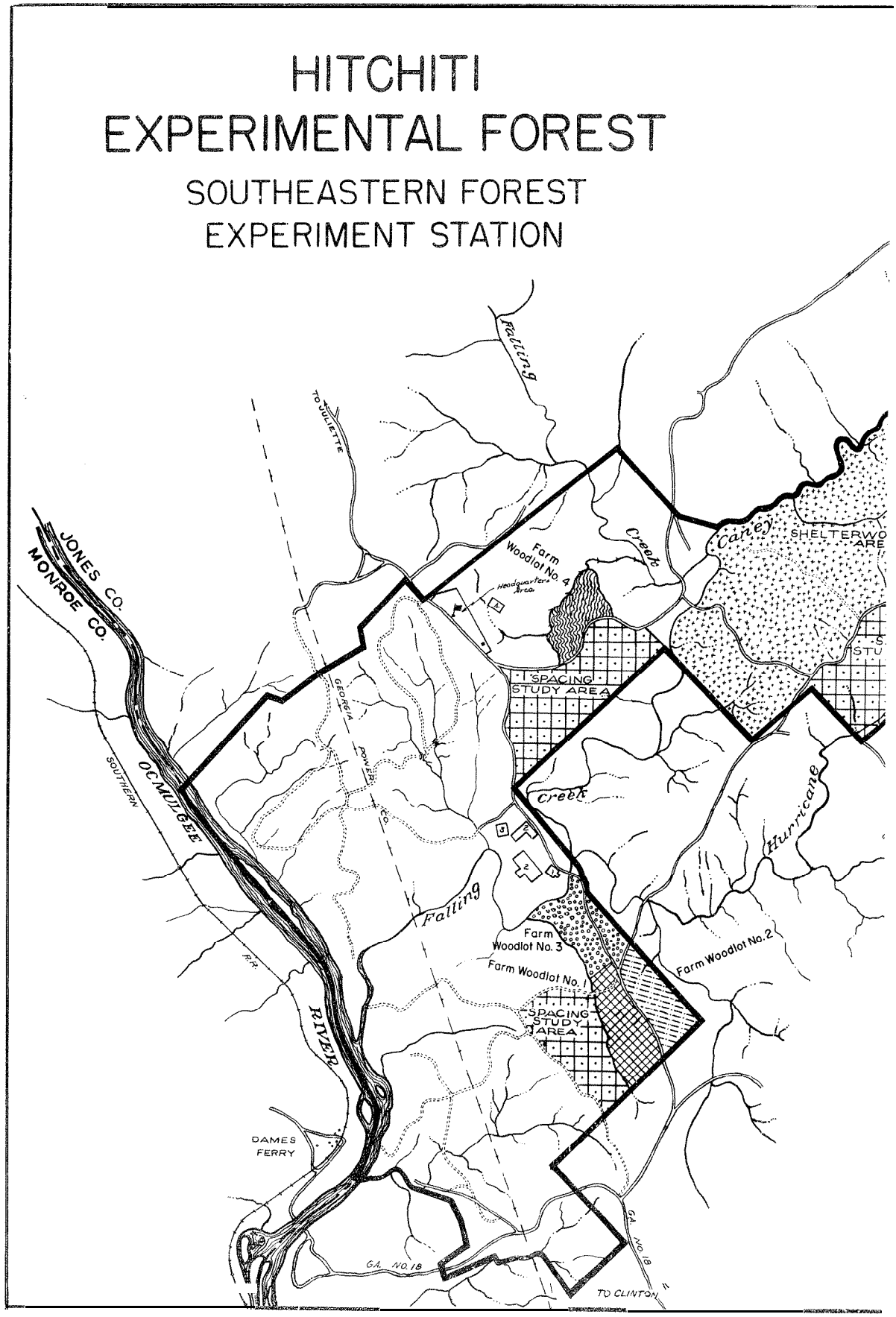
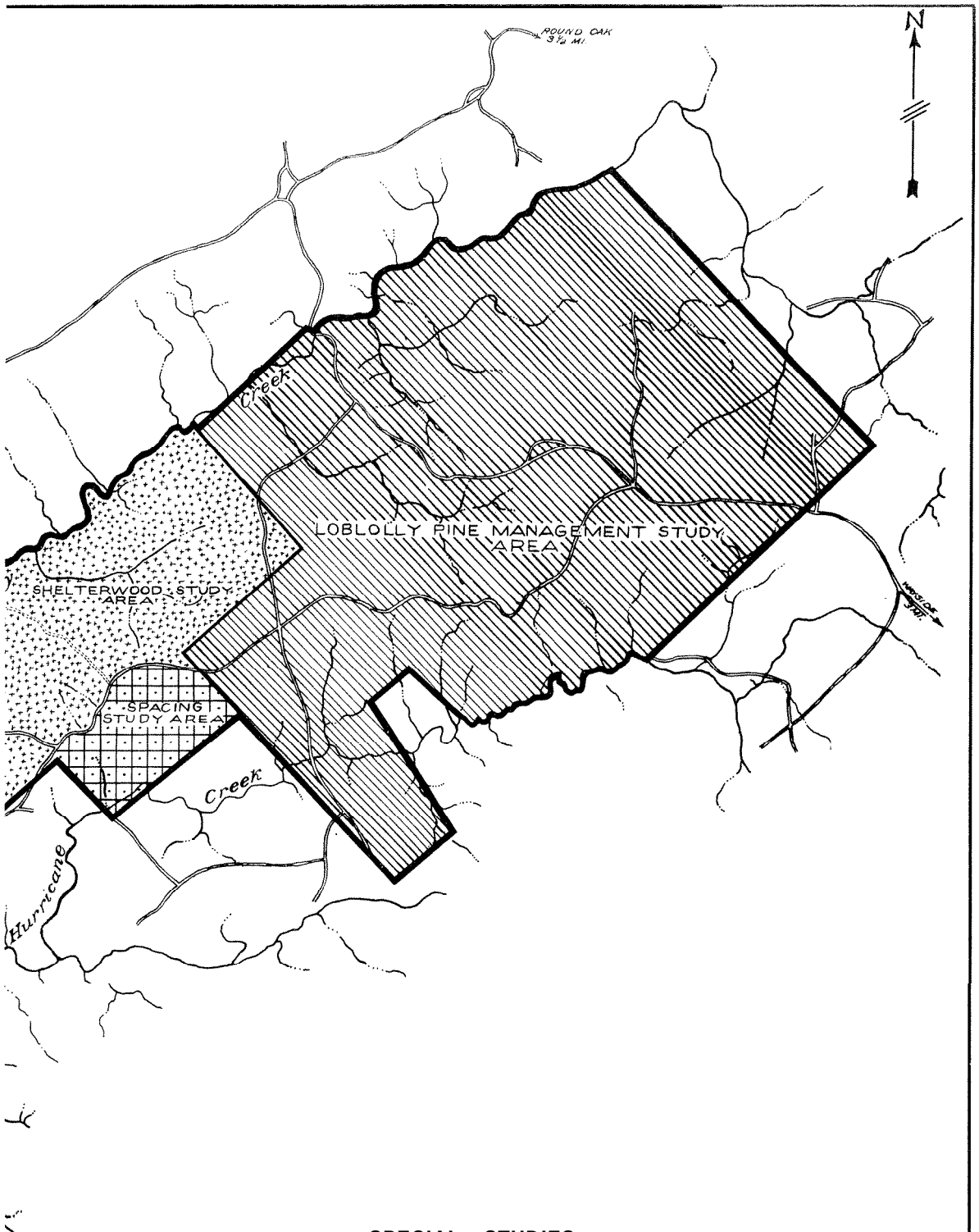



