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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 2 January 1952

RATES OF NET ANNUAL GROWTH IN BOARD FEET APPLICABLE TO LARGE FORESTED AREAS IN SOUTH CAROLINA

Foresters are sometimes called upon to predict timber growth by species groups on extensive areas such as state forestry districts or the drawing territory of a large wood-using plant. If the board-foot volume of saw timber is known, the annual growth percents below offer a quick way of doing this. Percents are given both for individual stand sizes and for the entire forest.

The growth rates shown are those the Forest Survey found average for the general run of site and stocking conditions in South Carolina. They allow not only for the increment of merchantable softwoods 9.0 inches d.b.h. and larger and of hardwoods 11.0 inches d.b.h. and larger, but for the average ingrowth of smaller trees to these sizes and for average mortality. There is also an allowance for loss of growth on trees cut before the end of the year. This allowance is based on the volume of commodity drain in 1946.

Stand-size class[1/]	Southern pine	Cypress, cedar, and hemlock	Gum, maple, and yellow-poplar	Other hardwoods
	Percent	Percent	Percent	Percent
STATE OF SOUTH CAROLINA				
Saw-timber stands	5.3	2.3	4.3	4.1
Pole-timber stands	6.5	4.1	6.0	5.8
Other stands	6.8	1.8	4.2	4.5
All stands	5.5	2.4	4.4	4.3
SOUTHERN COASTAL PLAIN				
Saw-timber stands	5.2	2.1	5.0	4.6
Pole-timber stands	7.3	4.0	7.2	6.7
Other stands	5.9	2.7	4.1	6.2
All stands	5.4	2.3	5.1	4.8
NORTHERN COASTAL PLAIN				
Saw-timber stands	5.2	2.4	3.9	4.0
Pole-timber stands	6.7	3.7	4.4	4.5
Other stands	7.2	1.8	4.4	4.3
All stands	5.4	2.4	3.9	4.0
PIEDMONT				
Saw-timber stands	5.8	3.2	5.0	4.0
Pole-timber stands	6.1	5.1	6.3	5.8
Other stands	7.3	1.8	3.8	3.6
All stands	5.9	3.5	5.2	4.4

1/ See back of sheet for definitions of saw-timber and pole-timber stands.

A. S. Todd, Jr.
Division of Forest Economics

Saw-timber stands: Stands containing at least 1,500 board feet per acre International 1/4-inch rule, in merchantable saw-timber trees (softwoods 9.0 inches d.b.h. and larger, hardwoods 11.0 inches d.b.h. and larger).

Pole-timber stands: Stands containing less than 1,500 board feet per acre but at least 10 percent stocked with trees 5.0 inches d.b.h. and larger, and with at least 5 percent in trees under saw-timber size.

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 3 January 1952

RATES OF NET ANNUAL GROWTH IN CORDS APPLICABLE TO LARGE FORESTED AREAS IN SOUTH CAROLINA

Foresters are sometimes called upon to predict timber growth by species groups on extensive areas such as state forestry districts or the drawing territory of a large wood-using plant. If the total volume in standard cords is known, the annual growth percents below offer a quick way of doing this. Percents are presented both for individual stand sizes and for the entire forest.

The growth rates shown are those the Forest Survey found average for the general run of site and stocking conditions in South Carolina. They allow not only for the increment of all sound trees 5.0 inches d.b.h. and larger, but for the average ingrowth of smaller trees to this size and for average mortality. There is also an allowance for loss of growth on trees cut before the end of the year. This allowance is based on the volume of commodity drain in 1946.

Stand-size class 1/	Southern pine	Cypress, cedar, and hemlock	Gum, maple, and yellow-poplar	Other hardwoods
	Percent	Percent	Percent	Percent
STATE OF SOUTH CAROLINA				
Saw-timber stands	4.7	2.2	3.0	3.6
Pole-timber stands	8.5	4.3	5.1	5.4
Other stands	7.7	3.1	3.5	6.1
All stands	5.7	2.6	3.3	4.2
SOUTHERN COASTAL PLAIN				
Saw-timber stands	4.6	1.8	3.3	4.1
Pole-timber stands	8.1	4.3	4.3	6.1
Other stands	7.7	5.7	3.3	4.7
All stands	5.4	2.7	3.4	4.6
NORTHERN COASTAL PLAIN				
Saw-timber stands	4.6	2.2	2.7	3.5
Pole-timber stands	8.9	3.1	3.8	5.4
Other stands	7.0	1.5	3.3	7.9
All stands	5.3	2.2	2.8	4.0
PIEDMONT				
Saw-timber stands	4.9	4.8	3.9	3.2
Pole-timber stands	8.5	5.2	6.1	5.1
Other stands	8.5	7.1	3.9	4.4
All stands	6.5	5.1	4.9	4.1

1/ See back of sheet for definitions of saw-timber and pole-timber stands.

A. S. Todd, Jr.
Division of Forest Economics

<u>Saw-timber stands</u>: Stands containing at least 1,500 board feet per acre International 1/4-inch rule, in merchantable saw-timber trees (softwoods 9.0 inches d.b.h. and larger, hardwoods 11.0 inches d.b.h. and larger).

<u>Pole-timber stands</u>: Stands containing less than 1,500 board feet per acre but at least 10 percent stocked with trees 5.0 inches d.b.h. and larger, and with at least 5 percent in trees under saw-timber size.

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 4 January 1952

RULES-OF-THUMB FOR VOLUME AND VALUE IN PULPWOOD TREES

Foresters, timber owners, and pulpwood buyers frequently need quick estimates of pulpwood volume and value in standing trees. Easy rules-of-thumb are often sufficiently accurate. A recent study of shortleaf and loblolly pine timber at the Hitchiti Experimental Forest near Macon, Georgia, showed that the pulpwood volume and value of second-growth Piedmont pine trees 8 to 13 inches d.b.h. can be quickly computed by these approximations, where D is tree d.b.h.:

Solid volume of rough wood in cu. ft. $= 4(D-6)$

Example: The solid volume of rough wood in an average 10-inch tree is $4(10-6)$, or 16 cubic feet.

Stacked volume of rough wood in cords $= \frac{4(D-6)}{100}$

Example: The stacked volume of a 12-inch loblolly pine is $\frac{4(12-6)}{100}$, or 0.24 cords.

Number of trees per cord $= \frac{100}{4(D-6)}$

Example: The number of 11-inch trees per cord of pulpwood is $\frac{100}{4(11-6)}$, or 5.

Pulpwood stumpage value per tree $= \frac{4(D-6)}{100} \times$ current pulpwood price per cord

Example: The value of an average 12-inch tree, when pulpwood is selling for \$4 per cord is $\frac{4(12-6)}{100} \times \$4$, or \$0.96.

The foregoing rules for individual trees are readily adaptable to stands. The volume and value of a stand of trees 8 to 13 inches in diameter can be approximated by entering the equation with the sum of tree diameters and the number of trees. Thus, if a cruise provides the following tally by diameter:

D.b.h.	No. Trees	D.b.h. times no. trees
8	16	128
9	20	180
10	32	320
11	21	231
12	12	144
13	4	52
Total	105	1055

the stand volume and value are obtained as follows:

$$\text{Solid volume of rough wood} = 4\left[1055 - 6(105)\right]$$

$$= 4(425) = 1700 \text{ cubic feet.}$$

$$\text{Stacked volume of rough wood} = \frac{1700}{100} = 17 \text{ cords.}$$

Pulpwood value at $4 per cord = 17($4) = $68.

Although the rule for solid volume has not been checked in the field, the estimates compare favorably with solid volumes read from volume tables commonly used in the Carolinas and Georgia. Comparisons with similar volume tables for shortleaf pine in the central piedmont and slash pine in Georgia and Florida are equally favorable. In first generation old-field stands and for Virginia pine the estimated volume should be reduced by about ten percent.

A somewhat older rule of thumb, $\left(\frac{D-2}{2}\right)^2$ provides solid volume estimates only slightly higher than the above rule.

In converting cubic volume to cords, it is common practice to divide the solid volume by 90 instead of 100 as shown in the above computations. In the study conducted on the Hitchiti Experimental Forest, converting factors for 8 to 13 inch trees ranged from 92 to 101, with an average of about 97. The negligible error introduced by using 100 for the rule-of-thumb is more than compensated for by the greater ease in calculation. This relatively high ratio of solid-to-stacked volume is apparently due to careful training and good supervision of the cutting and loading crews at the Experimental Forest. When it is known that the converting factor differs from 100, the local-practice figure should be used.

Thomas Evans and T. A. McClay
Division of Forest Management

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 5 January 1952

GUM YIELDS WITH DIFFERENT FREQUENCIES OF CHIPPING AND TREATMENT

Controlling the interval between chippings is an important factor in naval stores work when streaks are treated with acid. Many studies have shown that trees chipped and treated every 2 weeks yield at least as much gum as trees chipped weekly without treatment (weekly untreated chipping is the base level used as a standard for yield comparisons in most of our Lake City tests). Also, chipping and treating every 3 weeks will result in gum yields about three-quarters of those from untreated weekly chipping. Gum yields from a 4-week chipping interval are about half the yield from a weekly untreated streak. The significant factor to note is that both labor costs and face height are reduced when acid is used on streaks chipped every 2 or 3 weeks, and a satisfactory gum yield is still obtained.

Gum flow usually declines to a small amount by the end of the first week after untreated chipping, but when a streak is treated with acid, the gum continues to flow at a considerable rate for several weeks. The benefits of acid and the prolonged flow it brings are illustrated in the results of one season's work, with chipping and treating at intervals of 2, 3, and 4 weeks, shown in the figure on the back of this sheet.

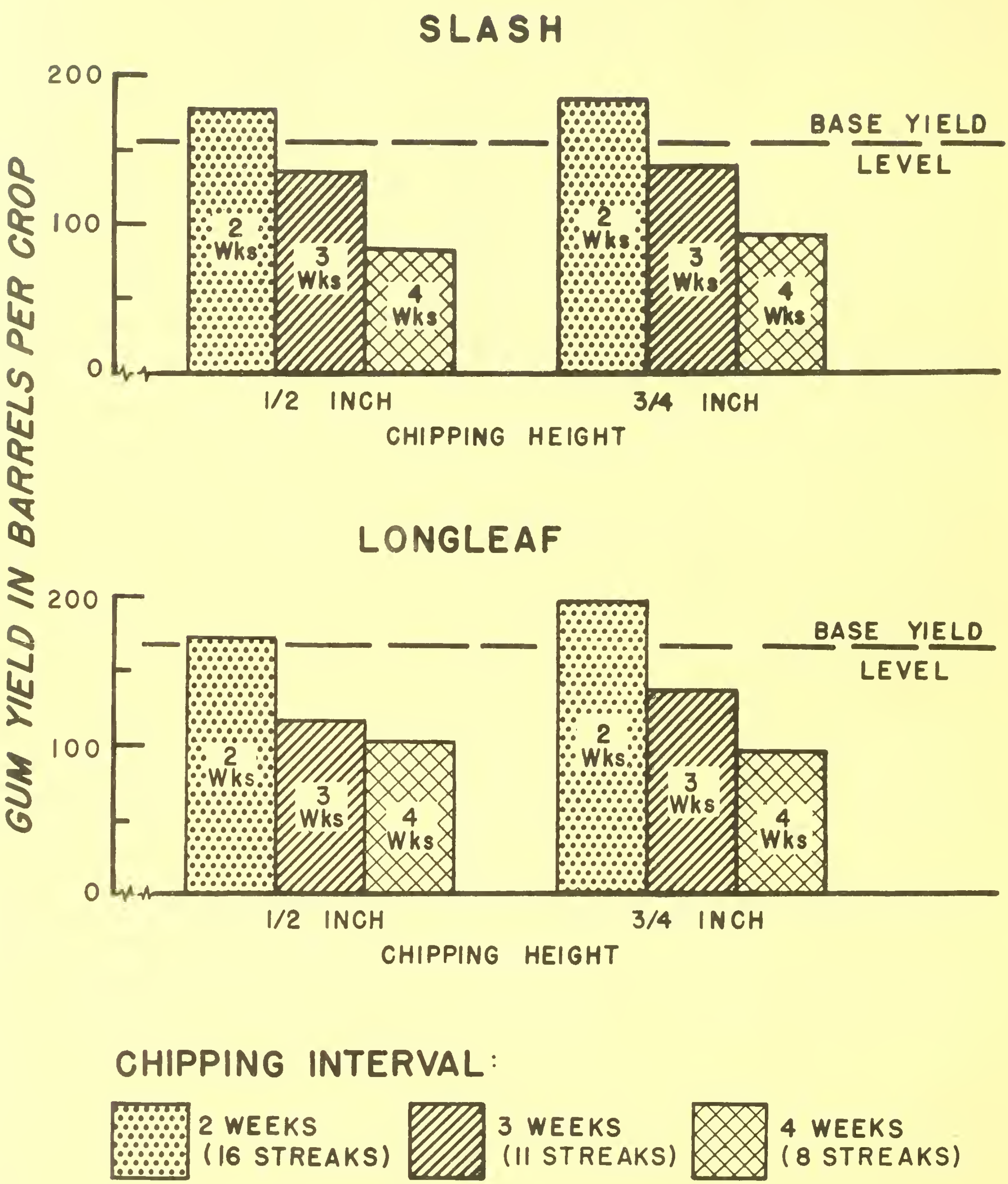
On a 2-week bark-chipping schedule the average yield with acid was 12 and 10 percent greater than from untreated weekly conventional chipping for the average of both chipping heights for slash and longleaf respectively. On a 3-week schedule these yields averaged 16 and 25 percent lower than conventional chipping. Chipping every 4 weeks resulted in yield decreases of 46 and 40 percent.

When sufficient labor is available and a high gum yield is desired, the 2-week chipping and treating interval is best. When conditions are such that trees can be visited only every 3 weeks, acid treatment helps in obtaining over three-quarters of the yield obtained with untreated weekly chipping. Though yields are lower, the output for each day of work for the laborer is greatly increased, with a further decrease in labor cost per barrel of gum produced.

Thus, for many naval stores operations the most efficient chipping schedule is every 2 or 3 weeks when bark chipping and acid is used. In this way labor costs are reduced and profits increased. Also, through face-height savings, the tree can be either turpentined for a longer period of time, or a smaller face will make it possible to sell suitable trees for poles.

Albert G. Snow, Jr.
Division of Forest Management

BARK CHIPPING AND ACID TREATMENT



Gum yields for one season from trees bark-chipped and treated with acid at different frequencies. The base yield level is for weekly untreated chipping 1/2 inch deep and 1/2 inch high.

Agriculture--Asheville

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 6 April 1952

RATES OF NET ANNUAL GROWTH IN CORDS APPLICABLE TO LARGE FORESTED AREAS IN FLORIDA

Foresters are sometimes called upon to predict timber growth by species groups on extensive areas such as state forestry districts or the drawing territory of a large wood-using plant. If the total volume in standard cords is known, the annual growth percents below offer a quick way of doing this. Percents are presented both for individual stand sizes and for the entire forest.

The growth rates shown are those the Forest Survey found average for the general run of site and stocking conditions in Florida. They allow not only for the increment of all sound trees 5.0 inches d.b.h. and larger, but for the average ingrowth of smaller trees to this size and for average mortality. There is also an allowance for loss of growth on trees cut before the end of the year. This allowance is based on the volume of commodity drain in 1948.

STATE OF FLORIDA

Stand-size class[1/]	Yellow pine	Cypress and cedar	Gum, maple, bay, and magnolia	Other hardwoods
	Percent	Percent	Percent	Percent
Saw-timber stands	5.1	2.6	3.5	3.7
Pole-timber stands	7.1	3.0	4.7	5.9
Other stands	5.4	0.5	3.1	2.8
All stands	5.8	2.5	3.7	4.2
NORTHEAST FLORIDA				
Saw-timber stands	5.1	2.0	3.6	4.0
Pole-timber stands	7.6	4.1	5.3	5.3
Other stands	6.6	0.6	3.6	2.2
All stands	6.0	2.3	4.0	4.1
NORTHWEST FLORIDA				
Saw-timber stands	5.5	2.6	3.4	3.9
Pole-timber stands	7.8	1.5	3.9	6.3
Other stands	5.7	0.4	2.3	3.0
All stands	6.3	1.9	3.4	4.4
CENTRAL AND SOUTH FLORIDA				
Saw-timber stands	4.1	3.4	3.3	2.7
Pole-timber stands	4.7	2.6	5.7	6.5
Other stands	3.9	0.5	3.7	3.7
All stands	4.2	2.9	4.0	3.9

1/ See back of sheet for definitions of saw-timber and pole-timber stands.

James W. Cruikshank
Division of Forest Economics

Saw-timber stands: Stands containing at least 1,500 board feet per acre International 1/4-inch rule, in merchantable saw-timber trees (softwoods 9.0 inches d.b.h. and larger, hardwoods 11.0 inches d.b.h. and larger).

Pole-timber stands: Stands containing less than 1,500 board feet per acre but at least 10 percent stocked with trees 5.0 inches d.b.h. and larger, and with at least 5 percent in trees under saw-timber size.

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 7 April 1952

RATES OF NET ANNUAL GROWTH IN BOARD FEET APPLICABLE TO LARGE FORESTED AREAS IN FLORIDA

Foresters are sometimes called upon to predict timber growth by species groups on extensive areas such as state forestry districts or the drawing territory of a large wood-using plant. If the board-foot volume of saw timber is known, the annual growth percents below offer a quick way of doing this. Percents are given both for individual stand sizes and for the entire forest.

The growth rates shown are those the Forest Survey found average for the general run of site and stocking conditions in Florida. They allow not only for the increment of merchantable softwoods 9.0 inches d.b.h. and larger and of hardwoods 11.0 inches d.b.h. and larger, but for the average ingrowth of smaller trees to these sizes and for average mortality. There is also an allowance for loss of growth on trees cut before the end of the year. This allowance is based on the volume of commodity drain in 1948.

STATE OF FLORIDA

Stand-size class 1/	Yellow pine	Cypress and cedar	Gum, maple, bay, and magnolia	Other hardwoods
	Percent	Percent	Percent	Percent
Saw-timber stands	6.6	3.0	4.2	4.0
Pole-timber stands	6.9	3.8	4.4	6.2
Other stands	6.3	3.1	1.9	1.7
All stands	6.6	3.1	4.0	4.1
NORTHEAST FLORIDA				
Saw-timber stands	6.8	2.5	4.0	4.6
Pole-timber stands	8.3	5.7	5.2	5.7
Other stands	7.1	2.8	0.3	1.7
All stands	7.1	2.8	3.9	4.3
NORTHWEST FLORIDA				
Saw-timber stands	6.7	3.1	4.3	3.9
Pole-timber stands	5.9	5.1	3.4	6.4
Other stands	7.5	2.0	3.0	1.9
All stands	6.8	3.2	4.1	4.0
CENTRAL AND SOUTH FLORIDA				
Saw-timber stands	5.4	3.7	4.5	3.5
Pole-timber stands	4.5	1.6	5.6	6.7
Other stands	4.3	3.8	2.2	0.8
All stands	4.7	3.4	4.3	3.7

1/ See back of sheet for definitions of saw-timber and pole-timber stands.

James W. Cruikshank
Division of Forest Economics

Saw-timber stands: Stands containing at least 1,500 board feet per acre International 1/4-inch rule, in merchantable saw-timber trees (softwoods 9.0 inches d.b.h. and larger, hardwoods 11.0 inches d.b.h. and larger).

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 1 January 1952

LETHAL TEMPERATURES AND FIRE INJURY

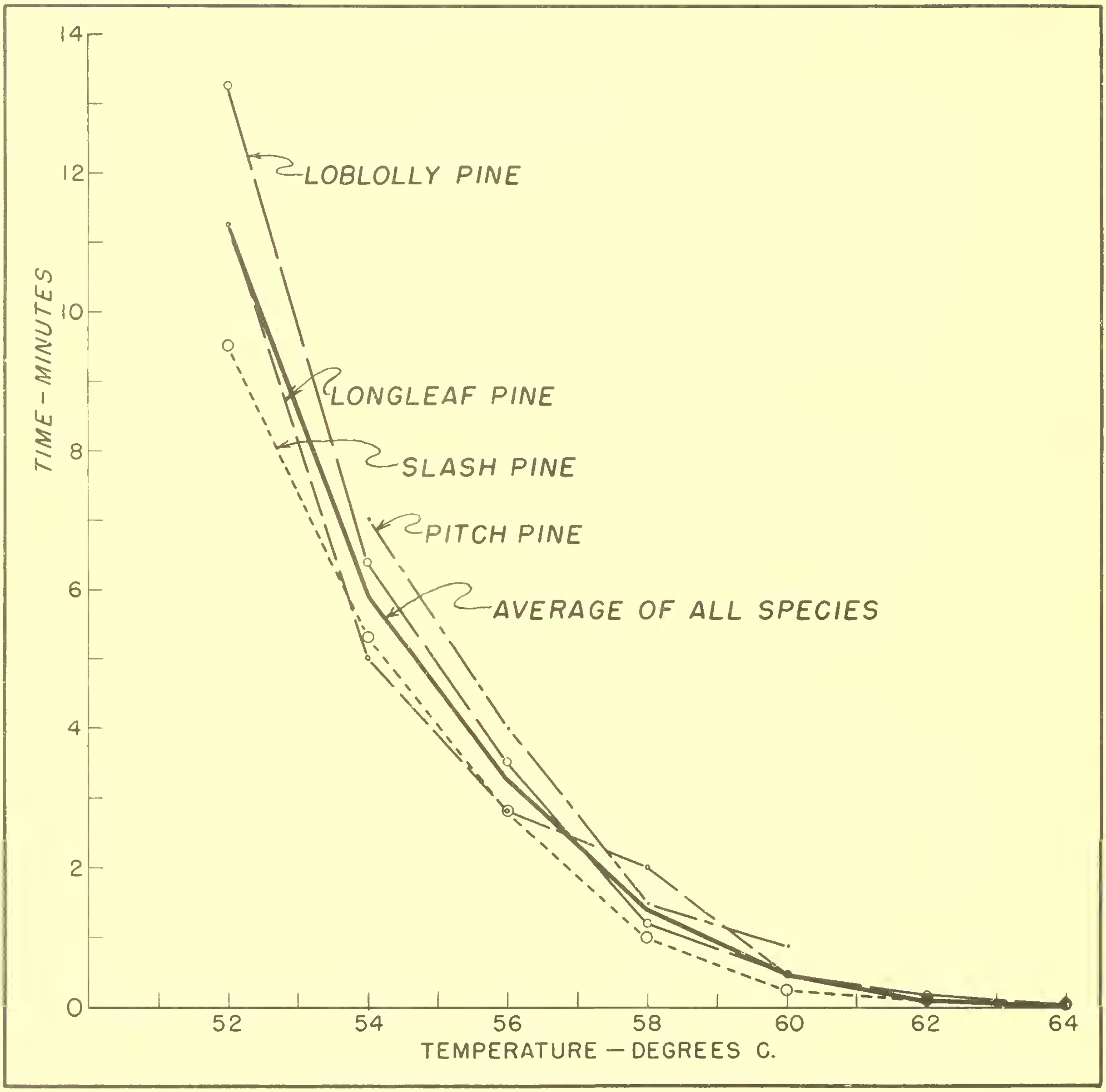
The direct and immediate damage effects of fire can be reduced to three primary variables: (1) the intensity of the fire, (2) the initial vegetation temperature, and (3) the lethal temperature of plant tissue. Whether the effects are scorching of crown needles, killing of buds and small branch endings, or the killing of patches of the cambium layer near the base of large trees, it is likely that the direct and immediate effects depend mostly on the three variables listed above. Other factors are also involved such as the heat capacity, thermal conductance, and structure of the critical parts of the tree. However, for any one species these factors are nearly constant although they are influenced to some extent by tree vigor and state of dormancy.

