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A Guide to the

Olustee Experimental Forest

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by Robert W. Cooper

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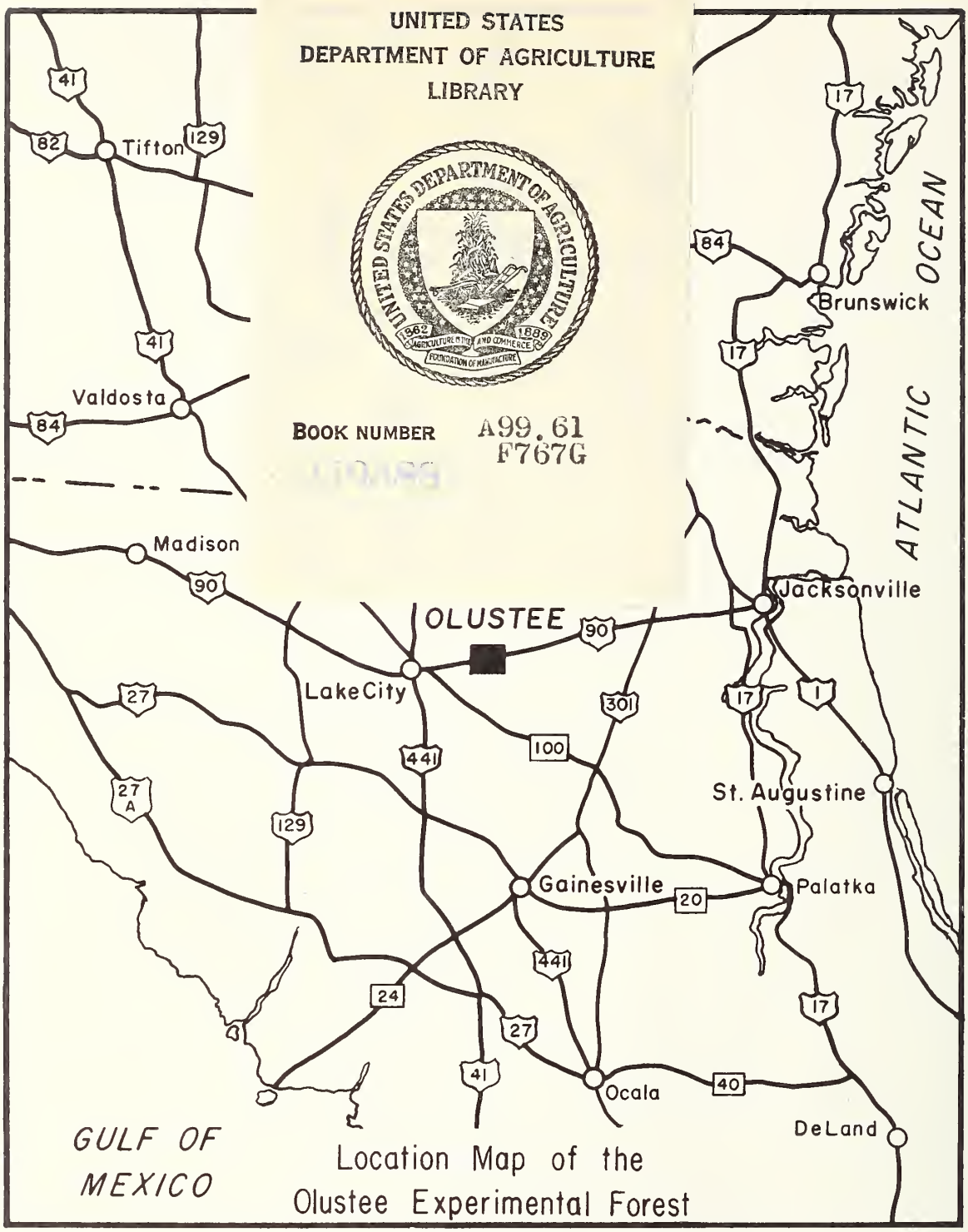


Location Map of the
Olustee Experimental Forest

Cover Photo:

An aerial view of the
Olustee Experimental
Forest headquarters site.

A Guide to the Olustee Experimental Forest

by

Robert W. Cooper
Southeastern Forest Experiment Station

The Olustee Experimental Forest is a field laboratory maintained by the Lake City Research Center of the Southeastern Forest Experiment Station to study the management of slash and longleaf pine forests in northeast Florida and southeast Georgia.

Located in the heart of the naval stores belt, this Experimental Forest serves as a testing ground for techniques and practices used in a multiple-use program of wood and gum production, and other forest products. It is the only experimental forest maintained by the U. S. Forest Service where an extensive research program in naval stores is being conducted. Forest tree improvement research and studies of insect and disease problems are also parts of the program.

Research results will apply in general to the management of about 14 million acres of forest land, but in particular to slash-longleaf pine stands. Results will also be applicable to some extent to the 34 million acres of forest land in the belt given over to timber and naval stores production.

Many of the studies being conducted by the Lake City Research Center are of a cooperative nature, and are located away from the Experimental Forest. Active cooperators include private landowners, pulp companies, lumbermen, naval stores operators and producers, the state forestry agencies of Florida and Georgia, the Florida National Forests, and other government agencies.

FOREST DESCRIPTION

The Olustee Experimental Forest was established in 1931. It lies within the boundaries of the Osceola National Forest and is located at Olustee, Florida, 12 miles east of Lake City and 48 miles west of Jacksonville on U. S. Highway No. 90. On an adjoining 10-acre block, the Agricultural Research Service of the U. S. Department of Agriculture maintains a Naval Stores Station carrying out research to improve the utilization of gum naval stores.

The Forest totals about 3,000 acres, of which about 2,400 acres are predominantly slash and longleaf pine stands. The remaining 600 acres are in mixed hardwood and cypress swamps.