Figure 4.--Location of special studies on the experimental forest.




## SPECIAL STUDIES

1. Hybrid pines.
2. Conventional pruning of loblolly pine.
3. Growing space plots.
4. Bud-pruning of loblolly pine.

SCALE
10 0 10 20 30 40 50 60 70 80 chains

## Observation Point, Compartment 19, Loblolly Pine

### Treatment

Even-aged management, shelter-wood method, large saw timber objective, high level of cultural practices (fig, 5).

Shelter-wood harvest cut made in winter of 1949. Left 27 trees per acre, with a volume of 3,160 board feet,

### Stand History--per-acre data (pine only)

| | Saw timber | | Pulpwood | | Topwood |
|---|---|---|---|---|---|
| | Total stand | Cut | Total stand | Cut | cut |
| | Bd.ft. | Bd.ft. | Cords | Cords | Cords |
| Stand - 1946 | 5,720 | 941 | 4.1 | - | |
| Stand - 1949 | 6,090 | 2,930 | 4.6 | 4.1 | 0.7 |

### Growth

The average annual growth per acre during three growing seasons, 1947 to 1949 inclusive, was 437 board feet, plus 0.3 cords of pulpwood which includes usable topwood.

### Cultural Practices

In September 1950, 29 low-value hardwoods per acre, averaging 5.4 inches at breast height (d.b.h.) were treated with ammate at a cost of $1.59 per acre.