Fire intensity (from the standpoint of lethal effects) may be defined as those properties of a fire which determine the amount of heat transferred from the fire to the critical or sensitive parts of a tree. Methods are available for its measurement or estimation. The lethal effects of a fire of a given intensity vary inversely as the difference between the lethal temperature and the initial vegetation temperature; hence the prediction of these effects requires that these temperatures be known. The initial vegetation temperature can be measured or estimated with considerable accuracy. However, there has been some disagreement among investigators as to lethal temperatures and their variation with exposure time. For this reason a series of experiments were made to determine the lethal temperature for needles of several species of pine and the relation between the lethal temperature and its dependence on time of exposure. The water bath method was used with close temperature control. Browning within 7 or 8 days after immersion was the criterion adopted for needle killing.

The results are shown graphically on the reverse of this page. Apparently there is no large difference between the species tested. All show a considerable range of lethal temperature with exposure time. The needles in a tree crown 15 to 18 feet above the ground might be in the hot gases of a backing fire about 6 minutes. In this case their lethal temperature would be about 54° C. (129° F.). For a fast-spreading headfire the time might be only half a minute, in which case the lethal temperature would be nearly 60° C. (140° F.). Hence, for equal intensities a backfire would scorch a tree crown higher than a headfire. However, headfires actually scorch to considerably greater heights because their intensity is almost always several times as great as that of a backfire.

Tissues in other parts of the tree may have somewhat different lethal temperatures from that of needles, but they will undoubtedly show similar trends with exposure time.

G. M. Byram and R. M. Nelson
Division of Fire Research



Killing temperatures for southern pine needles when immersed in a water bath.

CLEMSON COLLEGE

CLEMSON, SOUTH CAROLINA

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 8 April 1952

LOBLOLLY PINE SEED-TREES REMOVED WITH MINOR DAMAGE TO SEEDLING STAND

In the Bigwoods Experimental Forest,[1] logging of mature loblolly pine stands leaving seed-trees has resulted in disturbance of about 50 percent of the surface area. In reproduction cutting this much or more disturbance is encouraged in order to reduce competing vegetation and prepare the seedbed. However, when seed-trees are removed after a seedling stand is established, logging disturbance is undesirable because it damages the seedlings. The extent of such damage was the subject of a recent study on two managed compartments on the experimental forest. The study revealed only slight damage to a stand of very young seedlings by removal of six large (20-inch) seed-trees per acre.

The essential facts about the two compartments are given in the following table showing treatment and conditions on seed-tree cutting areas.

Compartment No.	Date of harvest cut	Date of seed-tree removal	Seedlings per acre at time of seed-tree removal			Percent of area disturbed in seed-tree removal
			1 yr. old	2 yrs. old	Total	
15	April 1950	February 1952	4250	640	4,890	16
17	August 1949	February 1952	1360	2230	3,590	17

Seed-trees were logged 2 to 2-1/2 years after harvest cutting, in the presence of 3 to 5 thousand seedlings per acre, most of them 1 or 2 years of age. Locations for loading were marked in advance of felling, and cutters were encouraged to fell trees directly toward or away from these spots. The seed-trees were skidded in tree lengths by crawler tractors, and bucking and loading was done within the stand. Daily output exceeded the average for the same crew in more conventional types of cutting.

As shown in the table, about one-sixth of the area was disturbed by the seed-tree removal. This figure is an estimate of the extent of damage to reproduction.

1/ Maintained by the Southeastern Forest Experiment Station in cooperation with Camp Manufacturing Company, Inc., Franklin, Va.

The reproduction damage was only slight on half of the disturbed area, or about one-twelfth of each compartment. Typical of the lightly damaged areas were the minor skid roads. Here the soil disturbance was slight and some of the seedlings survived. This damage should be only temporary, for the seed-trees deposited an average of 125,000 sound seed per acre in the good seed year which preceded their removal. This seed should readily restock the disturbed soil of the lightly damaged areas.

Heavy reproduction damage occurred on 7 or 8 percent of the total area. This damage was traceable to repeated trips by crawler tractors on roads and at the bucking and loading areas. Here all seedlings were destroyed, the soil was churned and packed, and much of the seed was buried too deep for effective germination.

Some seedlings will become established in the main tractor roads from seed on the ground. On the loading areas, however, damage is complete, and some provision must be made to reseed or plant such areas if full use of the land is desired.

Results of similar cutting on other areas will vary with the number and age of the seedlings on the ground and the number of seed-trees removed. This study showed that 1-year seedlings had the best chance of escaping damage. Because of their small size and limber stems they often survive even the passage of the tractor treads. Two-year and older seedlings are more brittle; they were usually eliminated from the logging roads by the skidding operation.

Kenneth B. Trousdell
Division of Forest Management

Agriculture-Asheville

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 9 April 1952

A BETTER MEASURING TAPE FOR MANY WOODS USES

Plastic clothesline makes a very good tape for measuring fixed distances such as plot radii and distances to sample trees. It is superior to tapes of other materials because it is light in weight, will not kink, is snag resistant, slips easily through brush, may be pulled around sharp bends, is readily seen, and is unaffected by weather. It can be purchased in most variety, department, and hardware stores in 50- and 100-foot lengths for about 2 cents per foot.

It is sold under many brand names. Two brands have been tested. One was advertised as Full No. 6 (breaking strength guaranteed to exceed government breaking strength specification TC-571A for Full No. 6) and was slightly larger in diameter than the other for which no specifications were given. The construction of both was the same--white plastic cover bonded to a rayon cord center.

Stretchiness of the samples was checked in the laboratory and compared with a standard steel tape. Lengths were calibrated at a pull of 15 pounds, the pull required to eliminate practically all of the sag in a 50-foot plastic line, and at a temperature of 70° F. Then the pull was varied to from 10 pounds to 25 pounds, and the lines and tape were measured after exposure to full sunlight for some time.

The results indicate that in measuring the radius of a one-fifth or one-quarter acre plot, for example, the difference in length between a steel tape and a plastic line should be less than $\pm$ 0.2 inch even though the pull varies from 10 to 25 pounds. Temperature extremes apparently have no more effect on the length of the plastic line than on a steel tape.

Plastic line has proven very satisfactory in the woods. Fixed distances can easily be marked with wire wrappings, metal bands, or by painted enamel stripes. Different metals or colors can be used if two or more distances are marked. The light weight and flexibility of the plastic makes the job of stretching a straight line in the woods much easier. The white color of the plastic can be seen more readily and for longer distances. And the plastic can easily be kept clean by merely wiping off dirt with a damp cloth.

The plastic is not damaged by water, oil, gasoline, or other common liquids. It can be rolled up when wet and stored without damage. Plastic lines must be protected from cutting edges and fire. The plastic is not flammable, but will disintegrate in fire.

A. W. Lindenmuth, Jr.
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Agriculture-Asheville

U. S. Department of Agriculture - Forest Service

RESEARCH NOTES

SOUTHEASTERN FOREST EXPERIMENT STATION

Asheville, North Carolina

Number 10 April 1952

EARLY COMPETITION IN SLASH PINE PLANTATIONS

Although it is well known that early growth of planted southern pine is affected by initial spacing, there is not much information to show when competition begins or how great an effect it exerts upon growth. Results of a study in slash pine indicate that mutual competition in 6 x 6-foot plantations begins as early as the third year after planting. Diameter growth of individual trees is reduced, but height growth after 7 years in the field is not affected.

These observations are based on a study of the effect of spacing upon growth of planted slash pine in the Piedmont of Central Georgia, near Athens. Originally planted in 6 x 6-foot spacing, one half of the plots were thinned at the end of the second growing season by removing alternate rows and alternate trees within the remaining rows so as to obtain a direct comparison of 6 x 6-foot and 12 x 12-foot spacing. Heights and diameters of 25 tagged trees in each of 16 plots were measured annually from the second through the seventh growing seasons.

At the time of treatment there was no difference between the two spacings in diameter of the average tree, but a significant difference appeared as early as one year after the spacing levels were established, as shown in the figure. This difference, corresponding to 0.3-inch better diameter growth in favor of the wider spacing, continued to increase in size and significance through the seventh growing season, when the wide spacing had a mean diameter advantage of one inch. The larger diameter associated with the 12 x 12-foot spacing is attributed to reduction in competition.

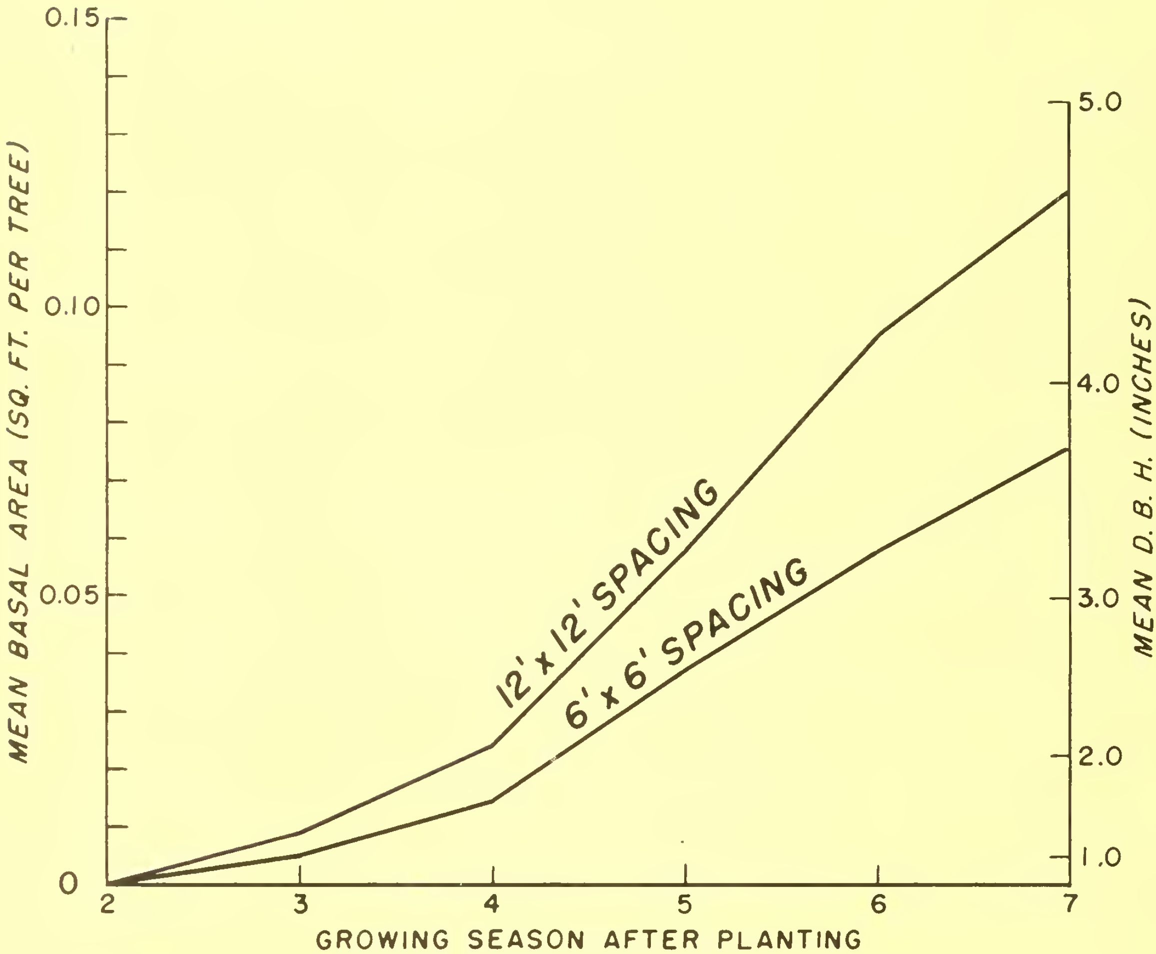
There was no significant difference in height before treatment or due to treatment during the period under study. Craib,[1/] in studying slash pine plantations in South Africa, obtained essentially the same results, i.e. early competition in closely spaced plantations, as expressed in diameter increment with little expression of competition in height growth.

One should not infer from these data that wide initial spacings or very early thinnings in 6 x 6-foot plantations are recommended. The 6 x 6-foot spacing still produced a greater total basal area than the

1/ Craib, I. J. The silviculture of exotic conifers in South Africa. Paper given at the British Empire Forestry Conference, Great Britian, 1947. City Printing Works, Pietermaritzburg, Union of South Africa. 35pp.

12 x 12-foot spacing, and also provided for better natural pruning. But the plantation manager should be aware that competition can occur at a rather early age in close spacings of slash pine and that the maximum diameter growth of potential crop trees is not realized at these close spacings.

Thomas C. Nelson
Division of Forest Management



Effect of reducing the spacing of 2-year-old planted loblolly pines on later growth in diameter and basal area.

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 11 July 1952

LOBLOLLY PINE NEEDLE BLIGHT CAUSED BY THE BROWN-SPOT FUNGUS

The brown-spot fungus, Scirrhia acicola, causes a damaging needle blight of longleaf pine seedlings. It has not been regarded as of any importance on other pines, although it has been collected on numerous species in all of the coastal States from North Carolina to Texas and in Arkansas, Tennessee, and Ohio.

S. acicola, however, was found to be associated with a prevalent needle blight of loblolly pines in the Carolinas and Georgia in the fall and winter of 1949, 1950, and 1951. The blight was noticed first in September when needles of the current season had partly died back from the tips. Large trees as well as seedlings and saplings were diseased. The foliage of some affected trees appeared at a distance as though scorched by fire.

Inoculations of loblolly pine seedlings in the greenhouse, with conidia of the fungus, resulted in the same kind of needle dieback as that observed in the field. Cross inoculations with the brown-spot fungus were made on different hosts. Conidia obtained by isolating the fungus from a diseased loblolly pine needle infected slash pine as well as loblolly pine needles.

Much of the loblolly pine needle blight that has been noticed in the autumn has resulted from infections by the brown-spot fungus. Although there is observational evidence that this disease when severe markedly checks the growth of young loblolly pine, mortality from it is unlikely except in heavy attack on small seedlings.

John S. Boyce, Jr.
Division of Forest Pathology
Bureau of Plant Industry, Soils,
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Agriculture-Asheville

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 12 July 1952

FIRE PREVENTION EFFORTS PAY OFF IN THE NORTHEAST

The frequency of forest fires in 13 northeastern states dropped about one-half from 1943 to 1950, exclusive of the fluctuations due to weather. The average downward trend and the annual observations from which the trend is determined are shown graphically in the lower chart on the other side of this page. Each dot on the chart is the ratio of fire occurrence (actual number of fires that burn) to fire expectance (number of fires proportional to measured fire danger). By transforming the data in the upper chart to a ratio, the effects of weather are largely eliminated from comparisons between years on the same area, and the error owing to differences in population, fuel types, land use, and other factors in comparisons between areas also is greatly reduced.

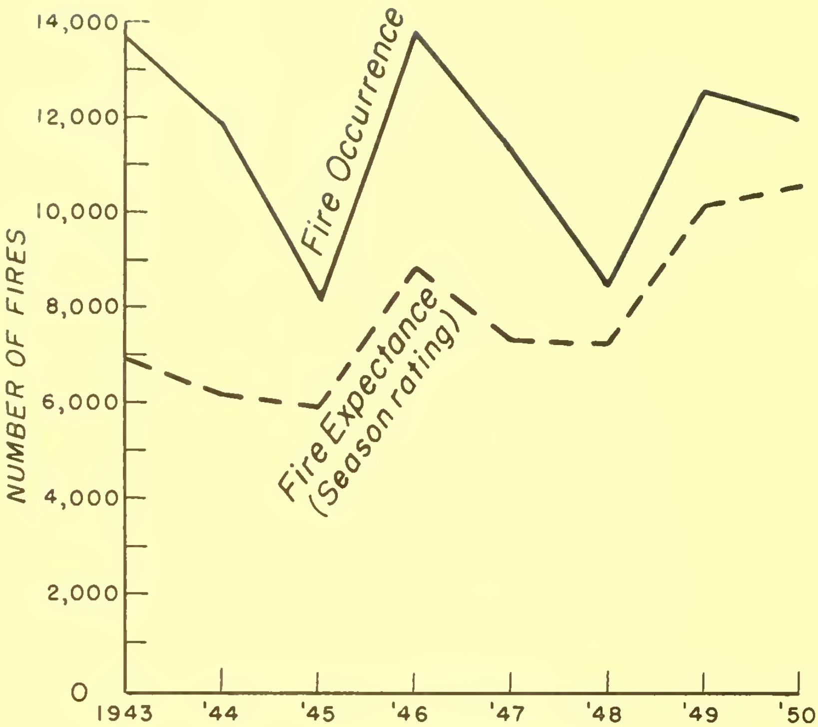
The decline in frequency of forest fires is common to most of the states, particularly during the last 5 years of the period. During these postwar years there was a downward trend in eleven states, very little change in one, and a moderate increase in another. The decline was sharpest in the following states, in the order listed:

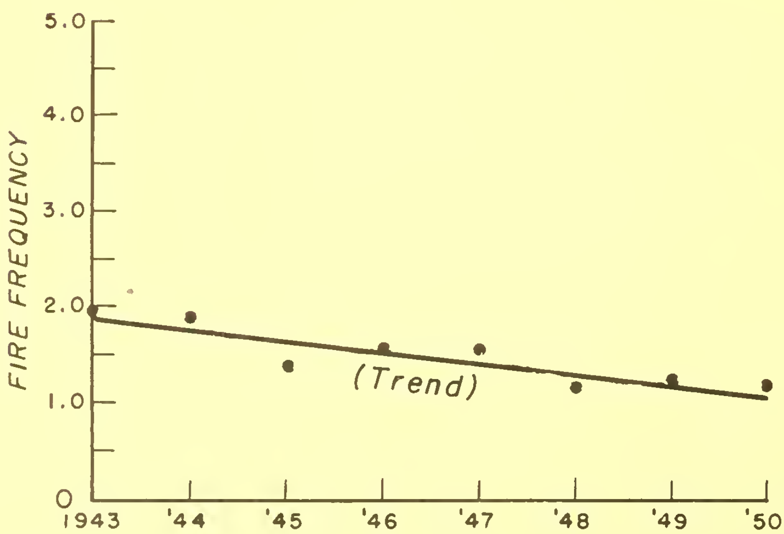
Kentucky
Pennsylvania
Virginia
Connecticut
West Virginia

The degree of change varies by states but there is no indication that the location of a state affects the trend. There are differences between states because each state places a different amount of emphasis on fire prevention, employs different methods and techniques in preventing fires, and faces different fire prevention problems. However, variations are not extreme, so the data may be pooled to make up a regional picture, as has been done in the figure.

The regional observations form a relatively orderly pattern around the average trend line with small deviations predominating. Hence, it may be inferred with some confidence that the downward trend is a caused effect rather than a happenstance. The most rational explanation in view of no significant population change, particularly no decrease, is that money spent for organized and sustained fire prevention programs is buying a significant reduction in the frequency of forest fires.

A. W. Lindenmuth, Jr., and J. J. Keetch
Respectively, Division of Fire Research, and Region 7





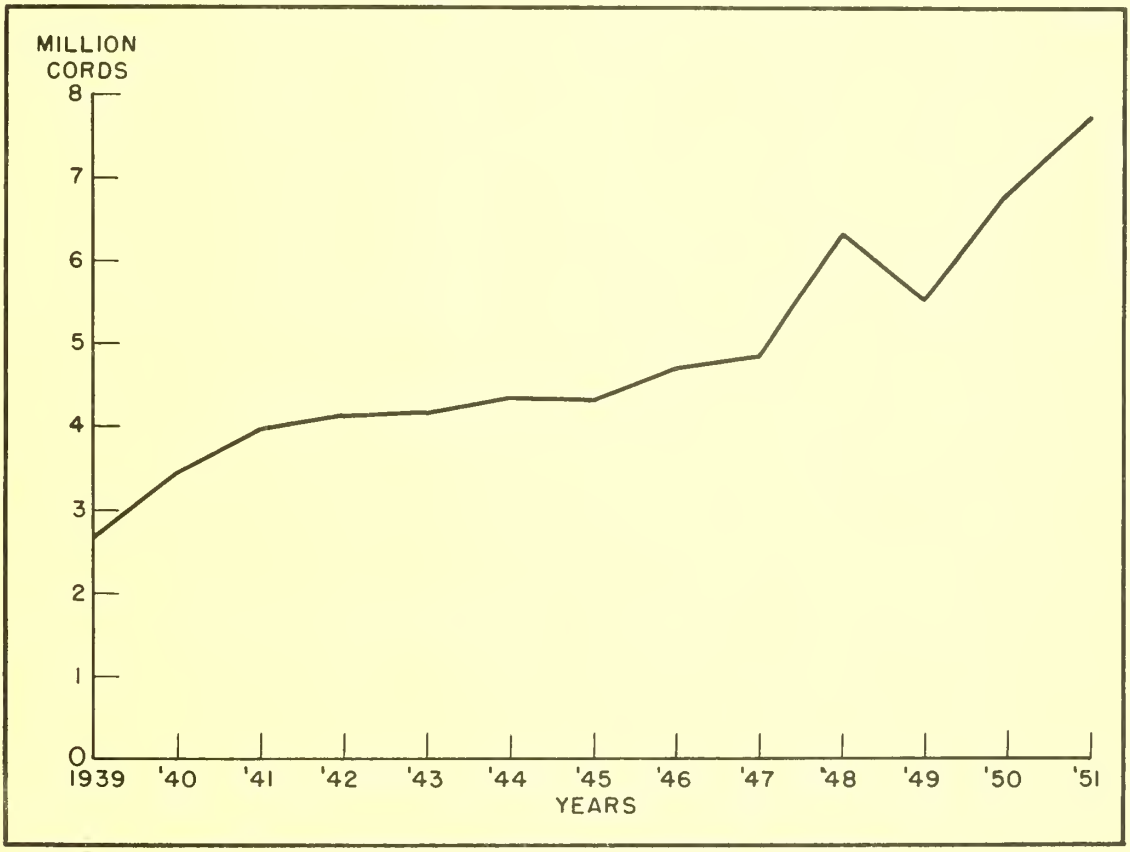
Fire frequency is the ratio of fire occurrence to fire expectance.