At the time of its establishment, the Forest was predominantly longleaf pine, much of which had been worked for naval stores. The original survey in 1932 indicated that longleaf pine occupied about 65 percent of the experimental forest area, slash pine about 15 percent, and cypress and hardwoods about 20 percent. Slash pine had been confined to the wetter areas because of its susceptibility to fire in the seedling and sapling stages, but fire-control measures have enabled slash pine to invade the longleaf domain. In 1957, after 25 years of fire protection, the longleaf pine type has decreased to 40 percent.

The Forest is typical of the flatwoods of south Georgia and north Florida. The soils are sandy, often underlain with hardpan, and poorly drained. Numerous shallow depressions store water for part of the year, but periodically they dry up. Low vegetation consists mainly of wire grass, saw-palmetto, and gallberry on the better drained areas; wax-myrtle, dwarf palmetto, and gallberry grow on the margins of depressions. The following soils are found on the Experimental Forest:

Soil series listed from highest to lowest elevation	Occurrence (Percent)
Blanton	1
Leon (hardpan)	10
Leon (softpan)	28
Plummer	29
Portsmouth	13
Muck	19

Site index averages approximately 70 and 80 feet for longleaf and slash pine respectively. The terrain is very level, as is usual in the flatwoods, the greatest difference in elevation being 20 feet. The average elevation is 150 feet above sea level.

The climate of the region is mild and humid, with annual precipitation of about 55 inches. The average annual range of temperatures is from 25 to about 100° F.

HISTORY

Under the treaty of 1819 with Spain, by which the United States acquired "The Floridas," all of the public lands lying in the ceded territory became the property of the United States. The best land was homesteaded or purchased, but that obviously unsuited for farming became the property of the State.

The State of Florida in 1855 gave right-of-way sections to the railroads to aid in their construction. Needing money more than land, the railroads issued bonds against these lands, but then failed to keep up their payments. In 1873, most of the land was sold to pay the bond holders. The area now occupied by the Olustee Experimental Forest was one of these tracts.

About this time, the end of the great lumber industry of Michigan was in sight, and lumbermen were looking South. A mill was built at Olustee in 1881, and nearly all of the virgin longleaf stand was cut to a stump diameter of 8 inches by 1886. In 1896 a severe hurricane did extensive damage to the remaining forest. Thus, in a relatively short time this combination of extensive cutting and tropical storm removed almost all the original timber. Adequate reproduction, however, restocked most of the area during the next decade.

Slash pine grows tall and straight on some of the better sites on the forest. What is the best economic rotation in a stand like this?

Wildfires were common in the years that followed, and the forest was often burned over annually. Turpentining began to flourish, reaching its peak after World War I, but almost 600 acres of unworked timber were included within the boundaries of the Olustee Experimental Forest at the time of its purchase.

RESEARCH PROGRAM

On the Coastal Plain slash-longleaf pine belt of Georgia and Florida there exists a potential for timber production that is probably not exceeded in any other part of the country. Well-managed natural stands and plantations on average sites are capable of an annual growth of better than 2 cords per acre. However, much of the forest area is understocked, or made up of cull and poor-quality trees. More than 5 million acres are in need of planting. Throughout the lower Coastal Plain, yields are only a fraction of the area's potential.

The research program at the Olustee Experimental Forest aims at providing the timberland owner, the woods manager, and the practicing forester with the knowledge they need to correct this widespread low productivity. The objectives of our experiments are the development and perfection of methods and techniques for: (a) maintaining maximum growth and adequate natural reproduction; (b) improvement of stocking and quality in poorly stocked stands; (c) integrating timber and gum naval stores production; (d) insuring maximum survival and growth of plantations; (e) genetic improvement of forest trees; and (f) protecting the forest from damage by insects, disease, and fire.

Management Systems

Which management system yields the greatest net return to the landowner and at the same time improves the over-all stand condition for future production? To answer this question, a test and comparison of different silvicultural systems of forest management applicable to forest landowners who are growing timber as a business is being made on the Forest ①.[1/]

Thirty-two 40-acre compartments are under management to compare several basic silvicultural systems--clearcutting and planting, seed tree, shelterwood, and group selection. Also included in the test are 30-, 45-, and 60-year rotations operated on two levels of cultural intensity. Naval stores operations are confined to the longer rotations, but even some of these compartments are managed without naval stores for comparison purposes. Although the final results of this study will not be available for many years, it is already evident that all-aged or group selection management is a difficult prescription for the longleaf-slash pine type. Under this system of management, prescribed burning is costly and arduous, natural regeneration is often inadequate, and conservative naval stores practices cannot be easily integrated with wood production.

1/ Numbers or letters in circles refer to locations designated on the map, pages 16 and 17.

Holes are opened up in the group selection compartments to permit regeneration. Will adequate reproduction come in? How long will it take?

Farm Woodland

About 90 percent of the forest land in northeast Florida and southeast Georgia is privately owned, and at least two-thirds of this acreage is owned by people who are not associated with the wood-using industry--mostly farmers. Most of the cutting practices on this private ownership, exclusive of lumber and pulp companies, are rated as poor or destructive.

The Olustee Farm Woodland was established in 1944 to study methods of managing small woodland areas for a continuous return of products for sale or farm use, and of improving wood and gum production ②. This tract is also used to demonstrate the methods under test and the financial and silvicultural returns and results to be achieved by these methods.

Products removed annually have yielded an average net stumpage return of $2.60 per acre, including interest on investment. Time spent in harvesting the products has given an additional return of $0.78 per hour. Naval stores has been coordinated with timber management by maintaining 400 active faces--cutting 100 worked-out trees, and installing 100 virgin faces each year. Basal area of merchantable timber increased 20 percent and net annual growth more than 100 percent in the past decade.

Slash and longleaf pine can be grown profitably as crops. All these products came from the Olustee farm woodland in one annual harvest.