Figure 5.--Shelterwood method of harvesting timber in Compartment 19, 3 years after cutting. Pine seedlings are still hidden in grass.

## Observation Point, Compartment 21, Loblolly Pine

### Treatment

Even-aged management, clear cutting and planting, small saw timber and pulpwood objective, high level of cultural practices (fig. 6).

Clear cut and planted in the winter of 1948.

### Stand History--per-acre data (pine only)

| | Saw timber | | Pulpwood | | Topwood |
|---|---|---|---|---|---|
| | Total stand | cut | Total stand | Cut | cut |
| | Bd.ft. | Bd.ft. | Cords | Cords | Cords |
| Stand - 1945 | 6,970 | 1,903 | 5.1 | - | - |
| Stand - 1948 | 5,325 | 5,325 | 1/5.7 | 4.4 | 2.1 |

1/ Some Of this wood was not harvested because it was too small for profitable operation.

### Growth

The average annual growth per acre was 1.1 standard cords.

### Cultural Practices

Brush disposal. --The tops and branches left from logging were piled and burned to permit immediate planting.

Planting. --As a result of brush disposal, 20 percent of the area could be machine planted at operating costs of $4.26 per acre, while the remainder was hand planted at a cost'of $9.64 per acre.

Hardwood control. --In August 1950, the worthless hardwoods were poisoned with ammate at a cost of $1.76 per acre. Forty-seven trees per acre, from 3 inches d.b.h. and up, were treated.

Figure 6.--Compartment 21, clear cut and planted in 1948, changed from pine straw litter to broomsedge in one year. Pine seedlings are now again crowding out the broomsedge.

## Observation Point, Compartment 27, Loblolly Pine

### Treatment

Even-aged management, clear cutting and planting, small saw timber and pulpwood objective, low level of cultural practices.

Clear cut and planted in winter of 1949,

### Stand History--per-acre data (pine only)

| | Saw timber | | Pulpwood | | Topwood |
|---|---|---|---|---|---|
| | Total stand | Cut | Total stand | Cut | cut |
| | Bd.ft. | Bd.ft. | Cords | Cords | Cords |
| Stand - 1945 | 5,294 | 1,174 | 5.6 | | |
| Stand - 1949 | 5,388 | 5,388 | 5.7 | 5.7 | 1.5 |

### Growth

The average annual growth during a 3-year period was 401 board feet per acre, or expressed in terms of pulpwood, 1.2 cords.

### Cultural Practices

Brush disposal.--Branches and tops left from logging were piled in windrows and put into gullies at a labor output of 10 man-hours per acre.

Planting. --Full stocking was obtained by planting between windrows. Planting machine could have been used on 36 percent of the area, where slope and soil were suitable.

Hardwood control. --In August 1950, the worthless hardwoods 5 inches and larger were treated with ammate at a cost of $0.93 per acre.

## Observation Point, Compartment 24, Loblolly Pine

### Treatment

Many-aged management, tree selection cutting, 5-year cutting cycle, small product objective.

### Stand History--per-acre data (pine only)

| | Saw timber | | Pulpwood | | Topwood |
|---|---|---|---|---|---|
| | Total stand | Cut | Total stand | cut | cut |
| | Bd.ft. | Bd.ft. | Cords | Cords | Cords |
| Stand - 1944 | 6,242 | 1,974 | 4.8 | | |
| Stand - 1950 | 6,089 | 1,538 | 5.5 | 0.2 | 0.4 |

### Growth

The average per-acre growth over a k-year period was 479 board feet, plus 0.5 standard cords of pulpwood.

### Cultural Practices

In July 1951, 48 hardwood stems per acre, averaging 4 inches d.b.h., were poisoned with ammate at a cost of $1.70 per acre.

## Observation Point, Compartment 29, Loblolly Pine

### 'Treatment

Many-aged management, individual tree selection cut, large product objective, high level of cultural measures (fig. 7).

Cutting made in winter of 1946-b-7.

### Stand History--per-acre data (pine only)

| | Saw timber | | Pulpwood | | Topwood |
|---|---|---|---|---|---|
| | Total stand | cut | Total stand | Cut | cut |
| | Bd.ft. | Bd.ft. | Cords | Cords | Cords |
| Stand 1947 | 7,726 | 2,602 | 4.7 | 1.8 | .4 |

### Hardwood Control

In the spring of 1951 openings created by the improvement cut made in 1946 were treated to release pine seedlings which had come up in these openings. An average of 50 trees per acre were treated at a cost of $2.30.