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 13 July 1952

PULPWOOD PRODUCTION IN THE SOUTHEAST INCREASES NEARLY 300 PERCENT FROM 1939-1951

In 1939 the pulpwood industry in the five Southeastern States produced 2.7 million cords of wood. Twenty-two pulp mills were operating in the region, but their installed daily capacity was only about 6,000 tons per 24-hour day. By 1951 there were 31 mills in operation and total capacity had been increased to slightly more than 14,000 tons per day. Pulpwood produced for these mills and others drawing from the Southeast amounted to 7.7 million cords, a 290-percent increase.



Trend in pulpwood production in the southeast, 1939-1951

At the beginning of this period all five states produced nearly equal amounts of pulpwood, about one-half million cords annually, but by 1944 Georgia was clearly the leading state and has maintained its leadership up to the present.

As an illustration of the change that has taken place in the last 13 years, almost as much pulpwood was cut in Georgia in 1951 as was cut in the year 1939 in the whole Southeast (see table on the reverse).

U. S. Department of Agriculture - Forest Service

Annual pulpwood production in the Southeastern States, 1939-1951

(In thousand cords)

Year	Florida	Georgia	North Carolina	South Carolina	Virginia	Total
1939	589	543	411	551	578	2,672
1940	704	701	646	670	751	3,472
1941	783	770	789	800	827	3,969
1942	748	945	730	907	806	4,136
1943	690	895	721	987	886	4,179
1944	602	1,109	727	1,054	895	4,387
1945	760	1,245	649	878	799	4,331
1946	865	1,143	710	1,022	971	4,711
1947	882	1,215	765	948	1,025	4,835
1948	1,221	1,771	926	1,108	1,306	6,332
1949	1,036	1,790	802	1,012	895	5,535
1950	1,384	2,221	1,024	1,182	1,044	6,855
1951	1,490	2,370	1,305	1,251	1,326	7,742
	11,754	16,718	10,205	12,370	12,109	63,156

James W. Cruikshank
Division of Forest Economics

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 14 July 1952

CALCIUM CONTENT OF HARDWOOD LITTER FOUR TIMES THAT FROM PINE; NITROGEN DOUBLE

Most Piedmont forests, growing on land worn out by row cropping and abandoned, are low in site quality. They contribute appreciable flood runoff and sediment. Soil structure is poor and nutrient content low. Such improvement as takes place comes generally from litter fall, particularly hardwood leaves.

Studies at the Calhoun Experimental Forest, near Union, S. C., reported in Proceedings of the Soil Science Society of America, January 1952, show that shortleaf and loblolly pine contribute less nitrogen, calcium, and magnesium than any of the other common species. Where it is necessary to increase these elements in the surface soil under pure pine stands, the improvement can be accomplished by favoring a hardwood understory, as the following comparison indicates.

Nitrogen, calcium, and magnesium content of various Piedmont tree species growing in Union County, South Carolina

(In percent of element on oven-dry basis)

Species	Nitrogen	Calcium	Magnesium
Eastern redbud	1.16	2.96	0.22
Eastern red oak	1.00	1.42	0.36
White oak	0.92	1.69	0.30
Blackjack oak	0.85	0.96	0.28
Post oak	0.80	0.97	0.22
Black oak	0.70	1.04	0.23
Southern red oak	0.60	1.06	0.23
Flowering dogwood	0.68	3.38	0.53
Hickory	0.62	2.78	0.62
Yellow-poplar	0.53	2.61	0.72
Red maple	0.51	1.32	0.33
American sweetgum	0.49	1.30	0.47
Shortleaf pine	0.45	0.59	0.19
Loblolly pine	0.31	0.43	0.15

To find the per-acre quantity and quality of litter fall under various Piedmont forest types, measurements were made in nine stands in Union County, S. C., from September 1950 to September 1951. As shown in the following table, although the weight of litter per acre from pure shortleaf stands nearly equals that from hardwoods, the amount of nitrogen returned is less than half, and the amount of calcium less than one-fifth that from hardwood stands. Owners troubled by littleleaf disease in shortleaf stands may find that such differences in nutrient content are important.

Litter fall from forest stands in Union County, S. C.
(In pounds per acre, oven-dry basis)

Stand	Total litter, including leaves, twigs, bark, and fruit	Leaf fall	Quantity of element returned in leaf fall: Nitrogen 1/	Calcium 2/
11-yr-old loblolly plantation	5619	4476	15	21
30- to 40-yr.-old loblolly and shortleaf	4103	2938	13	17
30- to 40-yr.-old shortleaf	4059	3771	12	16
Shortleaf-hardwoods (average of 3 stands)	4762	3472	24	44
Hardwoods (average of 3 stands)	4502	3818	26	88

1/ To get an estimate in pounds of equivalent applied sodium nitrate, multiply by 6.
2/ To get an estimate in pounds of equivalent applied limestone, multiply by 2-1/2.

Louis J. Metz
Divisions of Watershed Management
and Forest Management

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 15 July 1952

SOUTHERN PULPWOOD PRODUCTION HITS NEW HIGH

The South's pulpwood production continued its record-breaking advance by hitting a new high of 14 million cords in 1951. The increase amounted to 1-1/2 million cords, or 13 percent over the total production in 1950. Receipts of domestic pulpwood at all mills in the United States amounted to 25 million cords last year. Thus, the South produced 56 percent of all the pulpwood cut in the Nation. This information appears in a U.S. Forest Service report released by the Southeastern Forest Experiment Station, Asheville, N. C., and the Southern Forest Experiment Station, New Orleans, in cooperation with the Southern Pulpwood Conservation Association.

Pulpwood production for Southern States, 1951

State	1951 Production				1950 total production	Change 1950 to 1951
	Pine	Hardwood	Chestnut	Total		
	Standard Cords					Percent
Florida	1,489,201	1,124	--	1,490,325	1,384,694	+ 7.6
Georgia	2,278,843	78,550	12,750	2,370,143	2,221,279	+ 6.7
South Carolina	1,105,205	145,840	--	1,251,045	1,182,413	+ 5.8
North Carolina	1,053,593	179,651	71,296	1,304,540	1,024,005	+27.4
Virginia	989,205	312,069	25,059	1,326,333	1,044,147	+27.0
Southeast	6,916,047	717,234	109,105	7,742,386	6,856,538	+12.9
Alabama	1,392,180	14,027	--	1,406,207	1,321,204	+ 6.4
Arkansas	521,773	92,019	--	613,792	603,682	+ 1.7
Louisiana	997,193	113,768	--	1,110,961	883,306	+25.8
Mississippi	1,412,167	381,209	--	1,793,376	1,665,863	+ 7.7
Oklahoma	44,618	--	--	44,618	38,831	+14.9
Tennessee	60,464	72,334	58,617	191,415	143,958	+33.0
Texas	1,097,806	60,565	--	1,158,371	922,304	+25.6
Lower South	5,526,201	733,922	58,617	6,318,740	5,579,148	+13.3
Total South	12,442,248	1,451,156	167,722	14,061,126	12,435,686	+13.1
Percent	88.5	10.3	1.2	100.0	--	--

Hardwood pulpwood production increased 28 percent over 1950 in contrast to an 11 percent increase in pine. Each of the twelve Southern States showed increases in total production ranging from 1.7 to 33.0 percent. States showing the largest increases in the volume of pulpwood produced were Virginia, North Carolina, Texas, and Louisiana.

Georgia led all other Southern States with a harvest of 2,370,000 cords, or 17 percent of the cut in the South. Mississippi was second with a cut of 1,793,000 cords. All of the other states except Arkansas, Oklahoma, and Tennessee produced over a million cords each.

It is difficult for the average reader to get a concept of the physical volume of wood represented by 14 million cords. If all this wood were stacked as cordwood in a pile four feet high and four feet wide, it would make a continuous band extending more than four-fifths of the distance around the earth at the equator.

Not all of this pulpwood production came from sound live trees cut from the forests. Estimates based on utilization studies and company records indicate that 8 percent of the total production came from tops and waste material left in the woods following logging operations for other products. Another 8 percent came from dead or cull trees and other material not considered part of the primary growing stock. Forty-seven percent came from sound trees of saw-timber size and the remaining 37 percent from pole-size trees.

The volume of pulpwood production in the South has nearly doubled in the last decade. It now accounts for 18 percent of the total volume of wood produced in the form of sawlogs, veneer bolts and other primary forest products. Lumber accounts for 47 percent, and all other products make up the remaining 35 percent. The outlook for the future indicates a continuation of the upward trend in pulpwood production. Proposed new mills or expansions of existing mills in the South will increase pulpwood requirements by about 6 million cords in the next few years.

J. F. McCormack
Division of Forest Economics

CLEMSON COLLEGE
CLEMSON, SOUTH CAROLINA

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 16 October 1952

BUMPER LOBLOLLY CONE CROP FORECAST FOR VIRGINIA-NORTH CAROLINA AREA IN 1953

Loblolly pines will produce a bumper crop of cones next year in the coastal plain of Virginia and North Carolina, according to a 1-year forecast made in August by forestry agencies in the area. Participating in the forecast were the Division of Forestry of the North Carolina Department of Conservation and Development, the Virginia Forest Service, and the Southeastern Forest Experiment Station.

The forecast is based on a count of the small conelets which will make next year's crop, and a comparison of this count with the number of large cones that are maturing this fall. The comparison shows that over most of the area next year's crop will be somewhat greater than the large crop that will drop seed this year. This information is of value in planning seed-collecting and timber-harvesting operations.

The relative size of the 1952 and 1953 crops and the ratio of the two at 12 different locations are shown in the accompanying table and map.

As indicated on the map, the expected increase in cone crops in 1953 should be greatest near the coast, whereas somewhat smaller crops may be experienced in the inland areas.

The counts were made in stands ranging in age from 40 to 95 years. In one stand, the counts revealed that over half of the current crop of cones was attacked by insects which damage the seeds. In all stands combined, 26 percent of the 1952 cones were attacked.

Methods used in making the cone crop forecast one year in advance, allowing for such things as the defective conelets that will not mature, are explained in an earlier Station publication. 1/ A comparison of 1952 and 1953 cone crops by counties appears on the following page.

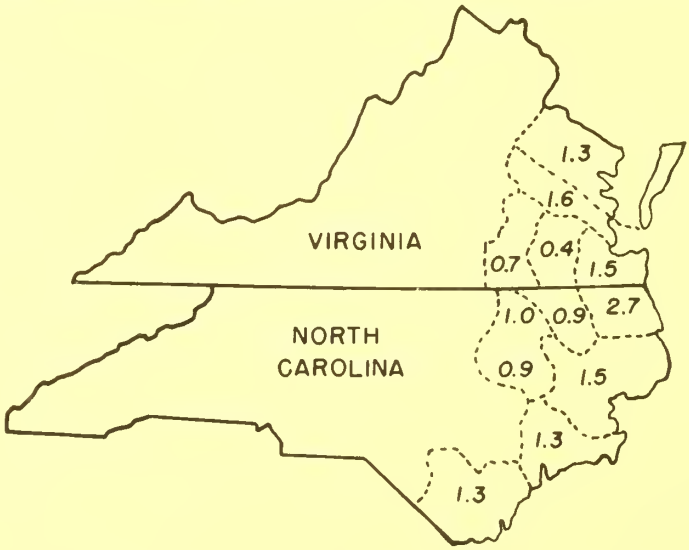
1/ Trousdell, K. B. Forecasting loblolly pine cone crops. Southern Lumberman 183(2297): 137-138. Dec. 15, 1951.

Relative size of 1952 and 1953 cone crops

Location		Cones maturing in 1952	Conelets that should mature in 1953	Cone ratio
State	County			
North Carolina	Pasquotank	135	371	2.7
"	Hertford	303	286	0.9
"	Halifax	293	292	1.0
"	Edgecombe	327	281	0.9
"	Craven	477	706	1.5
"	Onslow 1/	397	502	1.3
"	Bladen 2/	4,308	5,428	1.3
Total		1,932	2,438	1.3
Virginia	Richmond	268	343	1.3
"	Charles City	194	313	1.6
"	Chesterfield	302	216	0.7
"	Southampton	260	117	0.4
"	Nansemond	165	250	1.5
Total		1,189	1,239	1.0
Regional totals		3,121	3,677	1.2

1/ 45-tree samples; all others are 50-tree samples.

2/ Cone counts on entire tops--not included in totals. All others are counts on sample branches.



Ratio of expected cone crop in 1953 to present cone crop in 1952 in Coastal Plain area.

Kenneth B. Trousdell
Division of Forest Management

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

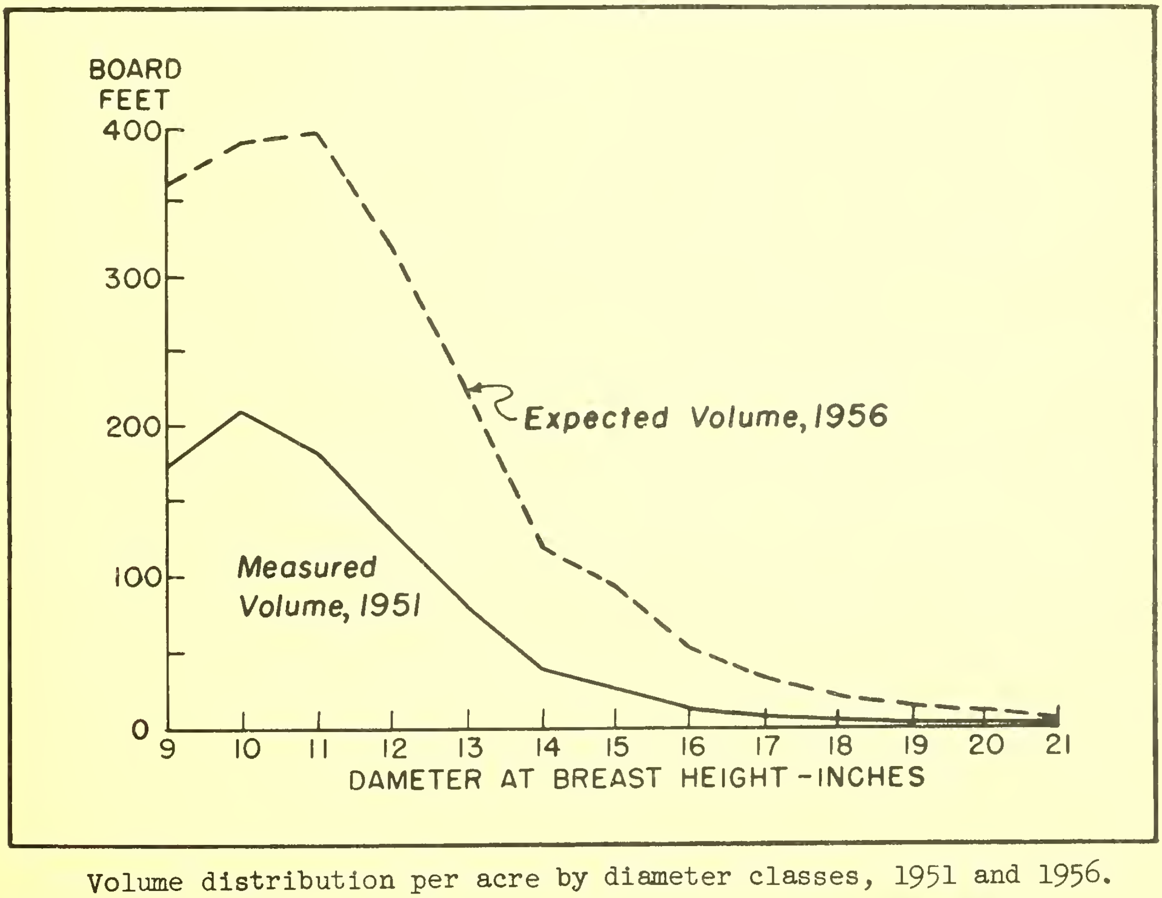
Number 17 October 1952

RAPID GROWTH RATES OF LONGLEAF-SLASH PINE
SAW TIMBER IN THE MIDDLE COASTAL PLAIN OF GEORGIA

Understocked young longleaf and slash pine saw-timber stands on a pilot-plant management area on the George Walton Experimental Forest, representative of the Middle Coastal Plain of Georgia, are increasing at a calculated rate of 27 percent in board-foot volume annually. This is the story told by repeat measurements on 1471 acres of the forest.

These lands have been under intensive management, including rigid fire protection, only 5 years. Although as yet but 56 percent of the total area bears timber in saleable quantities, the following figures are in terms of the average gross acre, for in an investment the poor must be balanced with the good.

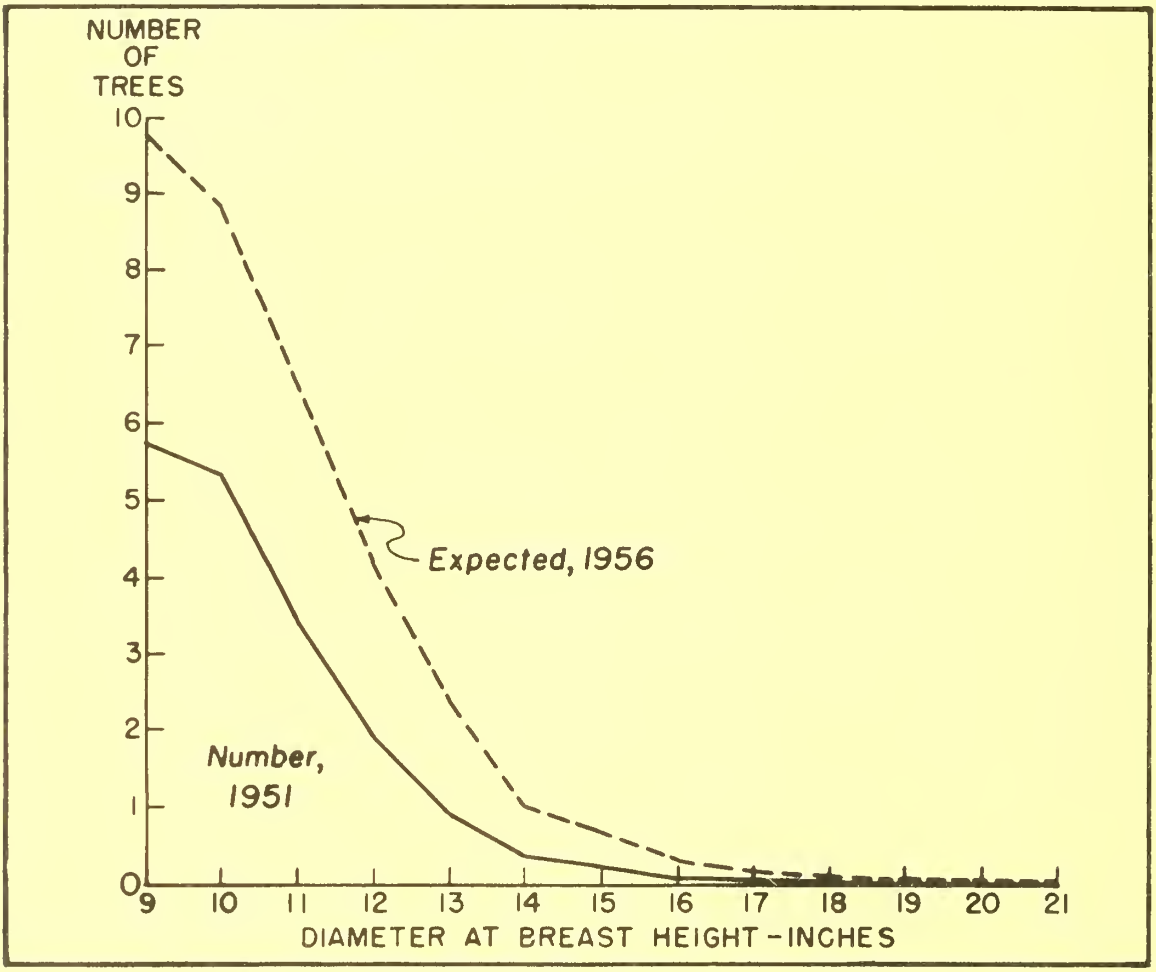
Following the first improvement cut, which removed 784 board feet per acre in diseased, worked-out, and poor-quality trees, 872 board feet were left. Annually this quantity is expected to increase by some 235 feet, or to a total of 2046 feet in 5 years. Quantities present by tree sizes in 1951, following the cut, together with those expected in 1956, are shown graphically on this page.



Volume distribution per acre by diameter classes, 1951 and 1956.

U. S. Department of Agriculture - Forest Service

In 1951, following the improvement cut, the 1471 acres contained an average of only 17.8 saw-timber trees per acre. By 1956 this number is expected to increase to 33.8. Distribution of trees by diameter classes is shown below.



Tree distribution per acre by diameter classes, 1951 and 1956.