Regeneration

Natural.--The re-establishment of a forest at the time of harvest cutting is of concern to all foresters. An adequate seed supply so located that seed are disseminated on the entire cut-over area is of prime consideration.

Studies of slash and longleaf pine seedfall have been in progress on the experimental forest since 1950 ③ . Periodicity of good seed crops (once every 3 years for slash and once every 3 to 7 years for longleaf), distribution (up to 150 feet), and seed stimulation as a result of release, have been fairly well determined for both species. Current studies, however, are expected to show the quantity of seed and number of seed trees normally required for a good seedling catch on a variety of seedbed conditions. In addition, further studies are under way to determine ways and means of even greater seed production through fertilization and mechanical injury ④ .

Artificial.--When natural regeneration fails because of an inadequate seed supply or improper seedbed conditions, artificial reforestation becomes necessary. Also, clearcutting and planting has been adopted by many foresters as a practical method of management. The usual prescription merely calls for planting 1-0 stock. To obtain consistently successful plantations, however, it is apparent that this prescription must be refined in several ways.

Cardboard receptacles are placed in the woods to catch the seeds, which are trapped in the wire basket below.

What conditions are necessary to obtain adequate natural slash pine reproduction like that shown above?

Proper site preparation is an important part of successful artificial regeneration. Is this treatment adequate for increased survival and growth?

Studies are being made in the nursery to determine the characteristics of a seedling best suited for planting. Methods of handling, storing, and planting have been under observation for many years. The most important research need at present, however, is to determine the influence of site preparation on the survival and growth of planted pines. An exploratory study of this nature was established in 1954 on the forest, and preliminary information is already available ⑤. A more comprehensive study is now being carried out on private holdings.

Comparison plantations to study the relative growth rates of slash, longleaf, sand, and loblolly pine have been established on a variety of flatwoods sites common to the region ⑥.

Another phase of artificial reforestation being investigated at Olustee is the fertilization of planted pines. The use of fertilizers in the woods has generally been regarded as too costly, and therefore outside the realm of economic forest management. The possible benefits of fertilization on cleared sites planted to pines with a virtual absence of other vegetative competition, however, can no longer be overlooked. Since none of the flatwoods soils is very fertile, light applications of nitrogen and/or possibly other elements might be justified in terms of increased survival and growth.

The newest field of artificial reforestation research on the Forest is direct seeding, an old technique that has offered great potential, but has never been perfected. Slash pine seeding tests were started in 1957 to determine the effect of temperature, moisture, light, rodents, and seed treatment on the germination and survival of seed and seedlings Ⓗ.

Stand Improvement

What treatments can the forest manager apply in immature stands to improve volume and quality production?

In 1935, a precommercial thinning study was established to observe the effect of various thinning intensities on the growth of young slash pine ⑦. After 20 years, net growth figures indicate that the light thinning (800 residual stems per acre) has yielded the greatest cubic volume per acre. Although other precommercial thinning trials have shown the same general trend, there is need for further study on the effect of strict diameter-limit cuts in very dense, young, but merchantable, stands of slash pine. To meet this need, a "high-grading" study was installed in 1955 ⑧, where all of the merchantable stems were harvested and the smaller intermediate and suppressed trees were left for the next crop.

One of the most persistent and elusive problems of the forest owner and manager is deciding how much growing stock to reserve during the intermediate ages or even the life of a stand. For this reason, a region-wide slash pine stand density study was started in 1955 to determine the optimum growing space for any combination of stand age, forest site, and economic rotation. One series of these plots is located on the Experimental Forest ⑨.

The need for efficient plantation management in order to obtain maximum returns is recognized by small and large landowner alike. Studies of site preparation, spacing, fertilization, and thinning are being conducted on a 140-acre tract devoted to plantation management in order to satisfy this need ⑩.

The survival of longleaf plantings on dry sites has been improved by preparing the site with a shallow fire line plow. Has competition been retarded enough to increase subsequent seedling growth?

Dense young slash pine stands such as this need to be thinned, even though the thinnings are not big enough for pulpwood. The specific densities that give most satisfactory growth are being studied.

Controlling growing space requires the marking and removal of trees that are too close together.

Tree Improvement

How much and in what ways can the quality and productivity of the native forest be increased through genetic tree improvement, as contrasted with development of higher yields through treatment and mechanical manipulation of the stands? No one knows, but preliminary results indicate that at least a doubling of yields is not too much to expect.

Tree improvement involves selection and breeding of superior strains of trees, and their wholesale propagation for outplanting in forest plantations. More than two decades of research in the propagation and controlled breeding of turpentine pines have been conducted on the Olustee Experimental Forest. The procedures followed and the success achieved have received nation-wide attention, and a brief review of this work follows.

Wide variation in gum yields among trees of comparable size led to the belief that gum yield is a heritable characteristic. To test this hypothesis, seedlings from above-average and below-average, open-pollinated longleaf pine were planted in 1935. In 1953 the gum yields were compared and proof was obtained that the ability to yield large amounts of gum can indeed be inherited.

After an intensive search, 12 slash pine trees were found that yielded at least twice as much gum as the run-of-the-mill tree used for turpentining. Some of the selected trees have been crossed with each other and with trees of average yield. The seedlings representing the progeny of these crosses were outplanted (11). Gum yields from these trees at 10 years of age showed that several of them had the ability to pass on their high-yielding characteristics to their progeny at the twice-normal level. Viscosity of the gum, exudation pressure, and deformity of the tree stem itself have also been determined as heritable characteristics.

Air-layers and grafts from nine of the outstanding progeny found among the trees in this plantation are being used to establish a seed orchard on the nearby Osceola National Forest. Gum yields of these trees have averaged from 2 to 4 times normal. Another progeny plantation which included four more selected parents was established in 1951 (12).