### Pine Seedling Establishment

Four years after the harvest cut, a sample survey on 9 acres disclosed the following:

1.) Twenty-one percent of the area is in openings, which resulted mostly from the cutting of large, mature trees.

2.) The average size opening, between perpendicular crown projections, is 35 feet,

3.) Ninety-three percent of the openings are well stocked with thrifty seedlings,

4.) The average height of the dominant seedlings at the end of the fourth growing season is 3 feet.

Figure 7.--Selective logging in Compartment 29. Pine seedlings established in openings since logging in 1946. Competing understory hardwoods treated with ammate.

## Observation Point, Compartment 41, Loblolly Pine

### Treatment

Even-aged management, seed tree cutting, large product objective, high level of cultural measures (fig. 8).

Seed tree cut made in winter of 1950-51, leaving six seed trees per acre, with 1705 bd. ft.

### Stand History--per-acre data (pine only)

| | Saw timber | | Pulpwood | | Topwood |
|---|---|---|---|---|---|
| | Total stand | cut | Total stand | cut | cut |
| | Bd.ft. | Bd.ft. | Cords | Cords | Cords |
| Stand - 1946 | 7,419 | 2,413 | 2.8 | | |
| Stand - 1950 | 8,151 | 6,100 | 3.1 | 2.9 | 1.1 |

### Growth

The average annual growth rate during the past 4 years was 786 bd. ft. per acre.

### Cultural Practices

In August 1951, 41 hardwood stems per acre, averaging 5 inches d.b.h., were poisoned with ammate crystals at a cost of $1.86 per acre,