The 235 board feet per gross acre is the distribution of annual growth now cumulating in merchantable stands, which comprise but 56 percent of the total area. If the remaining 44 percent carried equivalent stands, the annual growth rate for the whole would approximate 412 board feet per acre.

Norman R. Hawley
Division of Forest Management

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 18 October 1952

REGENERATION OF SOUTH FLORIDA SLASH PINE IS SUBJECT OF NEW RESEARCH

South Florida slash pine, which is often considered a distinct botanical variety of native American slash pine, is known to occur in the ten southernmost counties of Florida, or roughly from the northern edge of Lake Okeechobee to the tip of the peninsula. Within these counties there are approximately 1,750,000 acres of the South Florida slash pine type. Of this, a million acres is denuded pine land which cannot be reforested naturally because it lacks an adequate source of seed. Another half million acres is poorly stocked. If new crops of timber are to be grown, planting or some other method of artificial regeneration will be required on a big scale.

Because the area involved is large and the pine forest lands of the region are capable of producing valuable forest products, research to solve problems of regeneration was begun in November 1951 by the Southeastern Forest Experiment Station in cooperation with the Atlantic Land and Improvement Company, the Collier Company, and the Florida Forest Service. Planting experience in the region goes back only 4 years. In the first 3, North Florida slash pine was planted but failed to survive in sufficient numbers. In the fourth year, seedlings of South Florida slash also failed to become established.

The South Florida slash pine is a unique tree. Though it resembles the common slash pine of the turpentine belt, it is similar to longleaf pine in the slow initial height growth of the seedlings. Its South Florida habitat is likewise unique, consisting of a nearly flat sandy plain with a subtropical climate. Soil moisture conditions alternate from extremely wet in the summer rainy season to nearly arid in the dry, sunny winters.

The wood possesses unusual properties. At Duke University, South Florida slash pine was found superior to other southern yellow pines in all tests except those for elasticity and shear parallel to grain. Thus, it is a superior timber for many construction uses. The specific gravity of South Florida slash pine wood was 0.845, while that of the next highest (loblolly pine) was only 0.593. This higher wood density results in a greater yield of kraft-type sulphate pulp per cubic foot of wood.

Since such a vast acreage is in denuded condition, primary attention is being given to studies of artificial regeneration, with major emphasis on planting of nursery-grown seedlings. Less attention will be given to studies of direct seeding, as this has not been a consistently reliable method in many sections of the United States. Natural regeneration techniques will be studied also, so that full use may be made of existing seed trees.

The importance of learning certain basic facts about the growth characteristics of South Florida slash pine is emphasized by the present limited knowledge of the tree. Such factors as cone and seed production, seed dissemination, viability, germination, and final establishment will have to be investigated in connection with the studies of natural regeneration. A study of normal growth characteristics of the seedlings from germination to the end of two years will be commenced. Rates of height and diameter growth, and root growth characteristics of different individuals under different conditions of site will also be investigated. This area, one of the first in America to be explored, is one of the last in which we are getting down to study the life history of the leading timber tree.

David F. Olson, Jr.
Division of Forest Management

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 19 October 1952

ANNUAL SUMMER FIRES KILL HARDWOOD ROOT STOCKS

Hardwood root stocks are seldom killed by frequent winter burning. Even after five consecutive annual winter fires, we have observed no diminishing in the sprouting vigor of understory hardwoods in the loblolly pine type of the South Carolina flatwoods. On the other hand, three or four consecutive summer fires not only kill many root stocks but also reduce the size and vigor of the sprouts of surviving root stocks. Perhaps even these weak sprouts can be eliminated by further summer burning.

Tallies show that about 50 percent of the small hardwood population was permanently eliminated by four consecutive summer fires and that the ground cover of tree and shrub species was reduced by two-thirds, as compared to annual winter fires.

	Living sprout clumps of tree species (Number per acre)	Ground surface covered by trees and shrubs (Percent)
Annual summer fires:		
Plot 7	3600	8
Plot 17	3600	10
Plot 21	5500	14
Mean	4200	11
Annual winter fires:		
Plot 4	7000	32
Plot 19	9900	33
Plot 20	8100	24
Mean	8300	30

Summer fires, of course, are hotter and more destructive than winter fires. The air temperatures averaged in excess of 90° F at the time of summer burning, and only 50° during the period of winter fires. Our summer fires were all June fires, somewhat earlier than the period of lowest food reserves. Presumably, however, repeated burning has depleted the food reserves of roots already weakened by previous fires. At any rate, further studies are under way in which more precise observations are being made of the effect of these fires on different tree and shrub species.

L. E. Chaiken
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Agriculture-Asheville

U. S. Department of Agriculture - Forest Service

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 20 October 1952

10-YEAR DIAMETER GROWTH OF SELECTED TREE SPECIES IN SOUTH GEORGIA

Foresters, timber owners, investors, and others often need to know the diameter growth of different tree species of various sizes. The values shown below are derived from a sample of trees, of all crown classes and sizes, taken in the same proportions as they occurred in the forests of the coastal plain of Georgia. The 10-year growth is that which occurred after the trees reached the indicated diameter class, i.e., 6-inch longleaf pines grew 2.8 inches in 10 years and at the end of the period were 8.8 inches in d.b.h. Bark growth is included.

Inches of diameter growth in 10 years

Species	Diameter-class (inches) 1/								Average all diameters	Basis, no. of trees
	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0+		
Softwoods										
Slash pine	2.4	2.4	3.4	3.4	2.9	2.6	2.3	2.3	2.6	635
Longleaf pine	2.8	2.3	2.2	2.5	2.0	1.4	1.3	--	2.3	348
Loblolly pine	3.7	4.1	4.3	3.9	2.9	2.4	2.4	1.9	3.3	455
Pond pine	3.0	3.2	3.4	3.2	2.1	1.7	2.5	2.1	2.6	107
Pond cypress	0.8	0.7	0.8	0.6	1.1	0.9	0.8	1.0	0.8	231
Hardwoods										
Black gum	1.5	1.7	1.6	1.9	1.9	1.7	1.9	1.7	1.7	365
Sweet gum	1.9	1.8	2.1	3.2	2.2	2.1	1.9	1.6	2.1	197
Yellow-poplar	--	4.4	4.2	3.4	2.9	2.5	2.6	2.2	3.2	90
Sweetbay	1.8	1.9	2.6	2.4	1.7	1.6	1.5	2.3	2.0	80
Water oaks	2.1	2.2	3.7	2.6	2.5	2.2	2.5	2.8	2.6	295

1/ Each class includes diameters 1.0 inch below and 0.9 inch above the stated midpoint.

Other species which were sampled too lightly to provide reliable growth data by diameter class had the following average growth for all diameters: swamp chestnut oak--2.7 inches; red maple--2.1 inches; hickories--2.0 inches; ash--1.9 inches; white oak--1.5 inches.

James W. Cruikshank
Division of Forest Economics

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U. S. Department of Agriculture - Forest Service

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 21 October 1952

EXTENT OF LOSS OF LOBLOLLY PINE SEED IN WINTER FIRES

When prescribed fire is used to prepare a seedbed to regenerate loblolly pine, the practice has been to burn during September or October, prior to the seedfall. Later burning, it has been reasoned, would destroy the seed. Yet there are areas burned by wildfire during the spring--February and March and even in April--on which we have observed pine seedlings later in the spring and summer. We thought that these seedlings arose from seed that had filtered down into the lower litter and were not consumed by slow fires that merely burned the upper dry litter. We wondered whether it might be possible to prepare seedbeds by winter or spring burning, when the fuels are cured and more readily burned than during the late summer.

A small study was made during the seeding year of 1950-1951. Two plots were burned prior to seedfall and five were burned with different intensities during February and March 1951. In May, the following tally was made of germination:

	Seedlings per acre (Thousands)
Burn before seedfall	4.2
Light fire after seedfall	1.8
Medium fire after seedfall	0.5
Hot fire after seedfall	0.5

Obviously, many seed are destroyed by fire. And, from the tally, it seems that the hot fires destroyed more seed than the slow fires. However, many seedlings on the light-fire plots were in small unburned spots that were naturally protected from fire. Since the light fires were run during periods of low danger rating, they did not burn over every bit of the ground surface; hence some survivors. Furthermore, it was apparent that some of the seedlings on the hot-fire plots could not have come from seed that escaped the fire. The only plausible explanation is that these seed were disseminated after the fire.

The study was run again during the 1951-1952 seeding year with fires before seedfall and during February after the bulk of seedfall. This time, records were made of the seedfall after fire, and only those seedlings arising on burned spots were counted.

Seed disseminated and seedling catch on areas burned before and after main seedfall
(In thousands)

Treatment	Viable seed disseminated per acre		Seedlings per acre
	Before fire	After fire	
Burn before seedfall	--	91.0	7.8
Light fire in Feb. before main seedfall	69.0	3.0	1.9
Hot fire in Feb. after main seedfall	99.2	.8	.6

It seems certain now that on areas burned after the bulk of the seedfall, seedlings arise either from seed that happen to lodge in sheltered and protected spots or from seed disseminated after the fire. Furthermore, it is unlikely that sufficient seed will be disseminated during February and March to restock an area adequately, for records of 6 years of seedfall in coastal South Carolina show that from 92 to 100 percent of all viable seed has been disseminated by February 1st.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 22 January 1953

PRESCRIBED BURNING TO REGENERATE SAND PINE

Killing wildfires in mature sand pine stands are usually followed by dense stands of reproduction. The persistent, closed cones are opened, tremendous quantities of seed fall on a receptive seedbed, and a new stand takes over. Although some of the fire-killed merchantable timber is salvaged, much is lost. Conventional silvicultural methods are usually not effective in obtaining the desirable minimum of 500 stocked milacres per acre. One of the questions confronting local foresters at this time is whether fire can be controlled in the sand pine type and used as a regeneration tool without the loss of wood. To answer this question fire was used on several test plots of 10 to 20 acres on the Ocala National Forest during the latter part of August, 1951.

On one plot, a backfire (surface fire) was run through a mature stand just prior to cutting. A few individual trees were killed by scorch, but general observations indicated that the remaining trees were not damaged, although a clean seedbed was prepared and some hardwood control achieved. Cutting was completed during September and October, and the cones on the slash near the surface of the ground opened and released seed. Germination followed during the winter months. One-year reproduction counts indicated that the plot supported approximately 1618 seedlings per acre with a milacre stocking of 64 percent.

On another plot, an attempt was made to back a fire through a freshly-cut stand. The fire, however, would not run and settled in the slash piles where it consumed the cones and seed. Many of the residual trees were killed by the fire. Because the residual trees held a meager seed supply and the seeds on the ground were destroyed, reproduction on the area has been scarce.

Headfires were used on three plots: a freshly-cut stand, a 1-year-old cut, and a 2-year-old cut. The residual trees, which averaged about 30 to 40 per acre, were counted on as seed trees, although they were left because of their unmerchantability rather than their qualification as seed trees. The majority of these trees were killed by the fire, the cones opened, and the seed was released. New seedlings appeared about 4 months after the burn. Most of the seedlings were found in the vicinity of the better seed trees. One-year reproduction counts reveal that headfire in the fresh cut and the 1-year-old cut has resulted in adequate stocking.

It is dangerous to recommend prescribed burning in the sand pine type until tests are made to determine the times of the year when burning of this sort is safe and practical. We also need to know the maximum time interval permitted between burning and cutting, and the number of required seed trees where a headfire is used. If practical answers to these problems can be worked out, prescribed burning may become an inexpensive and effective method of obtaining reproduction.

R. W. Cooper
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U. S. Department of Agriculture - Forest Service

RESEARCH NOTES

SOUTHEASTERN FOREST EXPERIMENT STATION

Asheville, North Carolina

Number 23 January 1953

VIABILITY OF SAND PINE SEED

Sand pine trees usually produce heavy cone crops every year. The cones are persistent and seldom open at any time of the year on live trees on the Ocala National Forest. Hence seed is stored on the tree in closed cones of different ages. The viability of the seed within these closed cones is essential knowledge for regeneration and cone collection work.

Preliminary germination data, taken from petri-dish tests of January 1950 and based on total extracted seed from the cone crops of 1949 through 1945, show a rapid reduction in viability with age of cones. This apparent loss of viability cannot be attributed entirely to cone age, because it is also influenced by the rather erratic fluctuation in soundness of the new seed crop from year to year. The fact that soundness is not correlated with the year of maturity as shown by the lack of a definite trend in figure 1, where soundness of seed (based on cutting tests) is plotted against year of maturity. Soundness of seed also varied significantly from place to place on the Ocala National Forest, but this effect was not the same for any one location every year.

Assuming that the percentage of sound seed in any crop depends primarily on conditions at the time of pollination and during the 2-year maturation period, then loss of viability attributable to length of storage in the cones on the tree can be estimated by basing viability percentages on sound seed only, as in figure 2. Here a definite downward trend is apparent in viability of sound seed with increasing age. This relationship is based on viability as determined in June of 1950 on seed from the previous five annual crops. Seed tested from fresh cones collected in September, October, and November of 1950, show that the peak of viability (approximate maturity) was reached sometime between September 10 and November 10, probably during October.

Lopping the tops of harvested trees and scattering the branches on cut-over areas is used to hasten cone opening and help distribute seed. Since the viability of sound seed decreases with age, it is more economical and practical to concentrate on the branches bearing the most current cones. It is advisable to restrict cone collection work to the good seed years whenever possible. The greatest yield of viable seed per bushel of cones can be obtained by waiting for a cone crop in which the seed are at least 60 percent sound as determined by a cutting test, limiting collection to the current year's crop, and making the collection shortly after maturity.

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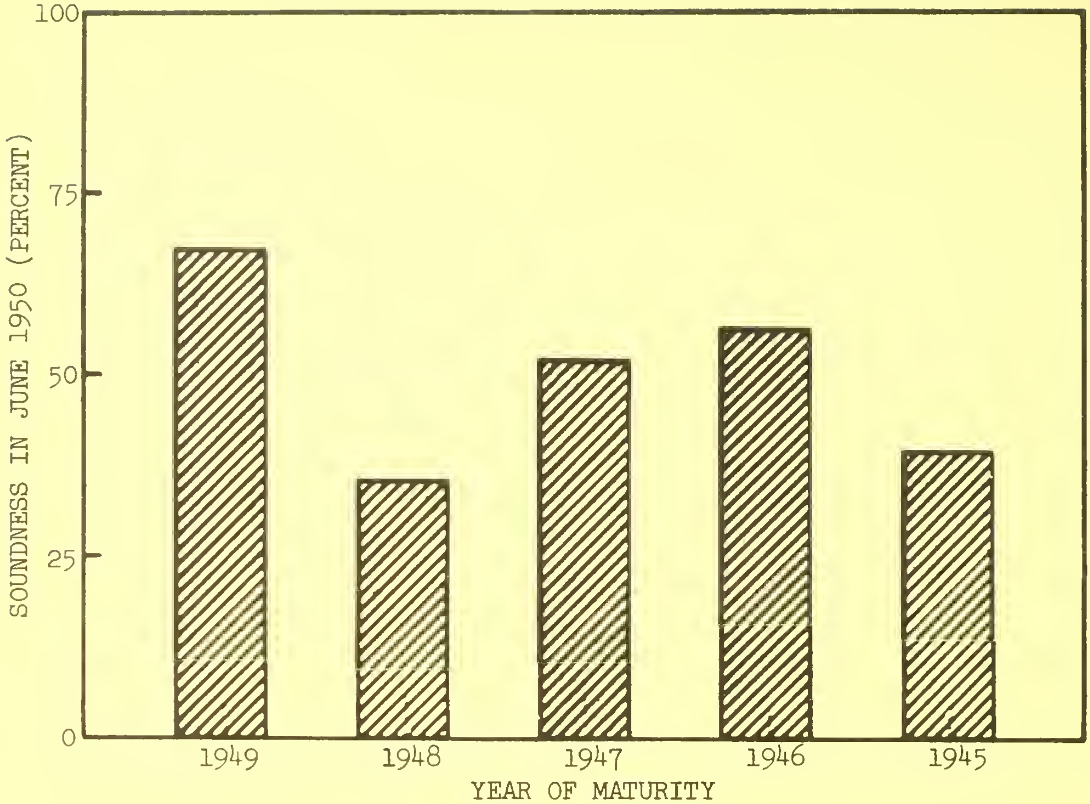

Figure 1.--Variation in percent of sound sand pine seeds with year of maturity.

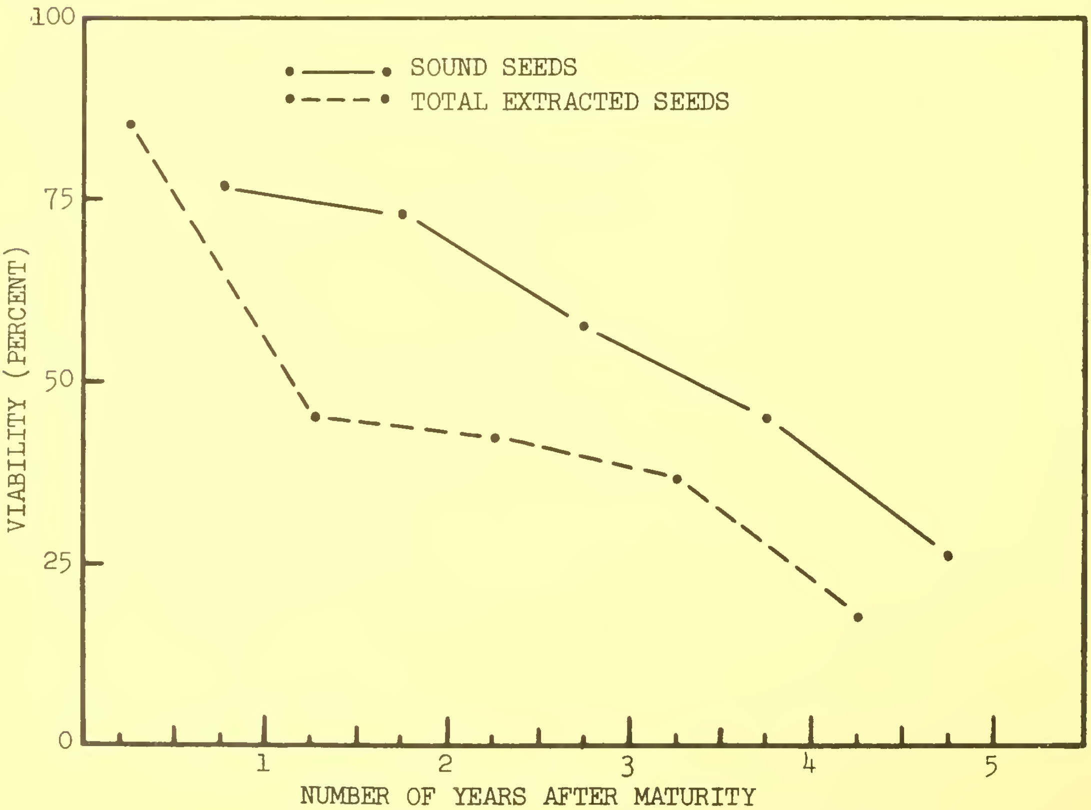

Figure 2.--Viability in 1950 of sand pine seeds for the previous five annual cone crops.

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 24 January 1953

HOW DRY WERE SOUTHERN APPALACHIAN FORESTS IN THE FALL OF 1952

Southern Appalachian forests were dry during the latter part of October and early November 1952. There were many fires during this crucial period and the heaviest concentration of fires was in eastern Tennessee. On the Cherokee National Forest alone some 43,000 acres of forest land burned in 48 fires, and at least 2,500 men were fighting fire there during the peak-load days. In other parts of the southern mountains, national forest and State fire fighting crews were strained to the utmost. The Pisgah Forest had 47 fires which burned a total of some four thousand acres. Fifteen thousand acres burned on the Nantahala Forest in 35 fires. The Chattahoochee had 45 fires, burning 6,484 acres.

Some fire control men consider it the driest season they have ever experienced. In view of this speculation on just how dry it was, available data are timely. They are also rather sketchy, since complete records are available from only one southern mountain danger station--that at Bent Creek, near Asheville.

The dryness of forests in that area is rated on the back of this page in terms of four indexes--rainfall, cumulative danger index, moisture in the lower litter, and burning index--all indexes of forest flammability. The shading designates the period (October 17-November 8) when the western districts of the Pisgah National Forest and the North Carolina Forest Service had their most serious fires. Similar conditions extended over a broad area, in fact most of the eastern and southern States.

The moisture content in the lower litter, based upon a system of estimating not yet a part of danger meters, averaged about 80 percent when the trouble started. The figure undoubtedly was lower for exposed aspects, so on these aspects the lower litter probably burned rather readily on October 17th. The moisture content continued to drop and for practical purposes reached a minimum owing to evaporational losses on most aspects by October 29 and remained approximately at that level until November 10. The two peaks in fire job load (October 25-30 and November 6) occurred while the moisture content was at or near the minimum.

Burning index varied during the bad period, but averaged about 40, which is a high average for 23 consecutive days. The peaks in fire job load are closely correlated to the high burning indexes.

Both indexes--lower litter moisture and burning index--indicate that the dryness of the forests practically stabilized at a minimum within a few days after the job load became heavy, and thereafter remained practically static throughout the dangerous period. Fluctuations in burning index are attributable chiefly to variations in wind velocity. Dangerous conditions usually do not persist for such a long time and neither do they cover so broad an area as last fall. The unusual may not soon happen again, but it could happen again next year.

This year the burning index showed as early as October 20 that unless we got rain we were in for it. It will give the same warning in the future, particularly if a greater number of suitably located, well operated fire danger stations are furnishing reliable data promptly to fire control men who are trained to gage the trends.