Although most of the tree improvement work on the Olustee has been aimed at the development of an improved strain of pine for gum production, recent effort is also being directed toward other phases of tree improvement such as quality, growth rate, and resistance to disease or insect attack.

Any tree improvement program, whatever its aims, must go through the phases of selection, breeding, progeny testing, and propagation, before it yields tangible results. In a program with increased wood production as its aim, there are interim measures which may serve until these intensive

phases bear fruit. One such measure is the establishment of seed-production areas for seed from better than average trees. Two such areas have been established on the Forest. The first, in 1953, was created for demonstration (13); the next, in 1957, to study the stimulation of cone production through fertilizer applications (4).

Vegetative propagation is an important tool in the tree improvement program at Olustee. It is a means of safeguarding against loss of desirable parents and serves to multiply selected individuals for establishment of seed orchards. Grafting and air-layering proved to be superior to rooting cuttings for slash pine. Air-layers from the highest-yielding saplings in the oldest progeny plantation have been outplanted in 1956 to serve as a reservoir for future breeding material and as a safeguard against loss of the originals (14). In 1957 another plantation was established to determine the growth response of air-layers and grafts of material from trees of various ages (15).

Extensive seed-source studies of slash, longleaf, and loblolly pine are underway to investigate the possible presence of distinct races within these species. The oldest of these plantations was established in 1952-1953.

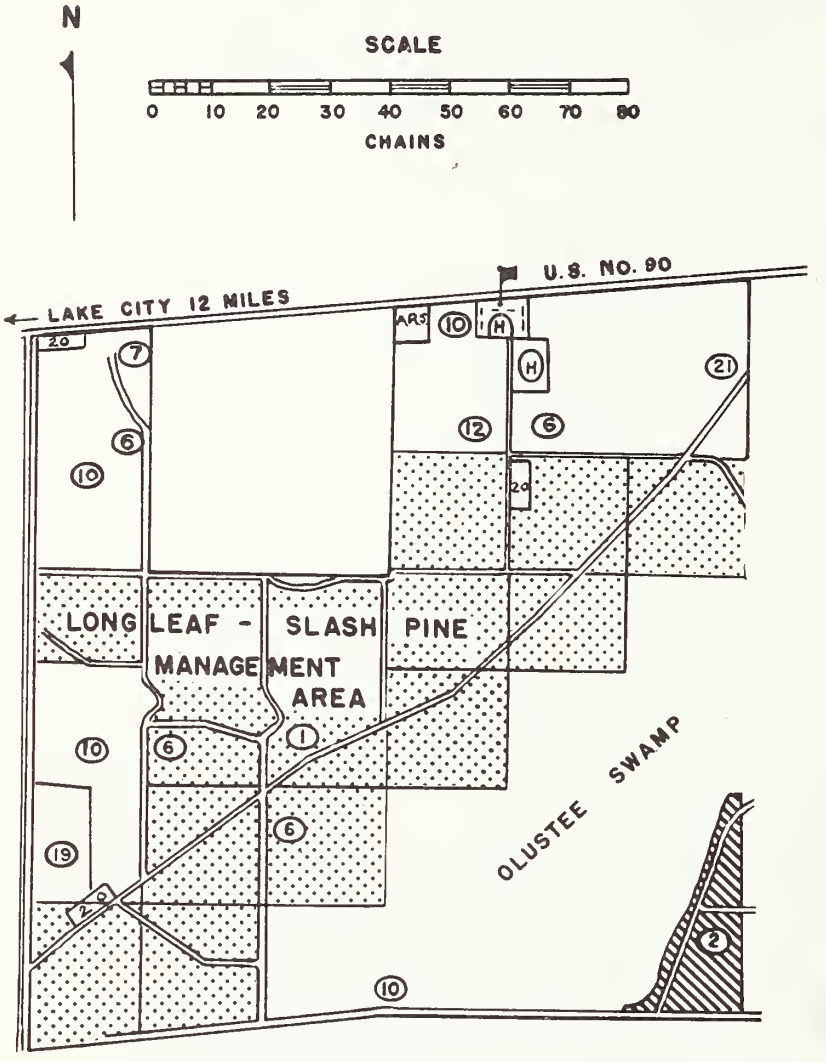
With an eye to the future, an arboretum was started in 1954 to provide future breeding material (16). Pines from all over the world as well as natural and artificial hybrids are represented. A small experimental nursery and lathhouse facilitate special treatments in raising exotic seedlings for the arboretum and permit rigid control in raising seedlings from controlled crosses (H).