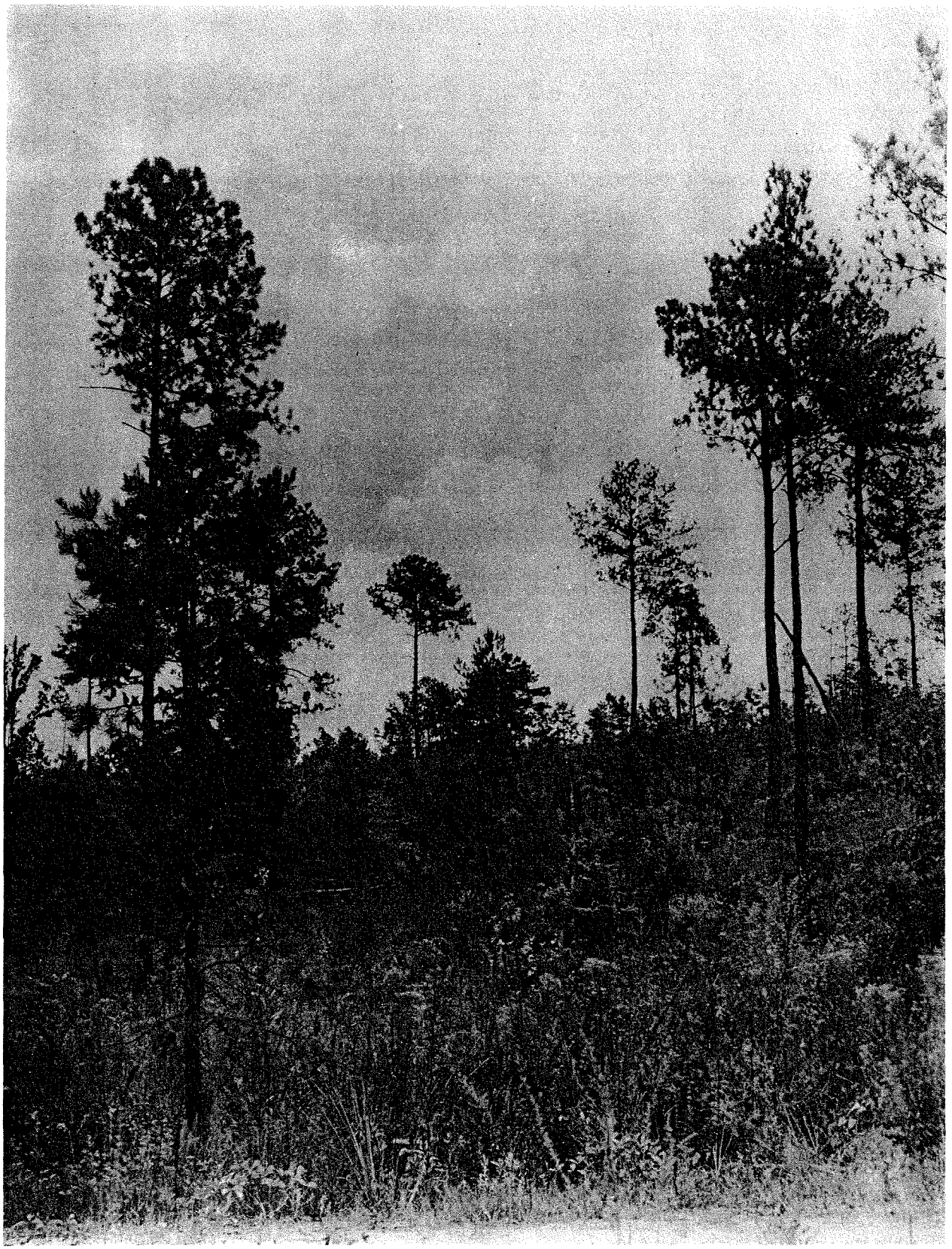


Figure 8.--Seed-tree cutting in Compartment 41. Seed trees were carefully selected for fruitfulness and good form.

## Farm Woodland Management

Investigations of forest management in the Southern Piedmont would be incomplete without considering the problems connected with the management of farm woods. The economic aspects of managing them are emphasized in our research work.

What are the returns to the farmer from selling stumpage and from harvesting and selling cut products?

What frequency of cutting is best suited for his business?

What kind of products can he grow best?

To answer these questions, four farm woodlots are under intensive management on this experimental forest. They differ from each other in amounts of initial growing stock and in the numbers of worthless hardwoods.

Initial growing stock per acre in 1948 was as follows:

| Woodlot | Area | Pine | | | | Hardwood |
|---|---|---|---|---|---|---|
| | | Total | Saw timber | Cordwood | Trees | Trees |
| | Acres | Cu.ft. | Bd.ft. | Std. cords | Number | Number |
| 1 | 40 | 2,047 | 7,967 | 4.5 | 85 | 8 |
| 2 | 43 | 1,461 | 5,206 | 4.1 | 73 | 29 |
| 3 | 43 | 902 | 2,666 | 3.9 | 67 | 26 |
| 4 | 30 | 441 | 104 | 5.6 | 91 | 7 |

### Group Selection

Three of the woodlots are managed by the group selection method, on an annual cutting cycle. One-fifth of the area of each woodlot is cut over each year, harvesting no more than the annual growth from the entire woodlot.

After the fifth annual harvest cut, woodlot No. 2 will be harvested at 5-year intervals only.

### Pulpwood Rotation

Woodlot No. 4 is managed on a 30-year pulpwood rotation by clear cutting and planting 1 acre each year. Occasionally, additional areas on this 30-acre woodlot may need to be thinned.