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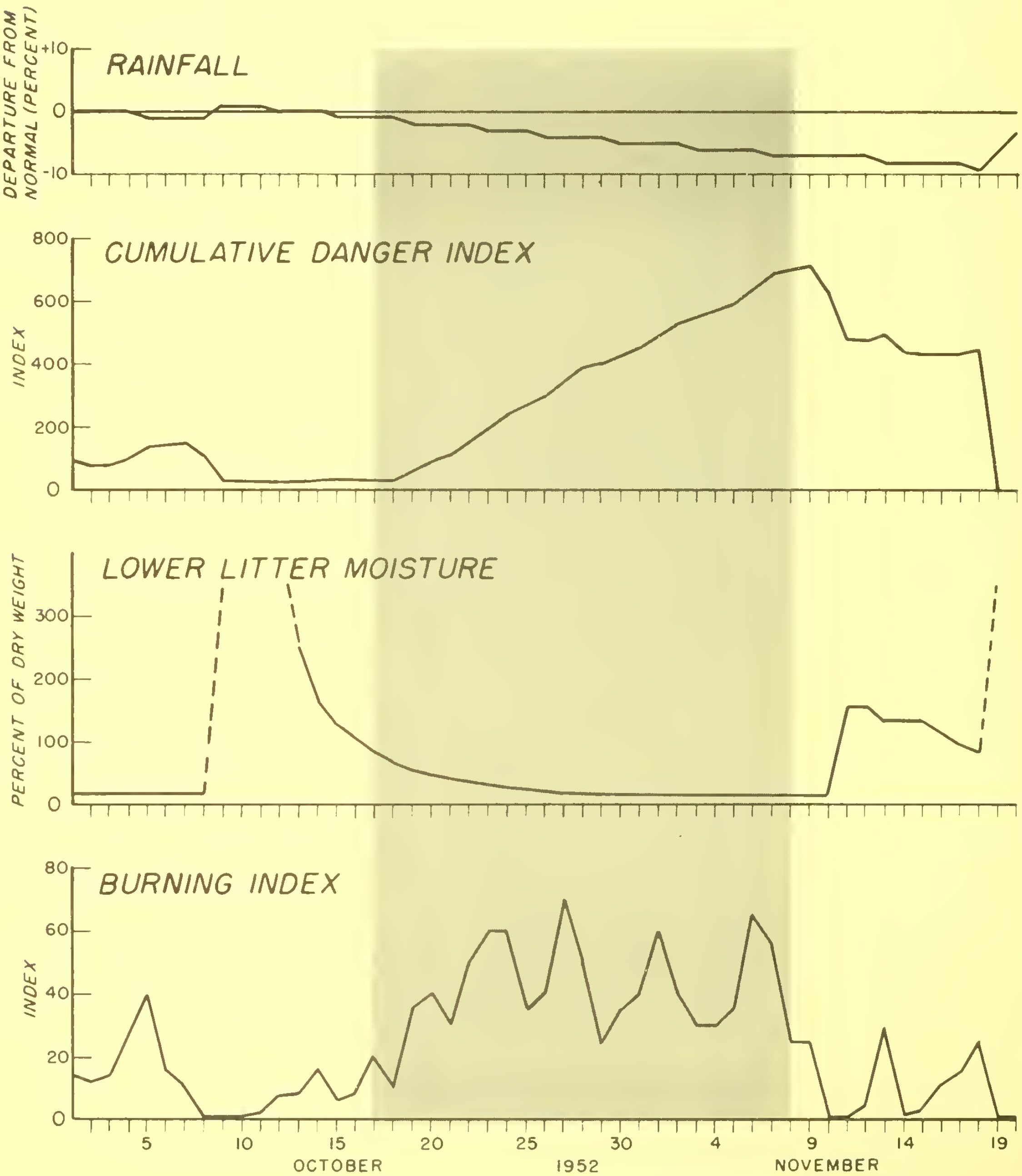

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 25 January 1953

ESTIMATING BOARD WIDTHS OBTAINABLE FROM PINE TREES OF DIFFERENT DIAMETERS

Lumber from the pine "roofer" belt of the southern Piedmont, extending from Virginia to Mississippi, is marketed primarily on the basis of board width. Timber buyers and appraisers might gage the value of a tract of timber more accurately if they had an estimate of the percentages of various board widths which might be produced from a particular stand.

A table prepared by Telford and McMillen[1/] was modified to provide an estimate of such percentages in timber appraisals at the Hitchiti Experimental Forest, near Macon, Georgia (table 1). All of the widths apply to 1-inch stock only.

Table 1.--Board widths cut from loblolly and shortleaf pine trees of different diameter

(In percent of total)

D.b.h. class (Inches)	Board width (1" thickness)					
	4"	5"	6"	8"	10"	12"
10	28	18	52	2	--	--
12	18	11	54	17	--	--
14	10	5	37	43	5	--
16	7	3	27	37	26	--
18	5	2	21	28	40	4
20	3	1	16	19	38	23
22	2	1	12	16	34	35
24	2	1	8	13	21	55

Over a period of several years it has been possible to check the accuracy of table 1 by comparing the actual with the estimated board-width percentages obtained from a number of timber sales (table 2). A 100-percent inventory provided an accurate estimate of the timber volume by diameter classes in each sale. The estimated percentages in table 2 were obtained by multiplying the volume within each diameter class by the appropriate figures in table 1, adding the volumes for each board width, and calculating what percent each is of the total sale volume. Actual board-width percentages were taken from a mill-tally record made

1/ Telford, C. J. and M. M. McMillen. Logging and milling costs and yields, production standards, and log and tree grades on a roofer operation in South Carolina. Forest Products Laboratory Project L-260-2. 1935.

at a portable sawmill which manufactured the lumber from each timber sale. There were no 5-inch widths cut by the portable sawmill, so the 4- and 5-inch-width percentages have been combined.

Table 2.--Actual versus estimated board widths obtained in a pine roofer operation in stands of different average tree diameter

(In percent of total)

Average d.b.h. of stand (Inches)	Volume cut	Basis	Board width (1-inch thickness)				
			4" & 5"	6"	8"	10"	12"
	M.bd.ft.						
12.4	233	Actual	26	46	26	2	--
		Estimated	27	45	22	5	1
12.5	105	Actual	30	36	30	4	--
		Estimated	26	44	23	6	1
12.5	223	Actual	30	39	29	2	--
		Estimated	24	43	25	7	1
12.9	258	Actual	26	36	31	7	--
		Estimated	23	41	25	10	1
13.3	49	Actual	25	35	24	16	--
		Estimated	19	37	25	13	6
14.1	104	Actual	23	27	24	26	--
		Estimated	16	30	23	16	15
14.2	75	Actual	18	34	35	13	--
		Estimated	17	36	29	15	3
14.8	68	Actual	15	32	42	11	--
		Estimated	15	33	34	16	2
16.5	27	Actual	18	20	25	21	16
		Estimated	14	22	25	25	14
17.9	7	Actual	11	22	30	13	24
		Estimated	7	20	24	27	22
	Average	Actual	25	37	29	8	1
		Estimated	22	40	25	10	3

The degree of conformity shown by actual and estimated percentages in table 2 indicates that the data in table 1 do provide a reasonably accurate estimate of board-width percentages from a pine stand of known diameter composition. Although board-width yield shows a relationship to average d.b.h., it will be further influenced by the diameter distribution of the stand to be cut. Such things as skill of sawyer and edgerman, or type, size, and condition of sawmilling equipment, would affect board-width percentage outturn in individual cases.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 26 January 1953

USE OF A SHORT-HANDLED PLANTING HOE IN THE APPALACHIANS

Because forest planting in the Southern Appalachian Mountains in the past has been sporadic, it has too often been done without the benefit of detailed knowledge of methods or suitable tools.

Knowing how to plant ornamental or fruit trees does not necessarily bring skill in forest planting, because the two are quite different. For example: a gardener digs a hole to accommodate the natural spread of semi-rigid roots, puts good loose dirt back to cover those roots, puddles the soil with water, and tamps in unfavorable portions of soil last. Such a procedure is appropriate in horticulture because the trees are larger, but is all wrong for extensive planting with the relatively small 2-year-old conifers distributed by forest nurseries. The forestry job calls for adequate slits in the soil rather than large holes. The flexible roots need deep rather than wide setting. Instead of loose soil settled with water, the forest planter frequently has to exert strong pressure on stiff soil to gain firm contact with roots. If he imitates the gardener he may get high survival, but he wastes his time.

Unsuitable tools likewise contribute to inefficiency. Planting machines are primarily for level or gently rolling lands. On mountain jobs it is feasible to use farmers' spades, mattocks, or grub hoes, but with these the planting is unnecessarily slow and often of poor quality. They were not made for the job. A better tool is the long iron dibble or planting bar of the South. If you must use hand tools, the bar is best in the coastal plain and on the flat lands in the Piedmont or Appalachian country.

For hillsides and mountain slopes there is a still better tool, the one-hand planting hoe. It is a short-handled hoe with a narrow blade 9 inches long, developed by the Forest Service in western Montana and northern Idaho (Region 1). There it was thoroughly tested, adopted as standard, and has given good service for 30 years or more. Men who set 800-900 trees per day with the old tools immediately began to put in 1100-1200, with no loss in quality of planting. That was about 35 percent gain in efficiency.

We felt that this tool could work in the Appalachians as well as it has in the Rockies. Because a short-handled hoe is too hard on a man's back when used for planting on flat land, we limited our use of the bar and tree-carrying tray to the bottomland sites. On the slopes we used the new equipment (furnished by Region 1), which included a planting hoe and a watertight canvas tree-bag for each planter. We tried the outfits on laurel replacement work and on inter-planting on the Bent Creek Experimental Forest.

The first thing the men noticed was the difference in weight of the equipment. Together, the bar and tray weighed 17 pounds, 1 ounce; the hoe and bag 4 pounds, 11 ounces--a saving of 12 pounds, 6 ounces per man. This is an appreciable advantage when working over rough ground.

Each member of a two-man planting crew (hole maker and tree setter) occasionally has to wait a few seconds for his companion to complete his task. This is avoided when each man does the whole job. When a worker charged with correct root placement has to widen the slits into proper holes himself, he is directly interested in and solely responsible for quality planting. Designed as a one-hand tool, the short-handled hoe is ideal for a one-man-unit crew. Except on difficult, obstacle-ridden sites, the division of labor between his two hands is complete, i.e., he manipulates the hoe with one hand and the seedlings with the other. With these motions coordinated in trained planters, the need for a tree-toting assistant is eliminated and maximum efficiency attained.

Although our crews have not reached the degree of perfection possible from long experience, their output is rising. On an average mountain site each man can put out about 100 trees an hour. Less can be set on rocky sites and in spot planting, as in under-planting or what is sometimes called reinforcement planting. Experienced planters can probably do still better in uninterrupted work on good sites.

The use of this tool is completely described in Station Paper No. 12.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 27 January 1953

ESTIMATING TIME REQUIREMENTS FOR TREE POISONING WITH AMMATE

The establishment and growth of pine can be seriously retarded by inferior hardwoods in a dominant position in a mixed stand. Eliminating such competition is part of a large-scale test of different methods of managing shortleaf-loblolly pine stands at the Hitchiti Experimental Forest, near Macon, Georgia.

During 1950 and 1951, hardwood control jobs were done by stem-wise treatment with Ammate in notches on seven compartments, each about 40 acres in size. The species treated consisted mainly of sweetgum, hickory, dogwood, and poorly formed oaks. Some 9600 stems were treated, of which 82 percent were under 6 inches diameter breast height, 17 percent from 6 to 11 inches, and 1 percent 12 inches and larger. There was a range of 13 to 48 stems per acre, and 2.9 to 5.4 square feet of basal area per acre.

The working crew consisted of two axe-men cutting notches and one man applying the chemical. Instructions were to give stems 3 inches and less in diameter breast high a heaping tablespoon of Ammate in a V-shaped stump, and stems 4 inches and larger a heaping tablespoon in a number of notches equal to half the stem diameter. A record of total time spent on each compartment was kept. Time spent for lunch and transportation to and from the job was not included.

A regression analysis of the time data showed that number of stems treated per acre and the sum of the d.b.h. of the treated trees are significantly correlated with man-hours of labor required per acre. A formula for estimating the time it takes to do a hardwood control job with Ammate in notches was derived where man-hours of labor per acre=0.009 (sum of diameters)-0.005 (N).

In the above formula, "sum of diameters" refers to the treated stems per acre, and N is the number of stems treated per acre.

Thus, if the area to be treated has 40 stems per acre averaging 5 inches d.b.h., the sum of their diameters is 200, and the total labor time required to do the job=0.009 (200) - 0.005 (40)

=1.80 - 0.20

=1.60 man-hours per acre.

If the treated stems are predominantly in the smaller diameter classes (under 6 inches), a rough estimate of time required can be obtained from a rule-of-thumb formula where man-hours labor per acre equals one-third the basal area in square feet per acre.

No precise record of the amount of chemical used on each compartment was available, but it should average about 4 pounds per 100 inches of diameter treated. This is at the rate of 1 to 1 1/2 ounces of chemical per notch. On a basal area basis for small stems, it will be about 1 1/2 to 2 pounds per square foot of basal area treated.

A complete treatment of all the various methods of chemical control of inferior trees may be found in Station Paper No. 10, by L. E. Chaiken, obtainable on request from the Southeastern Forest Experiment Station.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 28 January 1953

RELATION OF TREE SIZE TO PRODUCTION RATES WHEN CUTTING PINE PULPWOOD WITH A CHAIN SAW

It takes almost two and one-half times as long to fell, limb, and buck a cord of pine pulpwood from 5-inch trees as it does from 10-inch trees, according to results of a study of a power-chain-saw operation on the Hitchiti Experimental Forest near Macon, Georgia.

The actual man-hours expended in cutting pine pulpwood on different operations will vary according to crew organization and type of equipment used. Therefore, the effect of tree size on rate of production is best expressed as a percentage relationship. This relationship is shown in table 1, using a 10-inch, 7-bolt tree as a base.

Table 1.--Relative production time per cord for cutting pine pulpwood, by tree size

(In percent of time required for 10-inch, 7-bolt tree)

D.b.h. (Inches)	Number of 5 1/4-foot bolts								
	1	2	3	4	5	6	7	8	9
5	261	240	220						
6		197	186	177					
7			156	151	145	139			
8				130	126	123	120		
9					112	112	110	107	
10					98	100	100	100	
11						90	93	93	93
12						81	84	86	87

This table shows that if it took 100 man-hours to cut a given amount of pulpwood from 10-inch, 7-bolt trees, it would take 145 man-hours to cut the same amount from 7-inch, 5-bolt trees, or 86 man-hours if cut from 12-inch, 8-bolt trees. It should be noted that diameter has more effect on production rate than does height. But in trees 10 inches and larger it actually takes a little longer to cut a cord of wood from tall trees than from short ones of the same diameter, probably because of the additional limbing required on the taller trees.

This effect of tree size on production rate was established from time records kept on each of 722 trees ranging in size from 5 to 12 inches in diameter at breast height. Cutting was done by an experienced two-man crew using a 3-H.P. chain saw with bow attachment. After felling was completed, one man would mark off 5 1/4-foot bolts and limb the tree, while the other man did the bucking.

A regression analysis to determine the effect of tree basal area at breast height, number of bolts per tree, and total basal area of the bolts per tree showed that each of these factors had a highly significant effect on rate of production. The analysis considered only the time spent on individual trees, commencing with the start of the felling operation and ending when the last bolt was cut. Delay time, or non-effective time due to walking between trees, swamping, hang-ups, equipment delays, etc., was excluded from the analysis since it is not considered to be associated with tree size.

The actual man-hours per cord required to fell, limb, and buck average-height trees of varying diameter were calculated from the regression equation (table 2). These figures represent only 60 percent of the total time spent on the operation. The remaining 40 percent is constant regardless of tree size and is subdivided as follows: 20 percent for walking between trees and occasional swamping, 17 percent for on-the-job equipment delays, and 3 percent for hang-ups.

Table 2.--Man-hours per cord to fell, limb, and buck pine pulpwood, by tree size

D.b.h. (Inches)	Felling	Limbing & bucking	Total
	Man-hours	Man-hours	Man-hours
5	0.65	0.93	1.58
6	0.44	0.78	1.22
7	0.33	0.67	1.00
8	0.28	0.57	0.85
9	0.24	0.52	0.76
10	0.22	0.47	0.69
11	0.20	0.44	0.64
12	0.19	0.41	0.60

To convert net man-hours per cord to total including delay time, it is necessary only to divide the figures in table 2 by .60. The above rates may may have value for comparison purposes, but should not be used directly unless they are being applied to a similar operation.

The results of many studies, most of them made before the adoption of chain saws, have definitely established the significant effect which tree size has on rate of production, not only in the cutting phase but in loading and unloading as well. The large amount of time required to produce wood from small trees has many implications for the forest manager. The main value of the time data are that they enable the manager to put an economic value on the wood in trees of different size. This value is very low for small trees when cut for pulpwood by methods now in use.

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Hitchiti Research Center

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 29 January 1953

GUM YIELDS IN LONGLEAF PINE ARE INHERITED

Evidence just obtained shows for the first time that gum yield is an inherited character in longleaf pine. The gum-yielding capacity of individual trees in natural stands varies considerably, and naval stores producers occasionally have to provide one or more additional cups to hold the gum from unusually high yielders. Part of the variation in yields can be attributed to soil and moisture conditions, location in the stand, size of tree, crown development, and method of working, but the results of this study show that the genetic make-up of the tree also has a significant effect on gum yield.

In 1935 T. A. Liefeld started the first test of gum-yield inheritance of longleaf pine at the Lake City Research Center. Wind-pollinated cones were collected from longleaf pines whose gum-yielding ability had been determined during tests of commercial turpentining practice. The trees selected for cone collection were neither the lowest nor the highest yielders. One group of selected trees had gum yields ranging from slightly below average down to two-thirds of average, and the second group ranged from slightly above average to one and one-half times average yield. The seedlings in this one-parent progeny test were planted on the Olustee Experimental Forest in 1936.

During July 1952, 17 saplings from the below-average producing mother trees and 17 saplings from the above-average trees were tapped to determine their gum yield. These saplings varied from 3.1 to 6.2 inches in diameter at breast height. The gum was collected during a 4-week period from two punch wounds, each 3/4 inch in diameter, freshened once at the end of the second week. The wounds, placed close to the base of each tree were treated with a 50-percent solution of sulfuric acid. The gum was collected in paper cups stapled to the trees. The final yield included the weight of the crystallized gum which had accumulated on the wound.

The results are shown graphically in the diagram. Gum yields were plotted over diameter at breast height and a regression line was fitted to the data for each of the two groups of trees to reveal the effect of diameter on gum yield in each group. Since the difference in slope between the two lines was not statistically significant, parallel regression lines were fitted to the data. These data show that gum yield is related to tree diameter within the range studied. The statistical test showed that the difference in level of the two regression lines was highly significant. This indicates that the gum yields of 17-year-old longleaf pines from above-average mother trees are significantly higher than the yields from below-average trees.

Further tests will be made at a later date to see if these results hold for the same trees as they become mature.

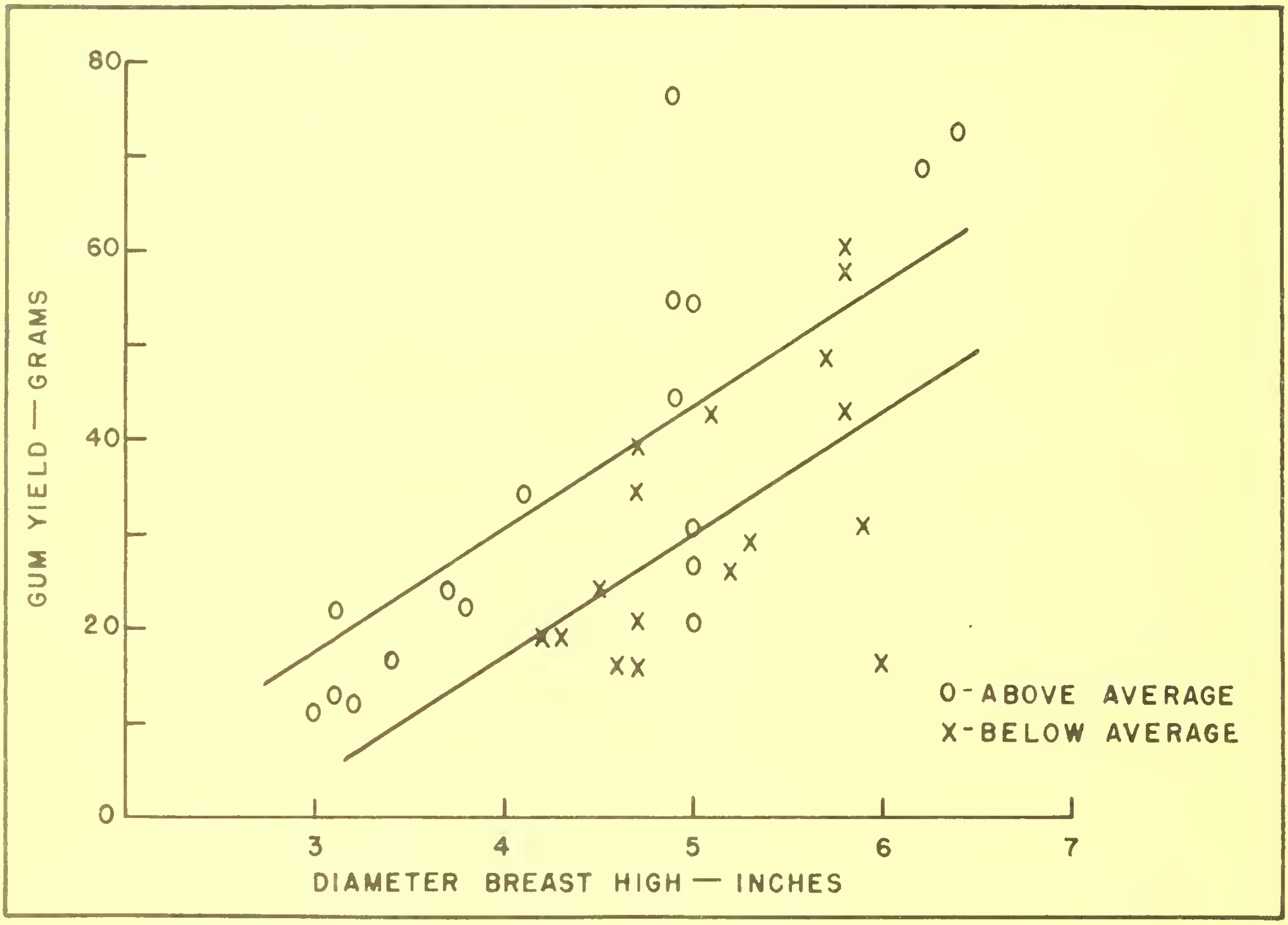

Figure 1.--Gum yields from one-parent longleaf progeny test. Open-pollinated seed was collected from trees with above-average and below-average gum yields.