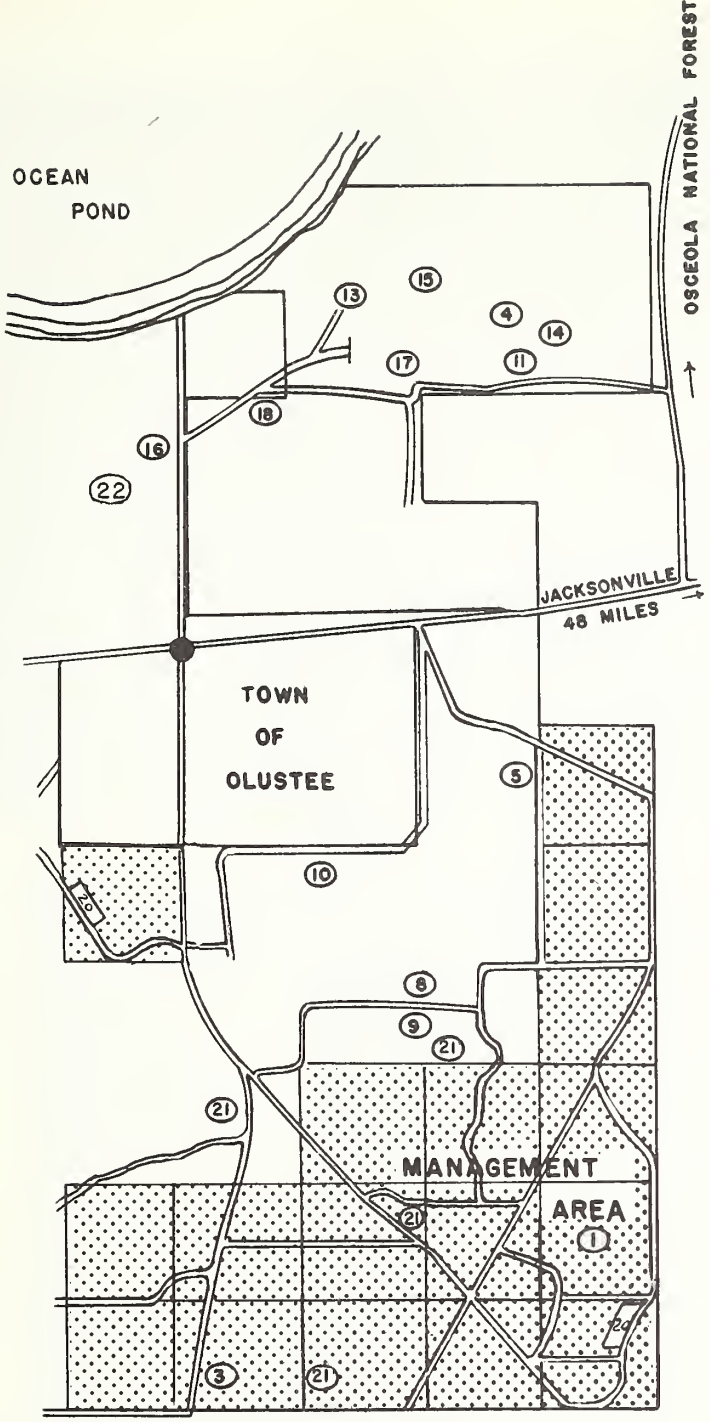
Fast-growing seedlings can be easily selected in nursery beds. Will these seedlings continue to grow faster than their neighbors after they have been outplanted? The background grid is composed of 1-inch squares.

Progeny plantations have been established on the forest to study the pattern of inheritance. Olustee's "million-dollar plantation" is proving the validity of selecting superior gum-producing trees. Controlled breeding permits further crosses in the second generation.

Seed-production areas may be created by removing all but the best 30 to 40 cone-bearing trees per acre. Cones may be collected by climbing into the tree crowns. How long is seed production stimulated through release? Will fertilization, mechanical injury, and other techniques, stimulate cone crops even more?

OLUSTEE
EXPERIMENTAL FOREST





STUDY AREAS

(1) Management Systems
(2) Farm Woodland
(3) Seedfall Studies
(4) Seed Stimulation
(5) Site Preparation
(6) Species-Site Plantings
(7) Precommercial Thinnings
(8) High-Grading Study
(9) Growing Space
(10) Fertilization, Site Preparation, Plantation Management
(11) Progeny Plantation No. 1
(12) Progeny Plantation No. 2
(13) Seed Production Area
(14) (15) Airlayer Outplantings
(16) Arboretum
(17) Gum Orchard Management
(18) Naval Stores Demonstration
(19) Ideal Forestry Demonstration
(20) Observational Plantations
(21) Rain Gauges and Water Table Wells
(22) Cone Rust Plots
(H) Special Studies, Headquarters Area

The experimental nursery at Olustee is used for all research seedings that demand rigid control. Grafting and rooting is carried on in the lathhouse and greenhouse.

Naval Stores

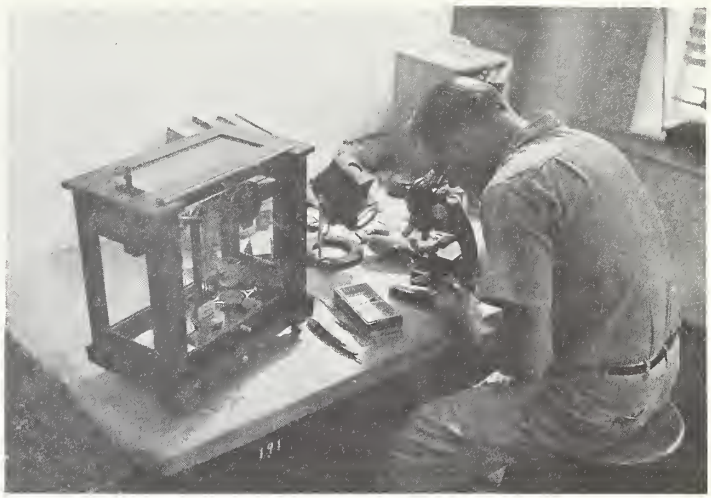
Slash and longleaf pine are the only trees in the United States used for commercial production of oleoresin. This product, best known today as a source of turpentine and rosin, was originally used to produce pitch and tar for wooden ships; hence the term "naval stores."

Research in naval stores production at Olustee includes both very technical fundamental research and quite practical applied research. Fundamental research is the foundation for much of the work in improvement of gum extraction methods and tree improvement. For example, sulfuric acid applied to fresh wounds prolonged the flow of oleoresin. The acid causes a disintegration of the cells at the ends of the ducts which contain the oleoresin and so acts as "the chipper's helper" by keeping the gum flowing twice as long as with the old methods. Thus, a saving of 50 percent in labor costs for chipping was made.

At present a study of the relation of the pressure of oleoresin in the ducts and the oleoresin viscosity to gum yields is being made. The results show that trees which have high exudation pressure and very fluid gum are the highest yielders.

Following the lead of fundamental research in the use of acid to prolong gum flow, a new system of gum extraction was devised. By reducing the depth of the wound so that no wood was chipped out, and using gutters and cups for gum collection which could easily be removed from the tree, research foresters

eliminated the waste of the lower section of the tree caused by the old destructive methods. This new method, called bark-chipping with acid stimulation, is now used by more than 70 percent of all naval stores producers. Research continues in the field of gum extraction to modify methods and schedules to suit all types of management.