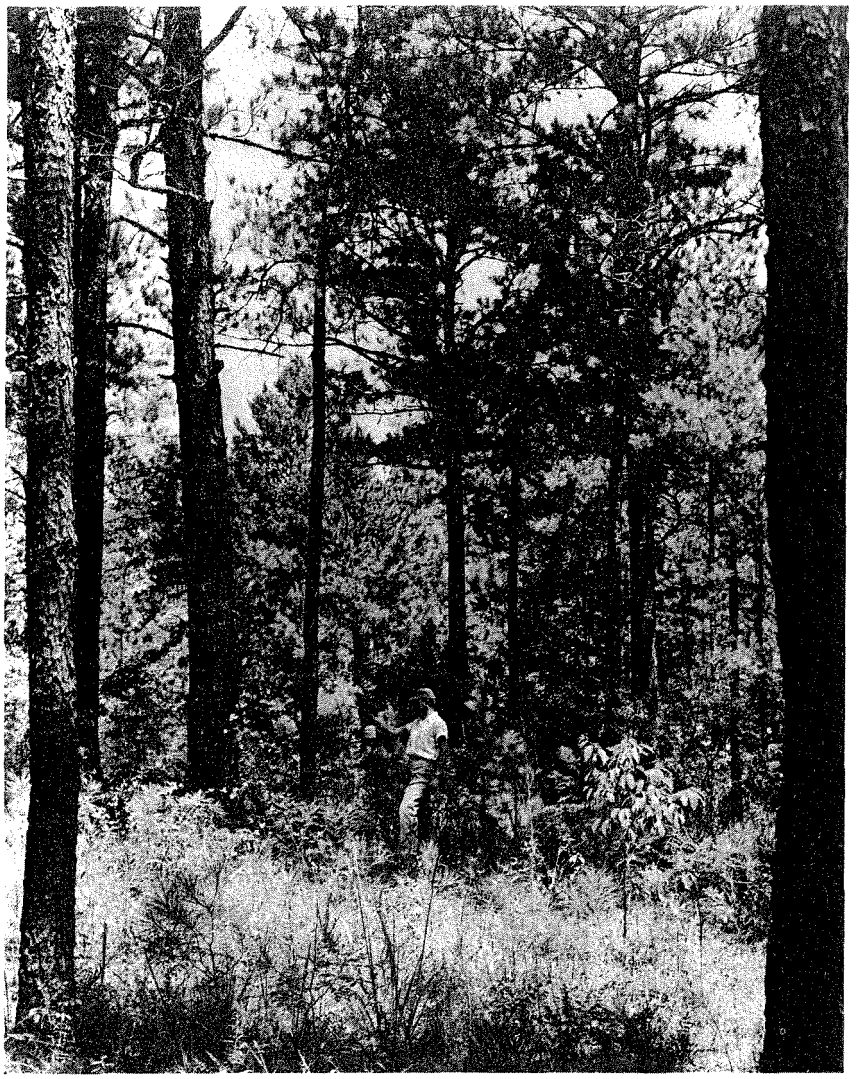


Figure 9.--A mature stand in farm woods being marked for harvesting by group selection.

## Financial Returns

The first three annual harvests combined gave stumpage returns of **$600.95, $328.10,** and **$160.10** for woodlots 1, 2, and 3. The respective roadside values were $1,021.89, **$639.34,** and $300.00. This reflects annual gross returns of **$8.52,** $4.96, and $2.33 per acre.

The location of these woodlots is shown in figure **4.**

## Special Studies

Numerous problems encountered in the management of a forest cannot be solved by large-scale tests.

Consequently, detailed studies are under way to solve more specific silvicultural and economic problems, These studlies are designed so that they can be statistically analyzed and the sigrtificance of results evaluated .

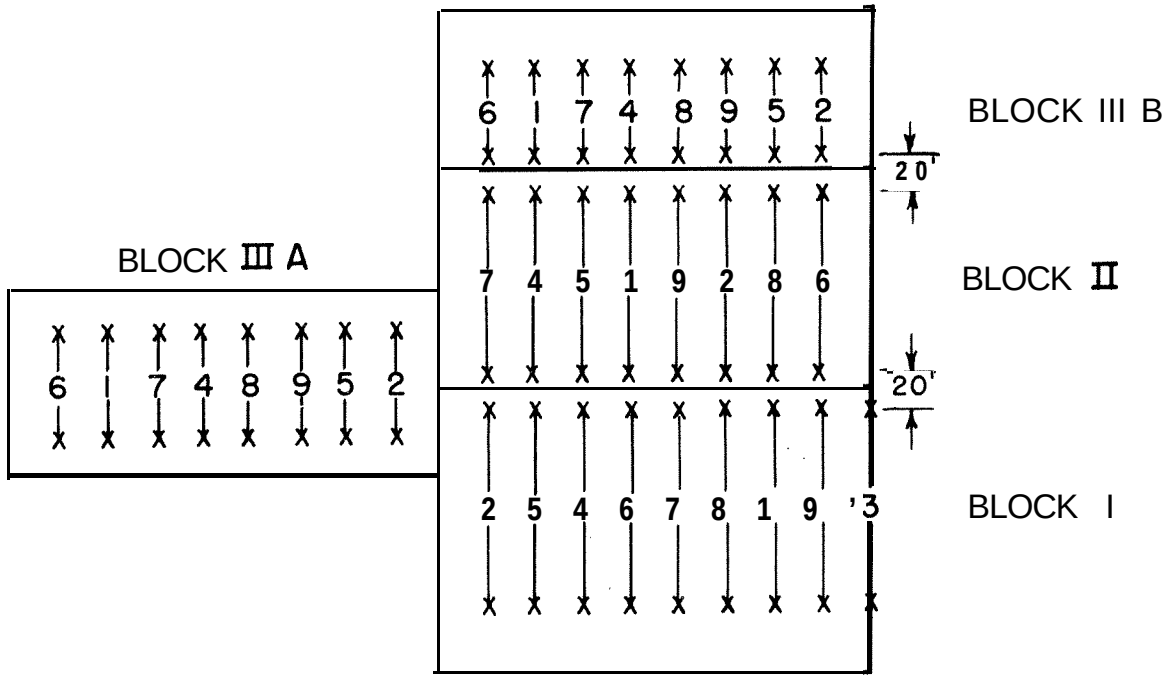
Their location is given in figure 2, and observation points are employed to describe them.