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RESEARCH NOTES

SOUTHEASTERN FOREST EXPERIMENT STATION

Asheville, North Carolina

Number 30 May 1953

EFFECTS OF BURNING AND GRAZING FLATWOODS FOREST RANGES

Landowners who combine timber and cattle raising in the longleaf-slash pine region claim that cattle do better when the woods are burned. They are correct--but only for spring grazing--according to a recent study1/ which also evaluates burning and grazing effects on herbaceous vegetation, shrubs, trees, and fire hazard. From 1942 to 1949 the following prescribed burning practices were replicated twice on 50-acre ranges near Alapaha, Georgia: completely burned yearly, alternate halves burned each year, different thirds burned each year, and no burn.

The effect of winter burning on forage quality was pronounced, but primarily limited to the spring months. Protein and phosphorus content of the important grasses were 2 to 3 times higher, and lignin content appreciably lower, on burned range during the early leaf stage of growth. But after the grasses reached full leaf--usually in June--forage from burned and unburned range was chemically similar. As shown in figure 1, cattle gains were likewise much greater on burned range than on unburned range during the spring, and 2 to 3 times higher for the entire season. Also, cattle showed a strong preference in the spring for fresh burn when available. Appreciable use of "rough" areas at this time occurred only after burns were closely utilized. Much of this palatability advantage, like the nutritional advantage, had disappeared by July and grazing of unburned areas increased in late summer. However, some effect carried over into the second spring when, in the absence of adequate fresh burn, cattle preferred 1-year-rough over older rough.

Heavier utilization of the burned area, and lower cattle gains, resulted from burning only 1/3, rather than 1/2 or all of a range yearly. But these responses were more closely related to the amount of burn than to the frequency of burning. Over the 7-year period cattle gains showed no definite long-time trends, either upward or downward, attributable to the different burning practices. Vegetation responses under grazing also were similar for the three burning schedules; apparently the 2- or 3-year recovery period compensated for the more intense grazing which resulted when cattle concentrated on the burned 1/2 or 1/3 of a range.

Practically all understory species of Coastal Plain pinelands tolerate winter burning. Without grazing, burning increased the herbaceous ground cover, apparently by removing litter which had accumulated for 8 years on part of the experimental area, and held brush in check. But the combination of grazing and burning markedly decreased the two

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1/ Georgia Coastal Plain Experiment Station; Southeastern Forest Experiment Station, Forest Service; and Bureau of Animal Industry, USDA, cooperating.

dominant bunch grasses (pineland threeawn and Curtiss dropseed) which are most important for spring forage; increased other grasses and broad-leaved herbs important for summer and fall grazing; and increased the amount of brush, principally gallberry. The increase in gallberry was directly related to the intensity of grazing. Without burning, the total herbaceous ground cover decreased and brush increased, whether grazed or not. An outstanding exception was Curtiss dropseed, the most important grass for winter grazing, which increased considerably under protection from burning and grazing.

Grazing had no detectable effect on established tree stands. The intervals between burns were too short to allow new slash pine seedlings to become established, but many trees as small as 6 feet in height survived the prescribed burns because they were applied with unusual care. On unburned ranges, slash pine seedlings continued to become established in the accumulated rough.

That forage diminishes as tree caopies become dense is commonly recognized but seldom measured. The relationship between tree shade and herbaceous ground cover on the burned ranges is shown in figure 2. Grazing values were negligible where more than 35 percent of the ground was completely shaded at noon. Sixty percent shade represents very dense pine, the heaviest stands found on the experimental area.

Fuel from herbaceous vegetation was found to build up rapidly for 3 years and then to stabilize at about 2 tons (oven dry) per acre if unburned and ungrazed. Reduction in herbaceous fuel from grazing only, burning only, and combined burning and grazing amounted to 25, 40 and 70 percent, respectively, when measured in late fall.

Complete results, with illustrations, are presented in Georgia Coastal Plain Bulletin No. 51, "Burning and Grazing in Coastal Plain Forests," by L. K. Halls, B. L. Southwell, and F. E. Knox. The bulletin can be obtained from the Georgia Coastal Plain Experiment Station, Tifton, Georgia, or from the Southeastern Forest Experiment Station.

W. O. Shepherd
Division of Range Management

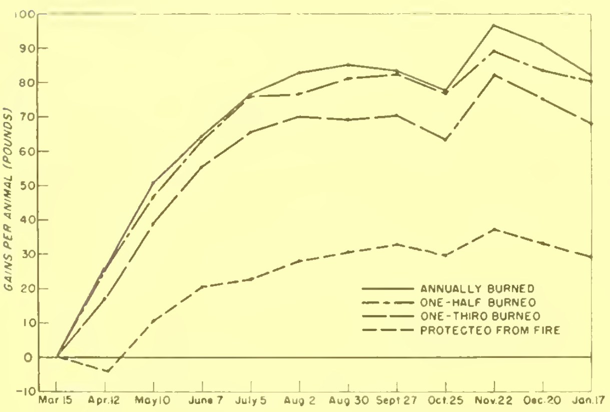

Figure 1.--Average cumulative animal gains, 1943 to 1949.

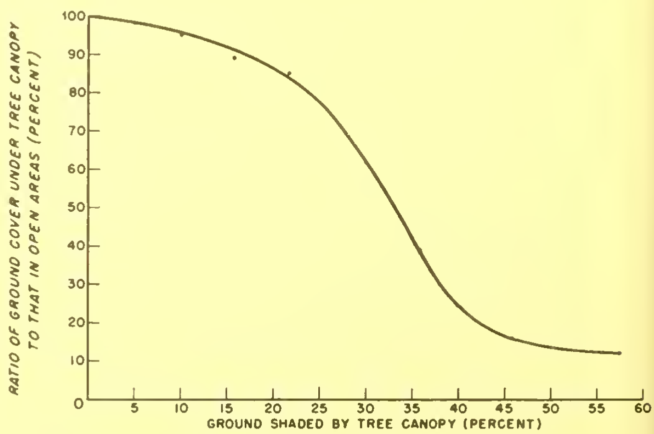

Figure 2.--Relation between tree canopy and herbaceous ground cover on burned, grazed areas.

RESEARCH NOTES

SOUTHEASTERN FOREST EXPERIMENT STATION

Asheville, North Carolina

Number 31 May 1953

ESTIMATING GROWING SPACE LIBERATED BY THE REMOVAL OF RESIDUAL HARDWOODS

The need for liberation of pine seedlings and expected benefits from poisoning or girdling can be judged quite accurately from the area under the crowns of inferior species. This area represents potential pine-growing acreage which will not produce pine for at least a rotation unless control measures are used.

A method of estimating the percent of area shaded by hardwoods 4 inches in diameter and larger has been developed from a study of residual hardwoods on cut-over loblolly pine-hardwood tracts near Franklin, Virginia.

Knowing the basal area[1/] of hardwoods per acre, which can be obtained from a small representative sample, an estimate of percent shade can be read directly from the diagram on the reverse side of this sheet. This percentage is an estimate of the additional area a successful girdling or poisoning job would make available for pine.

These estimates on area liberated can be used in conjunction with estimates of labor requirements for the removal of residual hardwoods. Data published by Yocum[2/] show that about 1 man-hour is required to girdle trees aggregating 200 inches in diameter. For poisoning with Ammate, McClay[3/] found that where most of the trees are less than 6 inches, poisoning time in man-hours equals about one-third of the basal area in square feet. These area and labor estimates offer a basis for deciding whether or not to undertake the work.

Robert D. McCulley
Division of Forest Management

1/ Cross-sectional area in square feet at the point of diameter measurement (4-1/2 feet from the ground).

2/ Yocum, Herbert A. Estimated labor requirements for girdling of hardwoods. Forest Farmer XI(10):10. 1952. The author's regression equation was:

Man-hours per acre = .006005 (sum of diameters) - .010066 (number of trees).

3/ McClay, T. C. Estimating time requirements for tree poisoning with Ammate. Southeastern Forest Expt. Sta. Research Note 27. 1953. The author's regression equation was:

Man-hours per acre = 0.009 (sum of diameters) - 0.005 (number of trees).

Agriculture-Asheville

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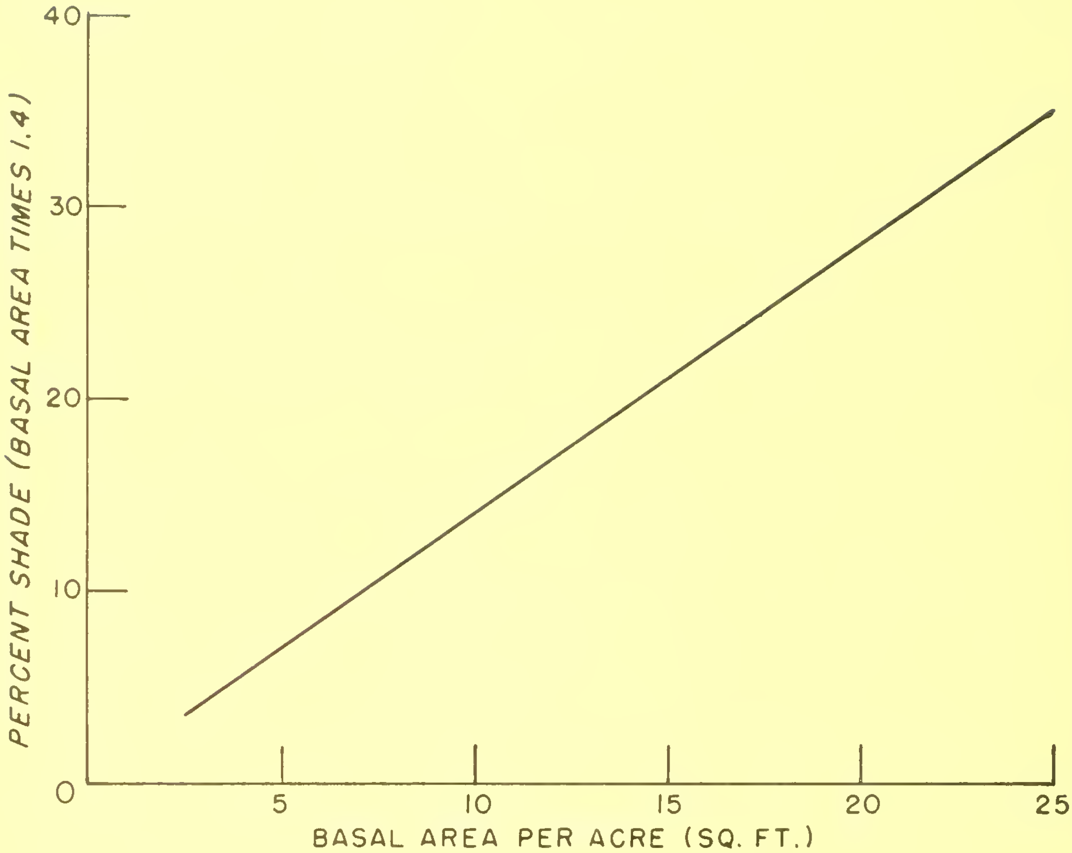


Relationship between basal area and percent crown cover of residual hardwoods

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 32 May 1953

RAPID GROWTH OF PLANTED SLASH PINE IN THE MIDDLE COASTAL PLAIN OF GEORGIA

Remeasurement of sample plots, established 5 years ago in the Stephens Plantation, 4 miles northeast of Coredele, Georgia, indicate that this 18-year-old slash pine planting spaced 15 by 15 feet has been growing at the rate of 949 board feet per acre during recent years.

The tract, an abandoned field of 127 acres, was planted by Holt Walton, of Cordele, in the spring of 1935. Native slash pine stock, probably 2 years of age, was procured from nearby "drains," or intermittant water courses, and hand-planted.

In March, 1948, 13 years after planting, initial measurements were taken on four 1-acre plots. Remeasurements were made in January 1953. Results, on an acre basis, follow.

	1948	1953
Trees over 4.5 inches d.b.h..............number	192.2	193.5
Average d.b.h............................inches	8.5	9.8
Diameter of largest tree.................inches	13.1	14.4
Basal area........................square feet	79.3	103.2
Cordwood volume (4-inches top outside bark).................standard cords	22.7	31.3
Saw-timber trees.........................number	56.8	137.5
Saw-timber volume (8-inches top outside bark, Int'l. 1/4-inch scale)...board feet	1912	6656

Over the 18 years since planting, cordwood growth has averaged 1.74 cords, and saw-timber growth 370 board feet per year. During the past 5 years these figures have become, respectively, 1.72 cords and 949 board feet. Most of the saw-timber growth in this young stand is "ingrowth" attributable to trees growing from the cordwood into the saw-timber size class. Nevertheless the stand promises to maintain a very satisfactory rate of saw-timber growth in the future.

Norman R. Hawley
Cordele-Tifton Research Center

RESEARCH NOTES

SOUTHEASTERN FOREST EXPERIMENT STATION

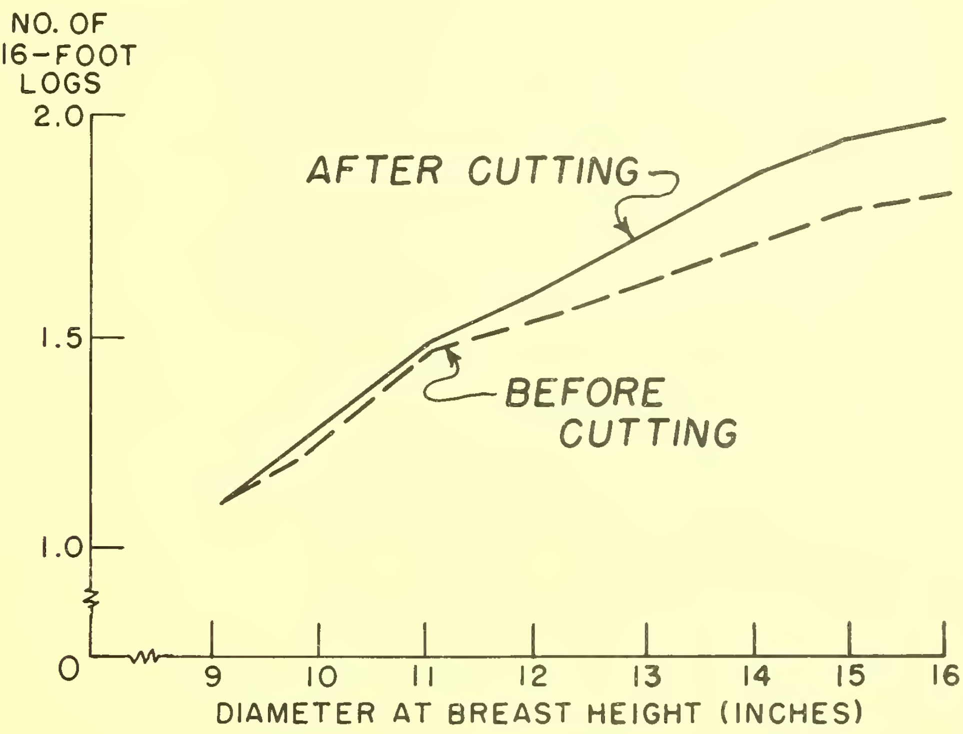
Asheville, North Carolina

Number 33 May 1953

MERCHANTABLE HEIGHT GREATER AFTER IMPROVEMENT CUT IN PILOT-PLANT MANAGEMENT TEST

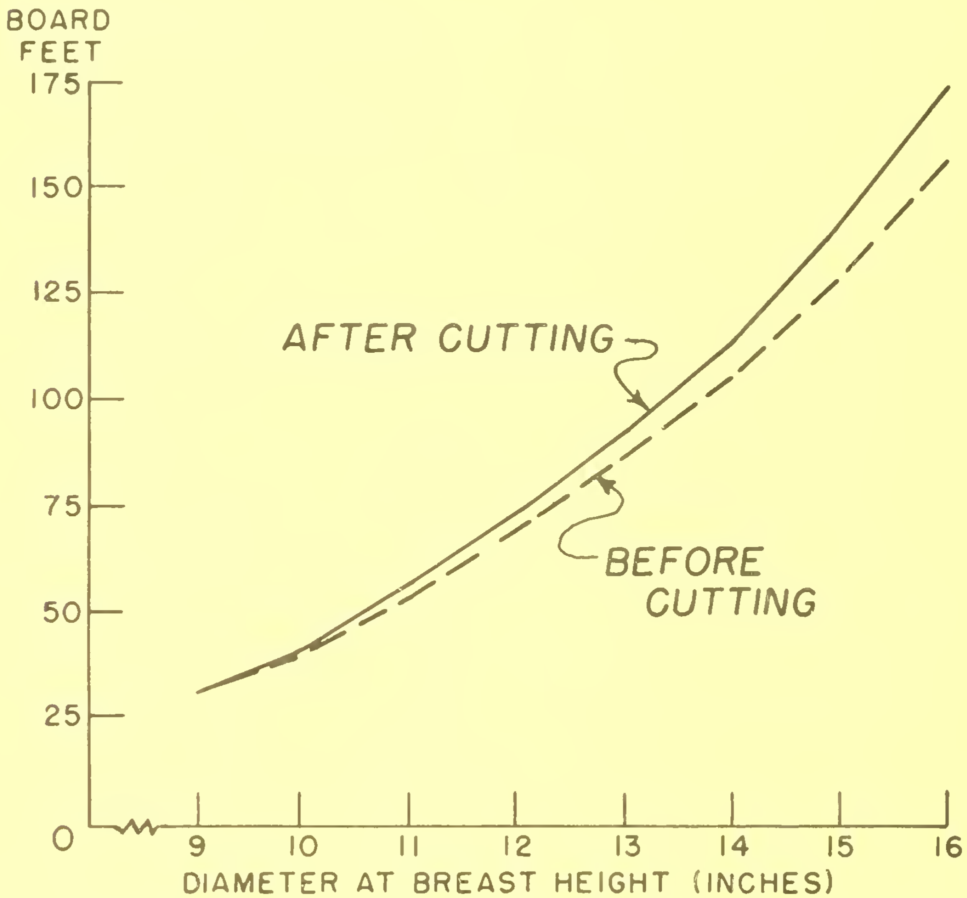
The first improvement cut in young longleaf-slash pine saw-timber stands had the effect of increasing average merchantable heights in larger diameter classes of reserved trees as much as 2-1/2 feet, or about 16-percent of one standard 16-foot log. This is the story told by successive 100-percent inventories over 1471 acres on the George Walton Experimental Forest, Dooly County, Georgia, in which the diameters of all trees were measured with calipers, and their merchantable heights occularly estimated.

The data deals only with round second-growth timber and disregards other classes also removed in the initial cut, such as overmature trees and those worked-out for naval stores. Differences in average merchantable heights before and after the cut, as shown graphically below, are thus the result of an improvement measure which was concerned primarily with removing short-boled trees of inferior quality.



Heights in 16-foot log lengths

The improvement cut had the effect of increasing average board-foot volumes in larger diameter classes of reserved trees approximately 10-percent. Average volumes per tree for the various diameter classes, before and after the cut, are as follows:



Volumes of average trees by diameter classes

The cut removed only 18 percent of the round second-growth trees, or four stems per acre. The results of this operation therefore indicate the beneficial effect of even a light improvement cut when judiciously applied.

Norman R. Hawley
Cordele-Tifton Research Center

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 34 May 1953

SITE INDEXES OF THE SOIL SERIES ON THE GEORGE WALTON EXPERIMENTAL FOREST

Site indexes for the soil series on the George Walton Experimental Forest, Dooly County, Georgia, show that the "drains," or poorly drained areas, are the best sites for slash pine. They also show that on identical soils slash pine has a higher site index than longleaf pine.

In the Middle Coastal Plain of Georgia, slash and longleaf pine commonly occur on identical upland soils, whereas the poorly drained areas rarely bear stands of longleaf pine. To obtain some idea of the comparative productivity between soils series and between species on the upland areas, stands of both species were sampled for site index over the range of soils found on the George Walton Forest. The soil series sampled, together with mean site indexes[1/] and their errors, are presented by species and site in the table on the reverse side of this sheet.

The average site index of the four slash hill soils is 74, while the average of the four drain soils is 83. Both external and internal drainage for all of the drain soils is slow to very slow. For the hill soils, Gilead and Lakeland, have high external and internal drainage, while Lynchburg has low surface runoff and slow internal drainage. Susquehanna, the fourth hill series, has medium to high surface runoff and slow to very slow internal drainage.

More available moisture, especially during drought periods, is doubtless primarily responsible for the higher site index in the drain areas. Moisture is accepted by many as the first limiting factor in tree growth. The depth of the A horizon is also probably greater in the drain areas.

In every case where comparisons can be made for specific soils, slash pine has a higher site index than longleaf. For the Gilead series the difference is 15 feet. Even on the Lakeland series, which is a loamy sand 40 inches or more in depth, the slash site index was 9 feet above the longleaf.

Although the data are exploratory, they indicate that slash pine is superior to longleaf on most soils of the Middle Coastal Plain of Georgia and should be the favored species. Also, since the drains are the best sites, every effort should be made to restock them, by planting if necessary, as early as possible.

Frank A. Bennett
Cordele-Tifton Research Center

1/ All site indexes were read from curves in "Volume, Yield, and Stand Tables for Second-Growth Southern Pines," Misc. Pub. 50, U. S. Dept. Agr. 1929.

SLASH PINE ON HILL SITES

Soil series	Site index	Standard error
	Feet	Feet
Gilead	80	2.7
Lakeland	76	*
Lynchburg	72	*
Susquehanna	69	*

SLASH PINE ON DRAIN SITES

Coxville	90	*
Plummer	85	3.7
Rains	82	*
Mixed Alluvium	76	1.0

LONGLEAF

Gilead	65	1.8
Grady	67	*
Lakeland	67	*
Lynchburg	68	1.7
Mayhew	70	2.3

*Insufficient data to calculate error.

RESEARCH NOTES

SOUTHEASTERN FOREST EXPERIMENT STATION

Asheville, North Carolina

Number 35 May 1953

86 PERCENT OF TOPS AND 54 PERCENT OF SLABS AND EDGINGS UNUSED IN CENTRAL PIEDMONT OF SOUTH CAROLINA

In the West, 30 percent of pulpwood requirements are supplied by logging and mill residues. Most of this material is obtained from large lumber operations. In the Southeast, where portable sawmills and small and scattered timber tracts are characteristic, salvage is more difficult. However, the tremendous volume of available material stimulates considerable interest in its possible use for paper or fibre board. For this reason, it may be helpful to know how much is now being used and for what purposes in one typical area.