Numerous improved field procedures are derived from basic research in the laboratory.

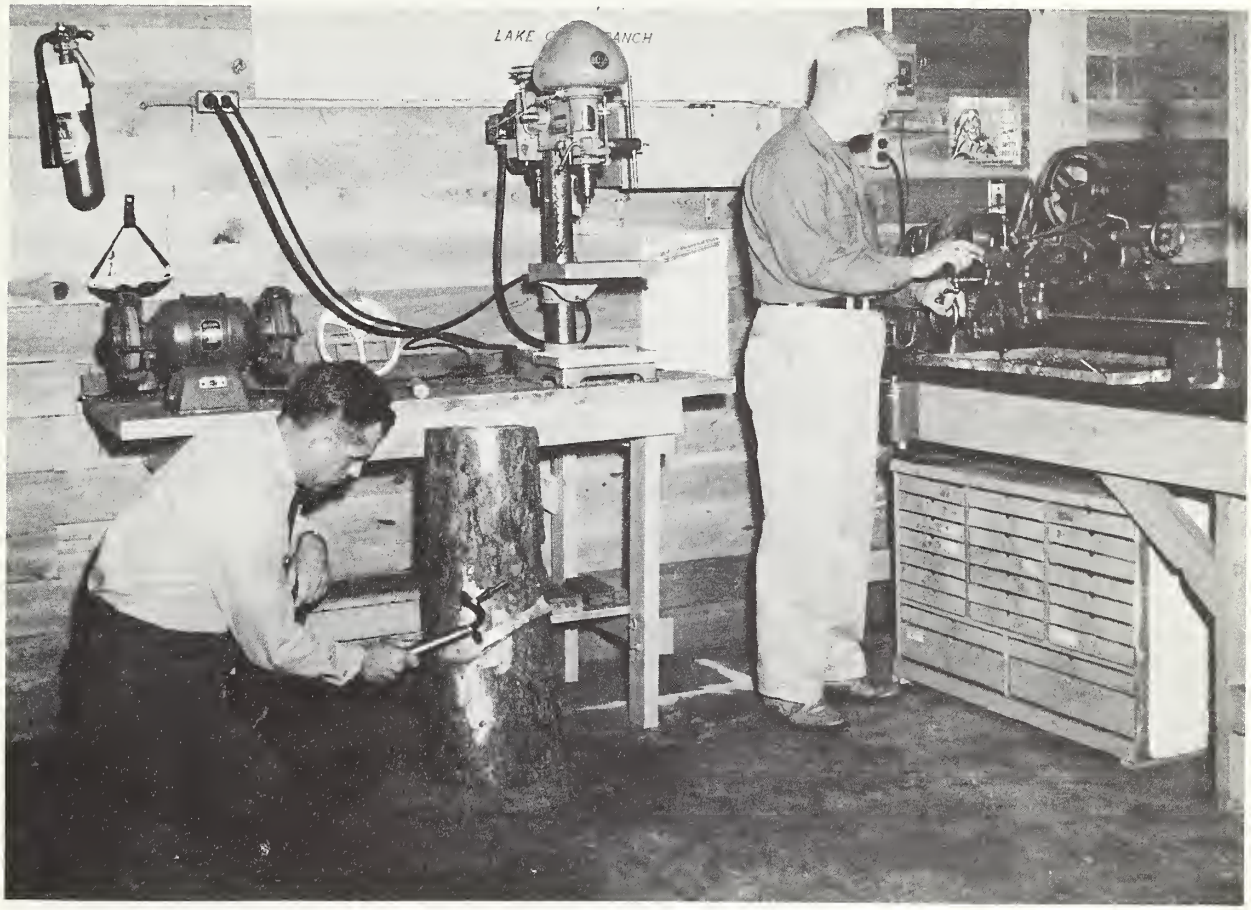
What effect does the width of streak and acid concentration have on gum production? Accurate measurements of gum yield are necessary to check this action.

Research has just begun in the field of oleoresin producing plantations or "gum orchards." With superior strains of high-gum-yielding trees under development, there is a need for information on the effects of fertilization, cover crops, and irrigation on tree growth and gum yields. A field test of these cultural practices on known high- and average-yielding stock has been installed on the Forest (17).

Another study with economic implications is designed to show the effects of gum extraction on wood growth. Results to date show that the reduction in wood growth during the gum extraction period is more than offset by the value of the gum produced.

Growth bands are being used on these trees to study the effect of gum extraction on wood growth. Studies like this must continue for several years to tell a complete story.

Equipment development for efficient gum extraction has been an important phase of applied research (H). Improvement of hacks, acid spray bottles, spray-pullers, and development of improved gutter and cup installations and tin installation tools have made it easier to "sell" the conservative new extraction methods to the public.



Tools need to be developed and tested before they can be put to work in the woods.

With thousands of acres of pine plantations on their way toward maturity, mechanization of naval stores extraction is a possibility in the near future. In these plantations, vehicles could move both laborers and their power-driven extraction tools down the rows, increasing labor productivity and decreasing costs. While the development of such equipment would be of great benefit to the naval stores industry, the work requires engineering and fabricating facilities that are beyond the resources of the Olustee Experimental Forest.

A naval stores demonstration area has been established on the Experimental Forest to point out the recommended management and gum extraction practices in a gum-farming operation (18). Farm and extension foresters will find this area a source of new ideas on marking, gum extraction and collection, and forest insect control.

Efficient naval stores management is shown in this demonstration area. Large 10-quart buckets are being hung to catch the gum from the trees that are to be worked.