## Special Studies, Observation Point No. 1

### Hybrid Pines

Recent studies have shown that there are different geographic races within the loblolly and shortleaf pine species. This in turn brings up the possibility of breeding for faster growth rates, better seed production, improved form, increased disease resistance, and other superior traits.

Seedlings from several hybrids of shortleaf and loblolly pine were planted in the spring of 1951 to test them against examples of the parent species from different localities. The experimental design for the progeny tests of these hybrids is shown below:




Row 2 is shortleaf pine.
Rows **5**, 8, and 9 are loblolly pine from different localities.
Rows 1 and **6** are crosses of shortleaf and loblolly pine.
Rows 4 and **7** are shortleaf loblolly hybrids backcrossed with loblolly.
Row **3** is a shortleaf-loblolly hybrid, self fertilized.

## Special Studies, Observation Point No. 2

### Conventional Pruning by Two or More Operations

Many areas in the Piedmont are only partially stocked with limby trees which are worthless for the production of lumber.

Is it economically practical to prune these trees so that clear lumber will be grown?

When should pruning be done--at a time when a clear 16-foot log can be pruned in one operation, or in two or more operations before the limbs get large and while the core of the stem is small?

How much of the live crown can one prune at a time without killing the tree or reducing its growth unduly?

What is the final value of lumber of a pruned tree versus an unpruned tree?

These are some of the questions under consideration here. There are eight blocks of five 1/10-acre plots where the following tests are being made:

1. Pruning 1/2 total height in summer in two or more operations.
2. Pruning 1/2 total height in winter in two or more operations.
3. Pruning 2/3 total height in summer in two or more operations.
4. Pruning a full 16-foot log by 2/3 height pruning in one operation.
5. No pruning.

The study was started in 1945. Three prunings have been applied so far. The two-thirds height pr-uning is 70 percent completed, half-height pruning is 42 percent completed, two-thirds height in one operation is 97 percent completed.

## Special Studies, Observation Point No, 3

### Spacing and Thinning Study

Of paramount importance to timber growers is a knowledge of growth that can be obtained under various degrees of stocking. Growth rate is influenced by the spacing of the trees, their age, and the site upon which they grow (fig. 10).