This area is a circle of 30-mile radius in the South Carolina Piedmont. Lumbering within the circle produces nearly 100,000 cords of tops, broken trees, slabs, and edging strips annually. As of May 1, 1952, 104 operations were in progress. At 55 sites randomly selected from this number, 4000 cords of tops and broken trees and 3000 cords of slabs and edgings were left unused by mill operators and landowners.

Tops are seldom utilized by loggers, and consequently became the property of the landowners in nearly all cases studied. On 32 percent of the tracts, some tops were sold for pulpwood or railroad-car stakes, but there were very few instances of complete salvage. As a rule, pulpwood producers who might come in behind the loggers say they can make money only if they cut standing trees as well as tops. Thus, only 14 percent of the tops were used. Usable logging residues from the 55 sample tracts were disposed of as follows:

	Cords	Percent
Sold as pulpwood stumpage	377	7.7
Sold as cut pulpwood	261	5.3
Sold as car stakes	12	0.3
Used as home fuel	50	1.0
Unused	4,202	85.7
Total	4,902	100.0

In comparison with tops, 46 percent of the slabs and edgings on the sample tracts were used, though only as fuel. Before gasoline and diesel power units were introduced in the thirties, a considerable quantity went to generate steam to drive sawmills. Now, the only use is home fuel. However, with the extension of electricity to rural areas and increased use of oil and bottled gas for heating and cooking, even this demand has declined greatly. For example, no slabs or edgings were sold at 49 percent of the mill sets examined, the price of uncut slabs at the mill site averaged only $1 a cord, and the highest price received was only $3. How the sawmill operators and landowners disposed of this material is shown below:

	Cords	Percent
By the sawmill operators:		
Sold as fuel	468	8.4
Used as home fuel	137	2.4
Given away	146	2.6
By the landowners:		
Sold as fuel	1,051	18.8
Used as home fuel	641	11.5
Given away	132	2.4
Unused	3,012	53.9
Total	5,587	100.0

William H. B. Haines
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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

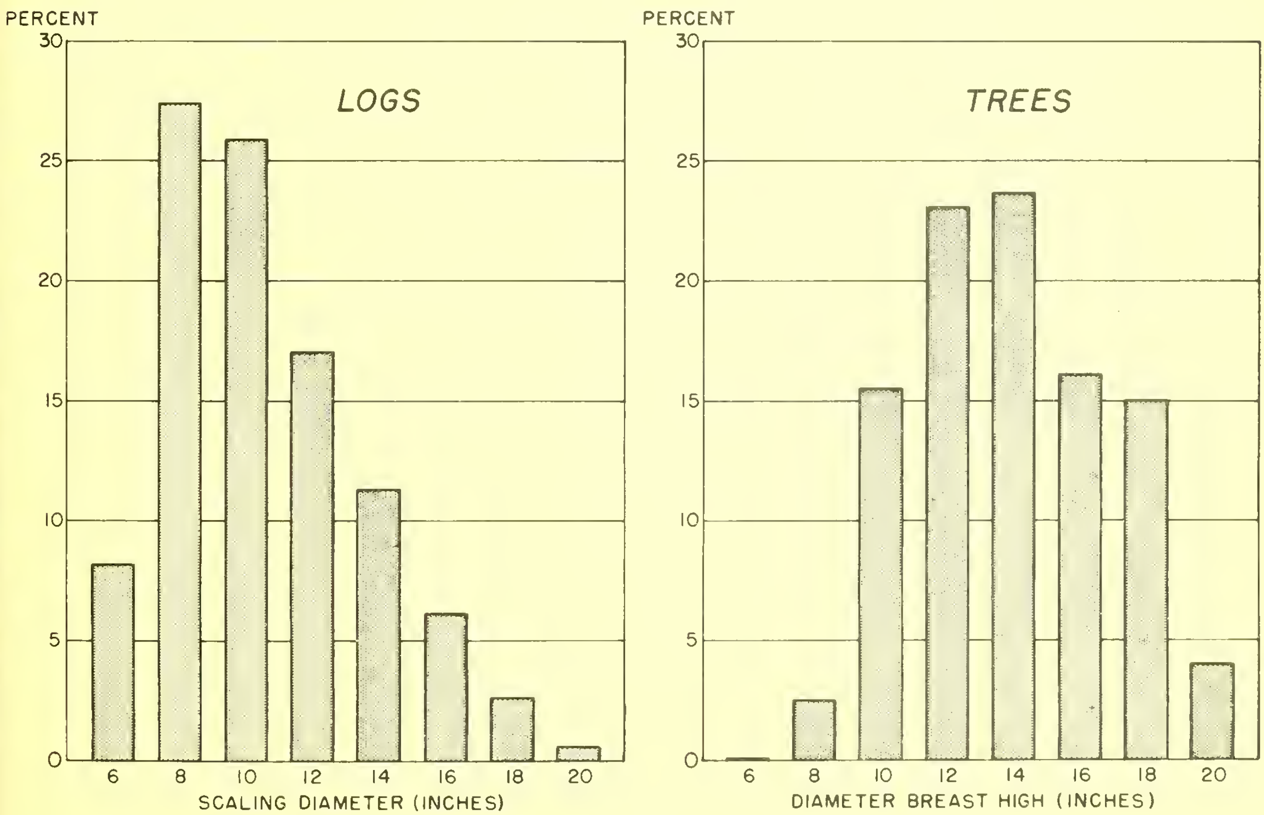
Number 36

May 1953

62 PERCENT OF PINE LUMBER IS CUT FROM 10-INCH OR SMALLER LOGS IN THE CENTRAL PIEDMONT OF SOUTH CAROLINA

Pine logs as small as 5 inches in diameter inside bark and trees 6 inches in diameter breast high are utilized for saw timber in the South Carolina Piedmont. More lumber is sawed from 8-inch logs than from any other size, while 12- and 14-inch trees provide nearly 50 percent of the board-foot volume cut. The bar graphs are based on measurements of 1,029 logs at 25 sawmills and 412 trees cut on 21 tracts.

In this area, as in many other parts of the South, pine saw timber is being cut faster than it is grown. The resulting scarcity of large timber, combined with an unusually favorable market for 2 x 4's and narrow boards, has brought about the utilization of smaller and smaller logs and trees.



Lumber output by log and tree size

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Agriculture-Asheville

U. S. Department of Agriculture - Forest Service

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 37 July 1953

FIRE FREQUENCY AS A MEASURE OF FIRE PREVENTION ACCOMPLISHMENTS

At the end of every year fire organizations regularly tally up the number of fires that burned in their territory and then try to decide whether the record is good or bad. Thirteen northeastern states reported 8,948 fires in 1951 on days of known fire danger, for example. Now the question is: would it have been reasonable to expect a larger or smaller number than 8,948 for the year?

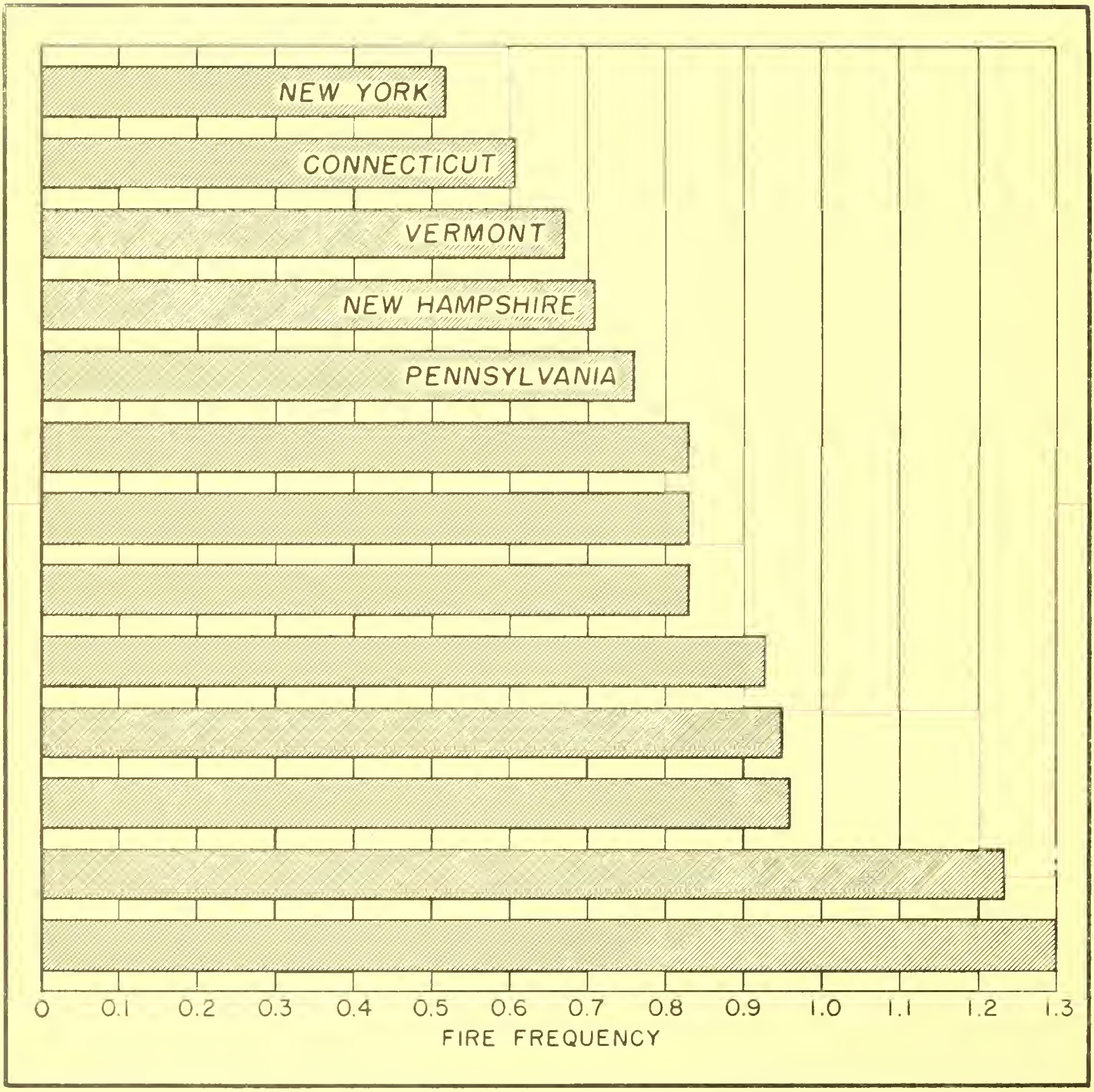
There probably never can be a precise acceptable answer to that question. But fire frequency, a relatively new term, at least gives some good indications as to what a reasonable answer may be. Fire frequency denotes the ratio of the number of fires that burn to the number that might have burned in keeping with the severity of the weather--fire occurrence divided by fire expectance (the number of fires expected according to measured fire danger). For these states the 8,948 fires that burned is a smaller number than the 9,745 fires expected. Hence, fire frequency is 0.92, and a value less than 1.00 indicates that for the whole region fewer fires actually occurred than might reasonably have been expected when the severity of the weather is taken into consideration.

The ratio was not uniform in all states, however. Fire frequency varied from a low of 0.52 to a high of 1.30, as shown in the bar graph. The five states with the lowest frequencies are identified.

Neither unusual concentrations of fires nor unusual weather conditions appear to account for the appreciable differences between states. In all states except one, Connecticut, fire expectance for 1951 approximated the 3-year average. Connecticut expected many more fires than average, so their job may reasonably have been more difficult than usual; yet they had next to the lowest fire frequency. The two states with the highest fire frequency expected a number of fires somewhat less than average, yet they apparently were not able to turn this to their advantage and reduce the fire frequency to 1.00 or less.

The fire expectance figure in these calculations is the product of burning index and the number of fires that occur per unit of burning index, on an average. The averages are calculated by months. For each month the average number of fires per unit of burning index used in calculating fire expectance is based on the 3 out of 5 years when the lowest number of fires occurred per unit of burning index. The calculations are made by months to take into account seasonal fluctuations in risk. Owing to this method of calculating fire expectance whereby months of relatively severe fire occurrence are eliminated from the averages, fire expectance represents the number of fires that will burn if a better than average job of preventing fires is done. Hence, fire expectance is a goal. It requires more than the usual fire prevention effort to reduce fire occurrence below fire expectance, that is, to hold fire frequency below 1.00. All except 2 of the 13 northeastern states held the fire frequency below 1.00 for 1951.

A. W. Lindenmuth, Jr. and J. J. Keetch
Division of Fire Research



RESEARCH NOTES

SOUTHEASTERN FOREST EXPERIMENT STATION

Asheville, North Carolina

Number 38 July 1953

POISONING SMALL-DIAMETER HARDWOODS WITH THE CORNELL TOOL

There is need for an efficient but economical method of controlling small hardwoods which overtop pine. A promising treatment involves use of the Cornell poisoning tool. This was originally designed for use with sodium arsenite--a good tree killer but highly toxic to animals, thus limiting its uses. A non-toxic chemical such as Ammate (ammonium sulfamate) could be a logical substitute. A recent exploratory study commenced by L. E. Chaiken shows that at the end of 18 months about three-fourths of the small-diameter hardwoods treated were effectively controlled by Ammate applied with the Cornell tool.

In this test the Ammate was used in solution at the rate of 6 pounds per gallon of water. This makes 1.4 gallons of solution, which is sufficient to treat about 350 trees of 3 inches d.b.h. Incisions were made around the basal perimeter of the treated trees by downward thrusts of the Cornell tool. The number of incisions was determined by diameter at breast height, one incision (jab) for each inch of diameter.

A total of 933 trees of five major hardwood species up to 3 inches d.b.h. were treated in January 1952 on three small areas at the Santee Experimental Forest. An examination made in May 1953 showed only about 24 percent of the stems still with live crowns (table 1). In many cases even these trees showed signs of foliage deterioration.

To satisfactorily release pine reproduction 2 years or older, a complete kill of all competing vegetation is desirable but not essential. The test shows only a 23-percent complete kill, excluding stems which are "dead with sprouts" and "nearly dead." If the latter two classes of stem condition are added to completely "dead" stems, the release of pine seedlings from overtopping hardwoods is about 76 percent effective. Furthermore this percentage figure does not include many trees in the "living" class with a high percent of crown kill. A study by Grano, "Effectiveness of Ammate in Controlling Hardwoods," reported in the Southern Lumberman, October 1952, shows a 92-percent kill on small-diameter Southern red oak using the Cornell tool with even lighter Ammate concentrations. Grano's treatment was applied in May and examined 18 months later. This suggests that the 76-percent release obtained in the present study may have been even greater if the treatment had been applied during the early growing season instead of the dormant season.

The least effective kill on small-diameter hardwoods using the Cornell tool was obtained on dogwood and hickories. Better results were obtained on sweetgum, myrtle and oaks, in the order named.

No comparative cost data are available from this study. However, the labor involved in using the Cornell tool should not be in excess of that required for release by conventional cutting methods. The small additional cost of the chemical (less than 1/2¢ per tree) is offset by a more complete release than that obtained by cutting only. Thus, the desirability of using this method would depend primarily upon the degree of release required.

Table 1.--Control of small hardwoods with Ammate applied by Cornell tool

Trees examined (Species and number)		Condition of treated stem			
		Dead, no sprouts 1/	Dead, with sprouts 2/	Nearly dead 3/	Living
		Percent	Percent	Percent	Percent
Sweetgum 4/	346	19	66	8	7
Myrtle	244	35	32	15	18
Oaks 5/	232	20	14	29	37
Dogwood	68	3	12	9	76
Hickories	43	28	16	9	47
All species	933	23	38	15	24

1/ Stem completely dead.
2/ Stem completely dead, but with basal sprouts.
3/ Small percentage of live cambium in stem; little or no foliage.
4/ Includes several blackgum.
5/ Includes mostly post, willow, and some blackjack oaks.

R. D. Shipman
Santee Research Center

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 39 July 1953

THE CHARACTERISTICS OF A HIGH-GUM-YIELDING TREE

Every turpentiner knows that some trees run more gum than other trees of the same size and general appearance. Although such differences have been common knowledge for generations, a clear understanding of the basic factors involved has just recently been obtained. Now scientists at the Lake City Research Center have identified three of the factors controlling gum flow and have found a fourth one which also might be effective. These controlling characteristics are:

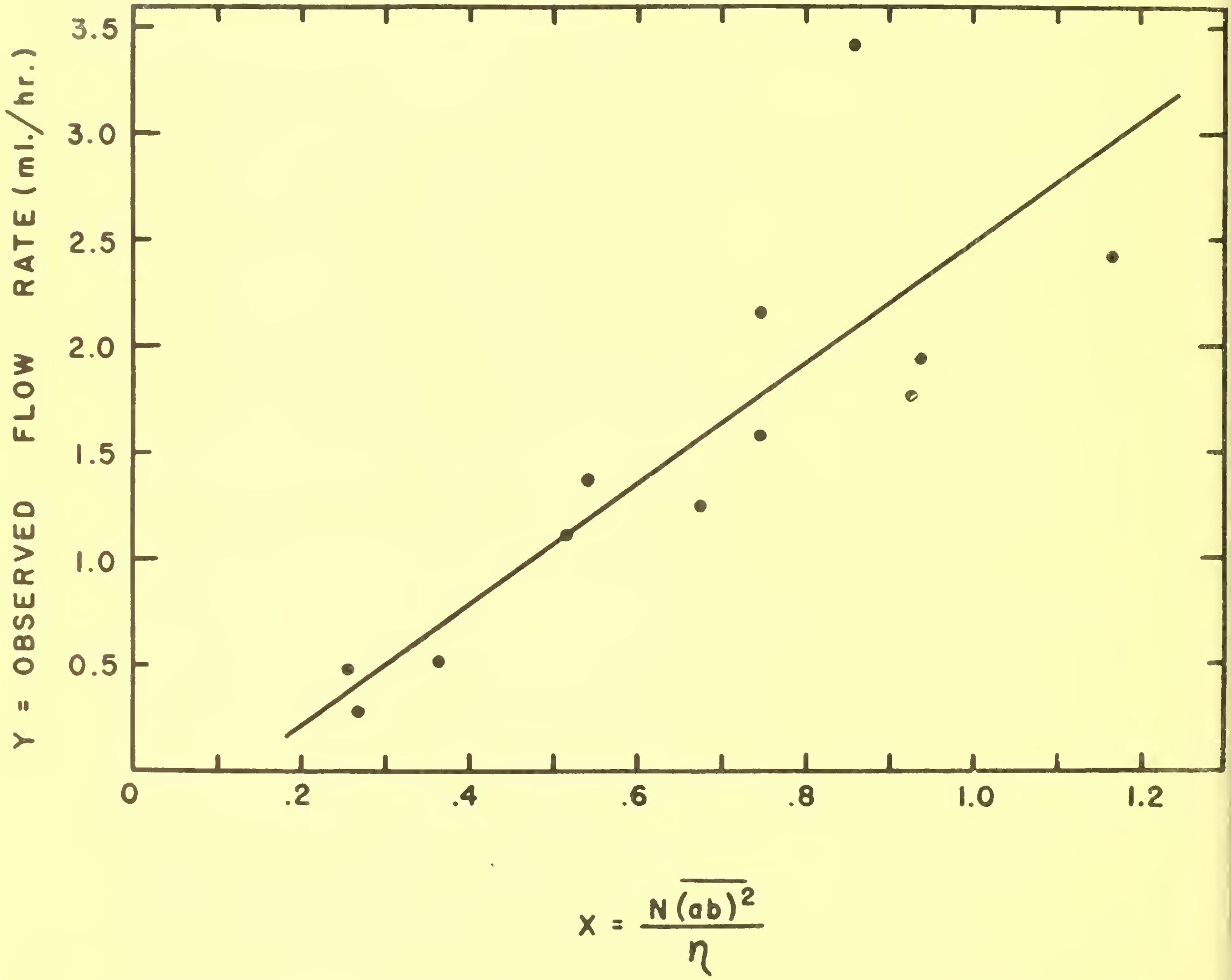
1. The size of the radial resin ducts exposed by chipping.
2. The number of resin ducts per square inch of fresh streak.
3. How viscous or fluid the gum may be.
4. And possibly, the pressure within a tree which tends to force gum outward.

Experiments with slash pines on the Olustee Experimental Forest disclosed that factors 1, 2, and 3 were very important in determining the rate of gum flow during the first 24 hours after chipping. But a more precise technique must be devised for measuring exudation pressure before its significance can be proven. No tree on which these measurements are available rated high on all four factors. High-yielding trees usually rated excellent for only one or two factors.

If size of resin ducts, number per square inch, viscosity of gum, and exudation pressure are inheritable characteristics, then trees rating high on all four factors can be developed by controlled breeding of carefully selected, high-gum-yielding parents. The resulting seedlings probably would have a gum-yielding capacity several times greater than any high-yielders known today.

A complete technical report on the methods and results of this study has been submitted for publication in the quarterly journal, Plant Physiology.

Clifford S. Schopmeyer
Lake City Research Center



This graph shows the relationship between observed flow rate and the three controlling factors: Number of resin ducts (N), multiplied by size of resin ducts (ab^2) and divided by the viscosity of the gum.

RESEARCH NOTES

SOUTHEASTERN FOREST EXPERIMENT STATION

Asheville, North Carolina

Number 40 July 1953

GUNNING FOR LOBLOLLY PINE CONES

Collecting pine cones with a gun is not recommended to State forestry departments who reckon their needs in the thousands of bushels. And seed collectors would find it too hazardous for general use even if it were practical. But this method has proved effective and efficient for experimental work. After the foresters at the Tidewater Research Center in Virginia had encouraged loblolly pine seed trees to produce more seeds by injuring them and fertilizing them, two cones had to be collected from each of 400 trees to permit a check on results. The trees couldn't be cut because their seed production had to be rated for several years. Climbing irons couldn't be used because they injure trees too, and that would have complicated analysis of results. So, a .22 rifle with telescopic sight proved to be a good answer. Enthusiatic volunteers for the job of shooting cones soon found that 400 is a lot of trees, that twigs waving in a gentle breeze toss violently when viewed through a telescopic sight, and a rifle gets mighty heavy after a few hours--even a .22 rifle. But even though shooting cones isn't as exciting as hunting squirrels, the forester's lot looks to others like a happy one indeed, as he strolls through the woods with his gun when the cones ripen in the fall, looking for an easy single near the middle of the tree crown.