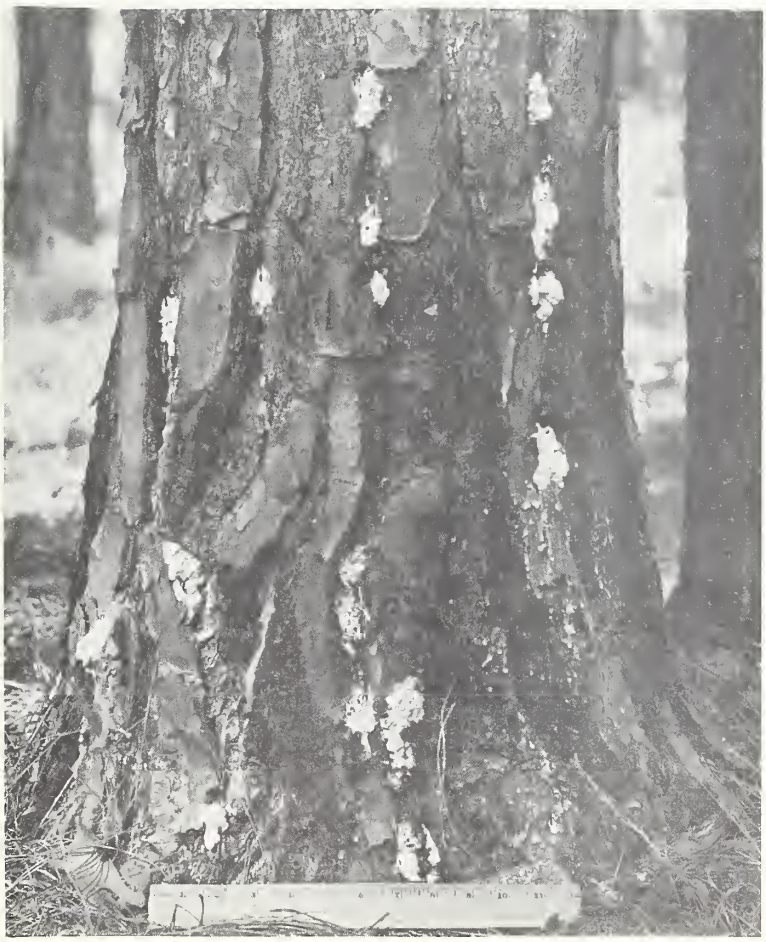
Forest Insects

Although not particularly spectacular, many forest insects are continually working away on forest crops, all the way from seed formation to the finished product. Can these insects be controlled? How?

The answers to these questions and others like them are being sought by the forest entomologists at Olustee. One of their major research projects is the study of the biology, ecology, and control of insects destructive to the flowers, cones, and seeds of longleaf and slash pine. Seed and cone losses not only hinder the progress of the over-all tree planting program, but retard efforts to breed better trees and develop seed orchards. Several insecticidal sprays, therefore, are being tested to control cone losses. Additional studies are also under way to identify and evaluate natural factors of control; i.e., parasites, predators, disease, climate, etc.

The black turpentine beetle and the Ips engraver beetle are two bark beetles that have been unusually destructive in naval stores timber. Studies on the Olustee Experimental Forest have indicated that effective control of the black turpentine beetle can be achieved through the application of a 1-percent benzene hexachloride spray if the treatment is applied before infestation is severe. Control of the Ips engraver beetle, however, requires further research. To meet this need, plans are under way to study the effects of different cutting methods and logging equipment on population build-ups. If management methods are not effective, other methods will be explored for preventing attacks and treating trees already infested.

The Ips engraver beetle often attacks without warning, killing a patch of timber and moving on before any effective control measures can be taken. Olustee entomologists believe that silvicultural control measures can be devised.



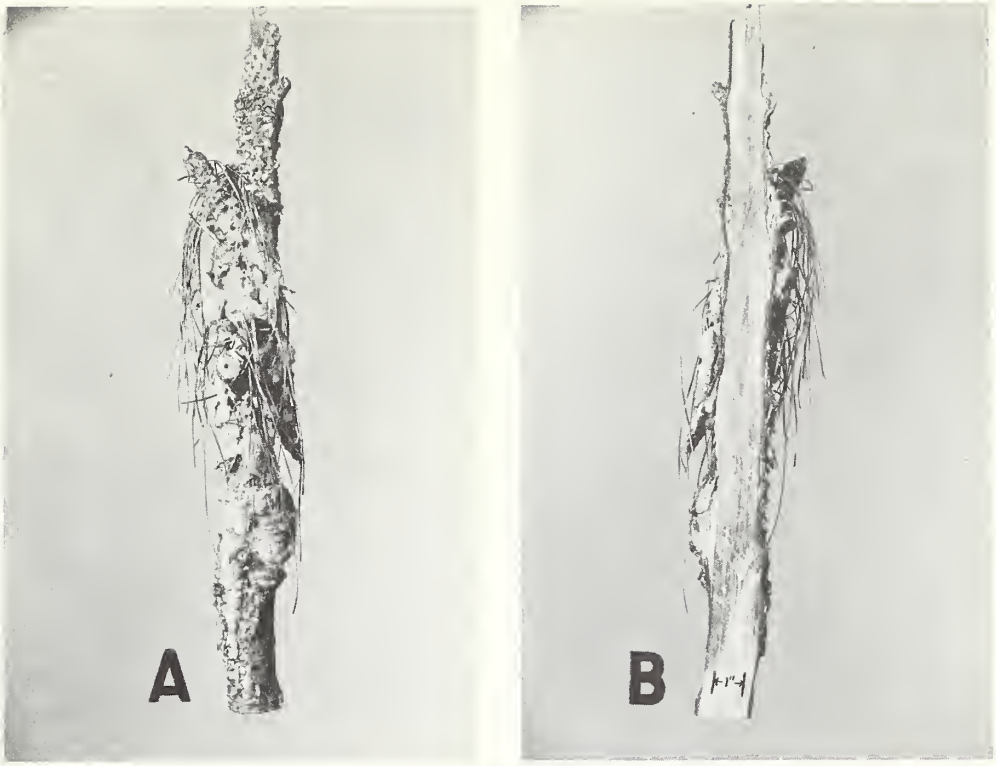
Large, globular masses of pitch at the base of the tree are the first external signs of black turpentine beetle attack. When observed in time, the beetles can be controlled by a BHC spray. Unless control measures are taken, losses will continue for several seasons. Further research is being conducted to determine causes of population build-up.