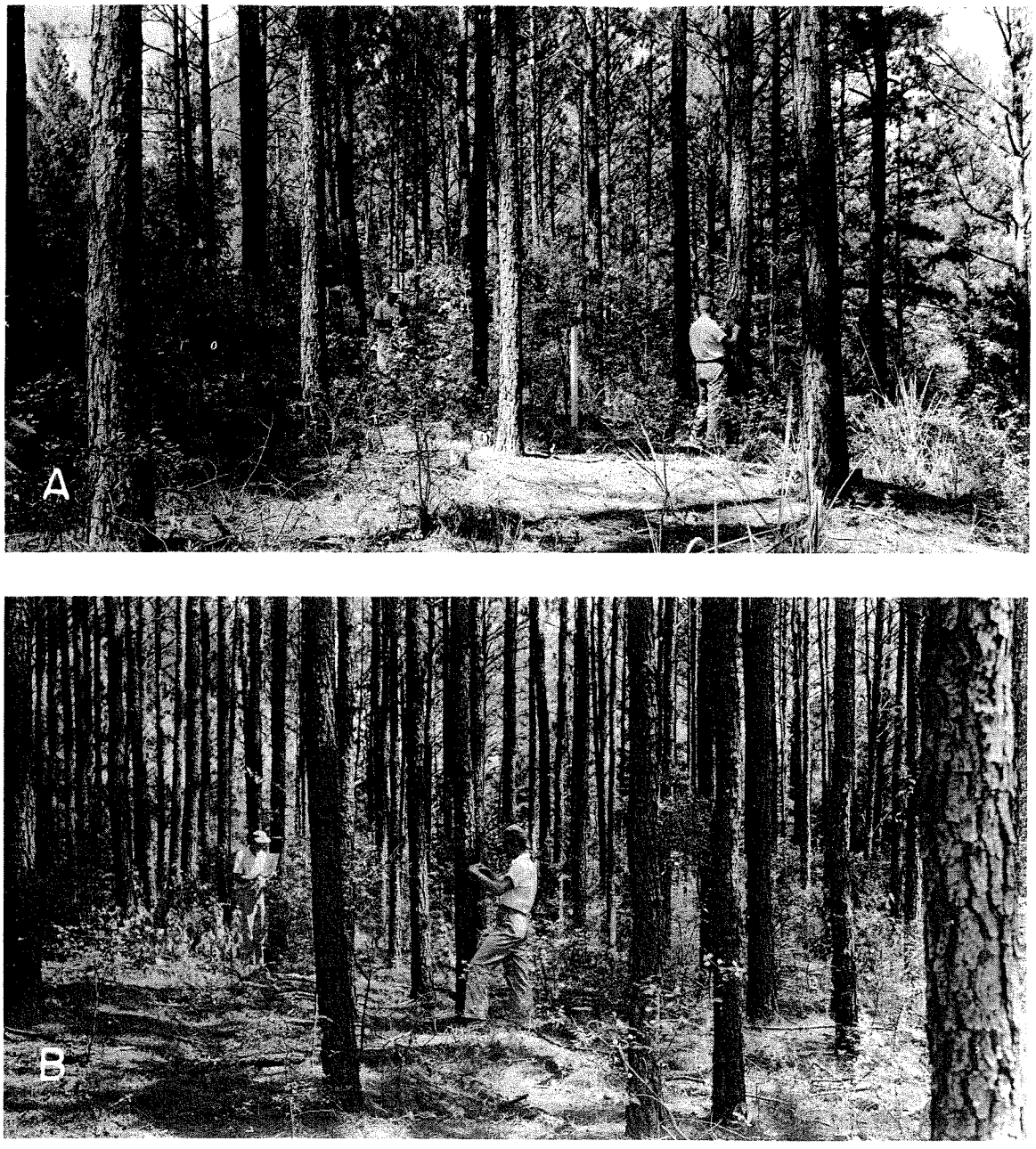



Figure 10. --Two plots, of a series of 72, designed to determine optimum spacing for saw-timber or pulpwood objectives. A shows low density of residual stand. B is high density.

To determine what the growth rates are under various combinations of the above conditions, 72 quarter-acre plots were established in the winter of 1948-49. Some of the plots were thinned to correspond to densities of other unthinned plots. This study is part of a region-wide study which will result in information on expected yields from loblolly pine under various conditions.

Two of the plots are described in detail below:

| Plot number | Age | Site Index | Average d.b.h. | Initial BA/acre | Volume cut | Residual BA/acre |
|---|---|---|---|---|---|---|
| | Years | Feet | Inches | Sq.ft. | Cords | Sq.ft. |
| 63 | 28 | 80 | 6.9 | 181 | 5.9 | 135 |
| 64 | 26 | 85 | 8.0 | 158 | 14.9 | 98 |

## Additional Studies

At the Casulon Plantation near Bishop, Georgia, an interesting study of bud-pruning slash pine, to develop knot-free lumber, is nearing completion. Another study, nearly completed, is to determine whether certain preplanting treatments in young hardwood areas are beneficial for establishing planted pines.

On the Hitchiti Experimental Forest, a bud-pruning study of loblolly pine has been started. A small study is in progress to determine what happens to the unmerchantable pine saplings left after clear cutting.

Figure Il.--Japanese honeysuckle in Piedmont forests is increasing.

Figure 12.--Detailed study of shelterwood condition often found in the lower Piedmont

Control of Japanese honeysuckle, which prevents the establishment of pine seedlings, is also being investigated (fig. 11).

Another study is intended to show how best to handle the more open-grown pine stands that have a heavy understory of pine seedlings. The purpose of the study is to find out how well and how long pine seedlings can thrive under various degrees of pine overstory shade, how seedlings respond to release, and what damage they suffer from logging operations (fig. 12).

The controlled use of fire as a possible tool for checking invasion of undesirable hardwoods, and its effect upon the soil, are subjects of a cooperative undertaking between several research centers and the Georgia Experiment Station.

Another cooperative enterprise, with participation by the Southern Pine Inspection Bureau, deals with determining lumber-grade yields for a new set of pine log and tree grades that were developed in cooperation with the Southern Forest Experiment Station.

At Hamilton, in west-central Georgia, the Station and the Ida Cason Callaway Foundation are cooperating on a broad-scale tree improvement study that occupies a graduate forester full time. Emphasis is on the four principal southern pines, longleaf, slash, loblolly, and shortleaf. The first step was to locate trees that seem to have outstanding growth rate, vigor, form, and disease resistance. Next step is to test their progeny to see whether these traits are inherited. After superior strains that breed true to type have been proven, seed will be produced in quantity. Nearly 300 outstanding mother trees have been selected from natural stands and plantations on a 35,000-acre property. Eight thousand seedlings grown from seed of these selected trees were outplanted in 1951, and additional seed was sown in the nursery in 1952. Also, controlled pollinations have been made between outstanding individuals of all four species.