To facilitate the life history and habit studies of forest insects, a field insectary is maintained at the Olustee headquarters site (H). Large numbers of insects can be reared and studied under conditions reasonably similar to those in the field.

Forest Diseases

Research on tree diseases has played a prominent part in the Lake City program over the years. A great deal of study went into dry face, a condition well known to naval stores operators. The tendency of faces to dry up was shown to be related to site, the condition being particularly prevalent along pond margins. Other factors conducive to dry face were a low crown ratio of the trees, deep chipping, and multiple cupping. Past work at Lake City has shown the value of prescribed fire to control the brown spot disease of longleaf pine. A disease of young slash and longleaf, known as pitch canker, is very conspicuous in north Florida and south Georgia. It is caused by a fungus that induces a heavy flow of gum and caking of gum on the outside of the affected part of the tree, and also induces heavy pitch soak of the wood.

The Olustee insectary provides the facilities for carefully controlled studies of habits and life histories of forest insects.

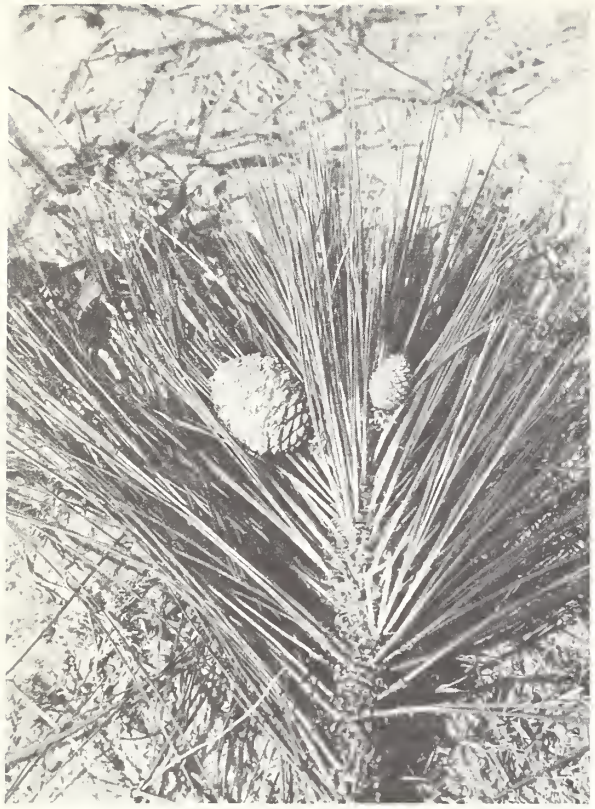


A, Pitch canker on slash pines. Note the heavy deposit of crystallized gum. B, The same canker cut through the pith of the wood to show the heavy pitch soaking of wood characteristic of these cankers.

At present, the work on tree diseases at Lake City is concentrated on cone rust. This disease has been causing damage to cones in the South for many years, but has now come into prominence since the demand for slash pine seed has become so great.

New slash pine, and to a lesser extent longleaf, cones were hit hard by cone rust, Cronartium strobilinum, for the second successive year in 1957. A survey showed attack from South Carolina to south Florida and westward through the Gulf states. In Florida the average cone crop loss to slash pine approached 20 percent, with many trees losing all their cones. The rusted cones also provided breeding material for insects, and the insects then moved down to attack maturing cones of the previous year's set, thus compounding the losses.

The new research on cone rust is featuring the possibilities of control by spraying the young conelets. Several fungicides are being applied at different concentrations to female flowers in the receptive stage in attempts to control this disease in seed orchards and seed production areas. Other methods will also be tried, and we hope that a practical control for cone rust may be in the offing in the near future. The pulp and paper companies are helping support this work with funds, men, and materials.



Cone rust on slash pine. The small cone is healthy and of natural size. The large cone is diseased and will never produce seed.

Other Research

A 300-acre tract has been set aside on the Osceola National Forest as a natural area to serve as a control for the intensive management being practiced on the Experimental Forest. It should provide an excellent opportunity for future soil and ecological research.

In the southwest corner of the Olustee Forest, a 20-acre block of timber is being established for a demonstration of ideal forestry practices (19). This is not an experimental area, but will provide a "birds-eye-view" of proper forest management practices for the visitor who desires a quick look-around.

In addition to this demonstration area, visitors will want to see some of the first plantings on the forest (20). These were made in 1934, and show growth potentials for slash pine on a variety of sites.

A cooperative study with the Division of Fire Research to determine danger ratings and drought indices should also be of interest. Rain gages and water-table wells have been established in a number of stands on the Forest (21), and weekly measurements may enable fire-danger forecasters to increase the reliability of their estimates.

Not all of the research studies at Olustee are in the field. A laboratory and greenhouse provide opportunities for basic research in plant nutrition, seed physiology, pathology, histology, and flower formation.

This guide is intended to help the visitor see and understand research in progress on the Olustee Experimental Forest. With the aid of the map and signs located on the experimental area, visitors can find their way around the Forest; staff members, however, are available for guided tours if desired. Large groups are requested to make their arrangements in advance.

Further details may be obtained by contacting the Officer in Charge, Olustee Experimental Forest, Olustee, Florida. Published information is available at the Lake City Research Center in Lake City, Florida, or at the Southeastern Forest Experiment Station, P. O. Box 2570, Asheville, N. C.

Agriculture--Ash