Robert D. McCulley
Tidewater Research Center

Agriculture-Asheville

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 41 July 1953

HONEYSUCKLE IS A SERIOUS PROBLEM

Honeysuckle smells sweet around the homestead, and honeysuckle bottoms provide emergency winter grazing. Honeysuckle is such a favorite food of the white-tailed deer in the mountains that game managers are planting it.

But honeysuckle has caused considerable damage to timber producers in the Southeast. It has not only ruined young pole-sized pine but threatens to take more good pine and bottomland hardwood areas out of timber production by smothering the reproduction and making such a heavy vegetative mat that seedling establishment is next to impossible. As the effects of fire control and time itself build up the more eroded sites in old-field stands, honeysuckle will become a menacing competitor to forest trees. The best timber growing sites support the rankest growth of honeysuckle.

The acreage involved in the honeysuckle problem is serious today in the lower Piedmont. Its seriousness is increasing each year and threatens to become a critical factor in the management of many loblolly pine stands. The best estimates of the Hitchiti Research Center are that approximately 1 million acres in the lower Piedmont have heavy honeysuckle invasion, and 2-1/2 million acres in this area have honeysuckle invasion in some degree. The honeysuckle problem is not confined to the lower Piedmont; reports from foresters in the Carolinas and Virginia indicate that they are concerned also.

In the lower Piedmont when people speak of "honeysuckle" in the timber stands, they are usually concerned with a group of vines that vary somewhat in their composition. The most common and damaging viney invader of the group is Japanese honeysuckle (Lonicera japonica), an ornamental that was introduced from Asia, escaped from cultivation, and established itself in woods and thickets from Connecticut to Florida. Trumpet honeysuckle, yellow jessamine, trumpet creeper, and several species of greenbrier,1/ alone or in various combinations with Japanese honeysuckle, frequently are included under the common title of "honeysuckle."

During the relatively short period that honeysuckle has been studied at the Hitchiti Experimental Forest several important facts have been determined. Honeysuckle can be spread both by seed and vegetative means. Seed was found to be viable immediately upon ripening. The seed is probably spread by water as well as by birds.

Most of the young patches of honeysuckle found on the ridges were quite definitely started as the result of bird droppings. This method of spread is especially vicious in that it makes every acre within the range of honeysuckle a potential problem area. With only a little extra light or nourishment, honeysuckle is ready to establish itself.

1/ Scientific names are: trumpet honeysuckle, Lonicera sempervirens; yellow jessamine, Gelsemium sempervirens; trumpet creeper, Tecoma radicans; greenbrier, Smilax spp.

Another means of spread is through vegetative propagation. Individual stolons of honeysuckle as long as 15 feet have been found. These stolons take root at frequent intervals and provide a nucleus for further spread and expansion. Evidence also indicates that heavy rains -- "gully washers" -- tend to orient the stolons or portions of them in the direction of runoff and thus provide for further spread.

Observational studies are under way to determine the rate of spread and the effect of different densities of honeysuckle on pine re-establishment. But the main effort in the honeysuckle study is to find the most economical controls that will be effective enough for the establishment of pine reproduction and its early growth. The control experiments are pointed towards a three-fold purpose: (1) to reduce the honeysuckle mass to such a degree that spraying equipment can be used in the control job; (2) to eliminate the honeysuckle on the ground and within reach of spraying equipment; (3) to kill the vines that have reached the crowns of advanced pine reproduction.

The use of fire and cattle grazing are being studied to reduce the layers of honeysuckle that are man-high at times. We know that a single winter season of heavy grazing will reduce the honeysuckle to a point where machine sprayers can be used. In some cases, it may be desirable to use a combination of controlled fires and grazing because it is difficult to get a good coverage of spray on the young sprouts within the heavier clumps of vines even after heavy grazing.

The best hope for reducing honeysuckle is the use of certain weedkillers such as 2,4-D, 2,4,5-T, or their combinations. Observations in South Carolina indicate that 2,4-D and 2,4,5-T are most efficient if applied to honeysuckle when air temperatures are above 70°F. Hitchcock and Zimmerman[2/] have found that sprays of 2,4-D are most effective when applied on shaded honeysuckle during late spring and early summer. The degree of shade and time of year of spraying are probably more important in control than are the concentration or rate of application of 2,4-D within rather broad limits. Investigations in middle Georgia also point to the necessity of a second and third spray treatment, regardless of the concentration or rate of application.

Severing the high-climbers by mechanical means offers the most promise for their elimination because the action zone of the chemical weedkillers on honeysuckle, for all practical purposes, is limited to the portion of the stem covered by the spray. Thus, vines wound high in tree crowns are not affected by a spray treatment.

The studies now being carried out hardly make a dent in the Piedmont honeysuckle problem, but many Piedmont landowners and foresters have a stake in its solution. The Station will be glad to exchange information with others working on the honeysuckle problem.

Thomas C. Nelson
Hitchiti Research Center

2/ Hitchcock, A. E., and Zimmerman, P. W. Effect of concentration of 2,4-D, rate of application and respraying on killing Japanese honeysuckle. Proceedings American Society Horticultural Science 51: 668-669. 1948.

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 42 July 1953

TOPWOOD VOLUME TABLES FOR SLASH AND LONGLEAF PINE[1/]

In order to better coordinate sawtimber and pulpwood sales and to provide for better utilization, a device for estimating topwood volume in our southern pines is needed. Topwood volume tables developed from data gathered at the George Walton Experimental Forest, Dooly County, Georgia, meet this need for slash and longleaf pine of the middle Coastal Plain of Georgia.

In gathering the data, all volume beyond an 8-inch top outside bark was considered cordwood. The upper limit of merchantability was taken as 4 inches, outside bark. Since a table expressed in terms of d.b.h. and number of 16-foot logs most easily lends itself to timber cruisers' needs, data were tabulated by these two variables.

To convert cubic volume to cords, a ratio of 90 cubic feet of solid wood to a standard cord of 128 cubic feet was employed. Separate tables were calculated for each species, and also for both round and worked trees in each species class. These tables appear on the reverse page.

Frank A. Bennett
Cordele-Tifton Research Center

1/ Prepared under the direction of Prof. F. X. Schumacher, Duke University, in partial fulfillment of the requirements for the degree of Master of Forestry.

Rough cordwood volume tables for slash and longleaf pine topwood

(In cords)

ROUND LONGLEAF

D.b.h. (Inches)	Number 16-foot logs					
	1	1-1/2	2	2-1/2	3	3-1/2
9	0.054	0.046				
10	.046	.039	0.035	0.033		
11	.039	.033	.029	.027	0.025	
12	.032	.027	.024	.023	.022	0.021
13	.026	.023	.021	.019	.018	.018
14	.023	.020	.018	.017	.016	.015
15	.020	.017	.015	.014	.014	.013
16	.017	.015	.014	.013	.012	.012
17	.015	.014	.012	.012	.011	.011
18	.014	.012	.011	.010	.010	.009

WORKED LONGLEAF

D.b.h. (Inches)	1	1-1/2	2	2-1/2	3	3-1/2
9	0.047	0.053				
10	.037	.042	0.044	0.045		
11	.030	.034	.036	.038	0.039	
12	.026	.029	.031	.032	.032	0.033
13	.023	.025	.026	.027	.027	.028
14	.020	.021	.023	.023	.024	.024
15	.017	.019	.020	.020	.021	.021
16	.015	.016	.017	.018	.018	.018
17	.013	.014	.015	.016	.016	.016
18	.012	.013	.013	.014	.014	.014

ROUND SLASH

D.b.h. (Inches)	1	1-1/2	2	2-1/2	3	3-1/2
9	0.062	0.064	0.066			
10	.050	.052	.054	0.054		
11	.041	.043	.044	.045	0.045	
12	.034	.036	.037	.038	.038	0.038
13	.029	.031	.032	.032	.032	.033
14	.025	.027	.027	.028	.028	.028
15	.022	.023	.024	.024	.024	.024
16	.019	.020	.021	.021	.021	.021
17	.017	.018	.019	.019	.019	.019
18	.015	.016	.017	.017	.017	.017

WORKED SLASH

D.b.h. (Inches)	1	1-1/2	2	2-1/2	3	3-1/2
9	0.048	0.054	0.060			
10	.037	.045	.050	0.051		
11	.034	.037	.041	.043	0.044	
12	.026	.031	.034	.036	.037	0.038
13	.022	.027	.029	.031	.031	.032
14	.019	.023	.025	.026	.027	.028
15	.017	.020	.022	.023	.024	.024
16	.015	.018	.020	.020	.021	.021
17	.013	.016	.017	.018	.019	.019
18	.012	.014	.016	.016	.017	.017

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 43 July 1953

D.B.H. IN RELATION TO STUMP DIAMETER AT VARIOUS HEIGHTS FOR SOUTHERN YELLOW PINES AND HARDWOODS

Foresters, timber managers, and operators often need to estimate the volume of timber removed from a tract after cutting operations have been completed. To do this they need to know the diameter at breast height of trees cut at various stump heights so that suitable volume tables can be applied. The table on the reverse side shows tree diameters at breast height for stumps of different diameters at 6, 12, 18, and 30 inches above ground level.

The data used in the table were obtained on Forest Survey sample plots in central and south Georgia and in eastern North Carolina as part of a study of tree form. Trees having abnormal butt swell, such as tupelo gum, are not included in the table. All measurements are in inches outside bark.

J. F. McCormack
Division of Forest Economics

Tree diameter outside bark at 4.5 feet above ground in relation stump diameter at various heights

Stump diameter (inches)	Yellow pine species				Hardwood species			
	Stump height (inches)				Stump height (inches)			
	6	12	18	30	6	12	18	30
	D.b.h.	D.b.h.	D.b.h.	D.b.h.	D.b.h.	D.b.h.	D.b.h.	D.b.h.
6	4	5	5	6	4	5	5	5
7	5	6	6	6	5	5	6	6
8	6	7	7	7	5	6	7	7
9	7	7	8	8	6	7	7	8
10	8	8	9	9	7	8	8	9
11	8	9	10	10	7	8	9	10
12	9	10	10	11	8	9	10	11
13	10	11	11	12	9	10	11	12
14	10	11	12	13	9	11	11	13
15	11	12	13	14	10	11	12	14
16	12	13	14	15	11	12	13	14
17	13	14	15	16	11	13	14	15
18	14	15	16	17	12	14	15	16
19	14	16	16	18	13	14	15	17
20	15	16	17	19	13	15	16	18
21	16	17	18	19	14	16	17	19
22	16	18	19	20	15	17	18	20
23	17	19	20	21	15	17	19	21
24	18	20	21	22	16	18	20	22
25	19	20	22	23	17	19	20	23
26	20	21	22	24	17	20	21	23
27	20	22	23	25	18	20	22	24
28	21	23	24	26	19	21	23	25
29	22	24	25	27	19	22	24	26
30	22	25	26	28	20	23	24	27
Basis: number of trees	1296	1320	380	943	557	620	259	421

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 44 July 1953

HOW TO ESTIMATE THE NUMBER OF CONES IN STANDING LOBLOLLY PINE TREES

Sometimes we need to know the numbers of cones on standing trees, particularly in research studies but occasionally also in practical management systems. A recent study of loblolly pine seed tree development gave an opportunity to compare actual numbers of cones with binocular counts of three different observers in three different years.

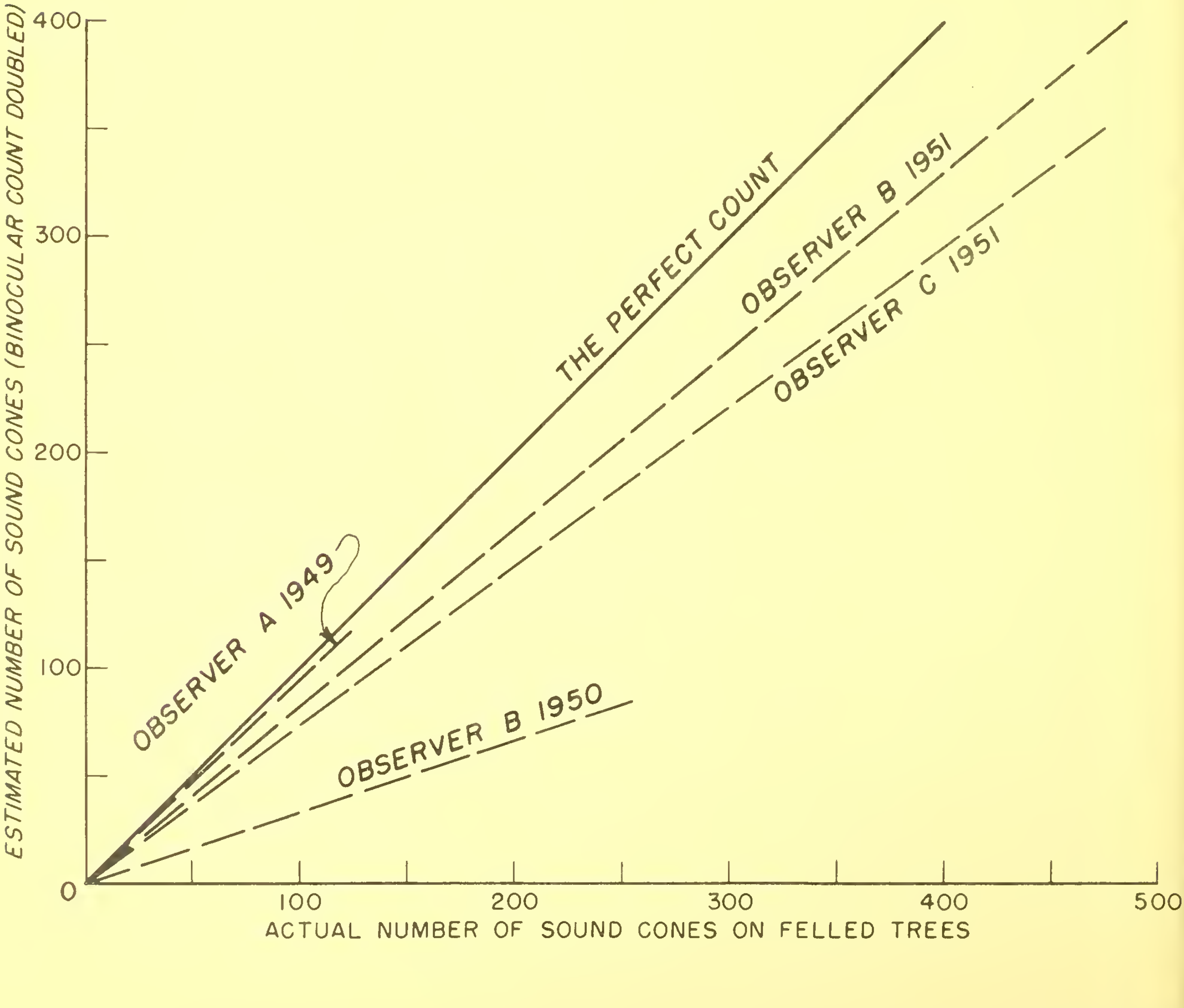
The comparison showed that the number of cones in standing loblolly pine trees can be estimated with reasonable accuracy if binocular counts are always made in the same way and are also corrected by some exact counts. All counting in one year should be done by the same man and a number of trees, from 15 to 25, should be chosen and cut, and the exact number of cones counted. Binocular counts on standing trees can then be corrected by multiplying them by the ratio of exact total number of cones on the sample trees to the total counted. These sample trees should, if possible, be chosen at random from among all trees counted. If they must be cut elsewhere, they should be similar in height, crown development, and vigor to those on which cones are to be estimated.

Cones can be counted in loblolly pine as soon as they get large enough to see in late summer. The current cones can be distinguished from old cones by their color, the fact that they are closed and old cones usually open, and by their position on the twig. They are usually still among the needles on trees of normal vigor. Old cones are on the bare portion farther back from the tip of the twig, the needles having been cast during the preceding fall and winter. This is an important distinction to make if both sound and defective cones are being counted, because defective cones are usually partially or completely browned and otherwise indistinguishable from closed old cones.

In making binocular counts the observer should stand at some distance from the tree with the sun behind him so that he can clearly see all of one side of the crown. Without changing his position, he should count all cones of the current crop that he can see. By counting cones in the openings between branches progressively up one side of the crown and down the other he can cover the whole crown without becoming confused in his count. It is important that he does not change his position, that he count all cones that he can see even though they appear to be on the far side of the crown, and that he cover the crown systematically. If he changes his position to see some cones more clearly, he will lose his place in the crown very easily, particularly if appreciable numbers of cones are present. Finally, he should double his count and apply the correction factor.

The need for a correction factor is shown by comparing the estimates of Observers A, B, and C with actual counts made from felled sample trees. Results of our comparisons are shown in the accompanying graph. It was evident that the tendency was to miss cones in counting; none of the observers managed to count all cones, although Observer A came very close. It was also evident that different observers counted with different degrees of accuracy, since Observers B and C differed in counting the same cones in 1951. Also, the accuracy of a given observer varied with the passage of time; for instance, Observer B's count was much better in 1951 than in 1950. Finally, the fact that the relationship between counts and actual numbers for all observers can be presented as straight lines shows that each one counted with the same accuracy in any one year regardless of the number of cones in the tree. When defective cones were included in the counts there was a distinct tendency for more cones to be missed by all observers, probably because it was easier to confuse the discolored defective cones with those of previous years.

Karl F. Wenger
Tidewater Research Center



RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 45 July 1953

PREHARVEST RELEASE OF LOBLOLLY PINE SEED TREES WILL INCREASE SEED SUPPLY AT HARVEST

Choosing seed trees and releasing them from competition of surrounding trees 3 to 5 years before a loblolly pine stand is harvested will make them produce much more seed at the time of the harvest cut. A much larger number of seed will be cast upon the fresh seedbed created by logging, greatly improving the chances of satisfactorily stocking the area with pine.

That's the main conclusion drawn from a study recently completed near Franklin, in southeastern Virginia, on land belonging to the Camp Manufacturing Company, Inc. The cone production of 78 trees released during the winter of 1946-47 in even-aged stand 27 to 43 years old is compared with that of matching check trees in the figure.

The large increase in cone crops of released trees in 1949 shows that the effects of release on flower initiation and cone development commenced immediately. The increase in cone crop could not have occurred before 1949 because flower buds had to develop first and the cones needed two more growing seasons to mature. This third-year response of released loblolly pine trees has been observed whenever careful records have been kept, and can be expected with confidence. In this case it occurred in one of the poorest seed years on record.

The released trees continued to produce larger crops in 1950 and 1951. There is, therefore, at least 3 years' leeway in the time when the fresh seedbed created by logging can be made to coincide with larger amounts of seed.

How many such released trees would be needed to give a reasonable assurance of satisfactory stocking of seedlings in the first year after cutting? In the poor seed year of 1949, 4 to 13 released trees that had previously borne 30 or more cones per year and were at least 15 inches in diameter at breast height would probably have produced the seed required. This conclusion was reached by comparing the sound seed production of the released trees in 1949 with the seed requirements for 90-percent milacre stocking on disturbed first-year seedbeds.[1] The table shows the results of these computations.

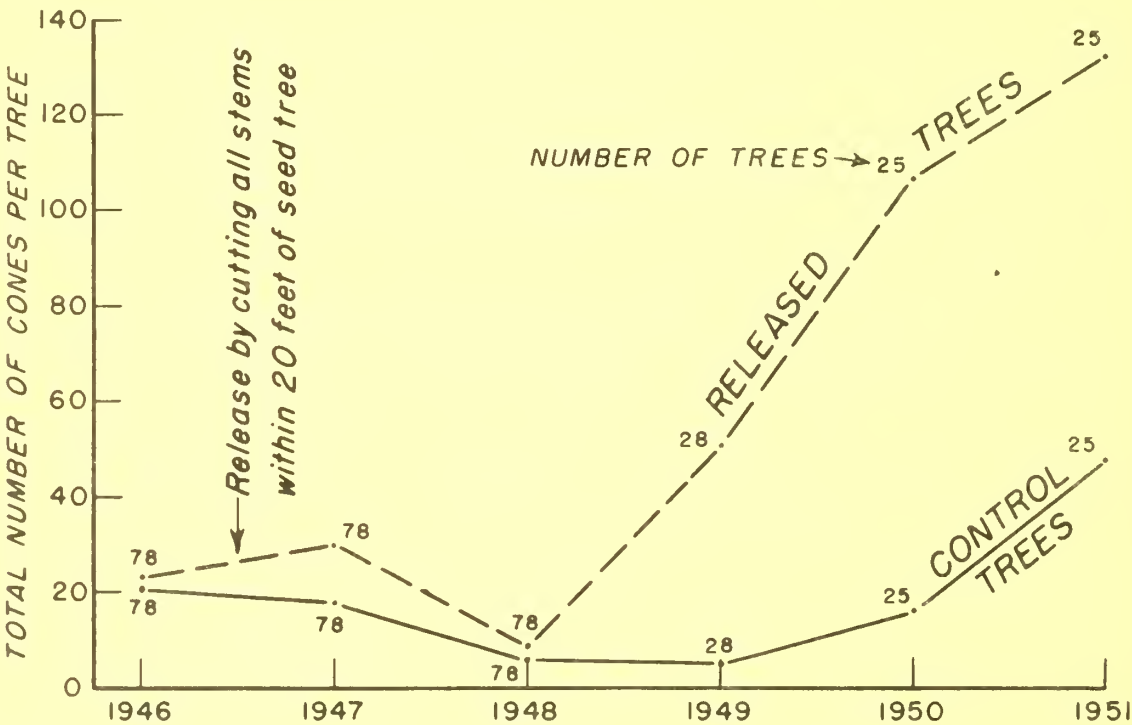
Theoretically, the maximum number of seed trees that can be released to an average radial distance of 20 feet is 35 per acre. Releasing this number would result in the cutting of all other trees, and would stimulate the growth of an undesirable hardwood understory even before the increased seed crop became available. Thus, seed tree release should ordinarily be applied to 4 to 12 seed trees per acre to minimize understory growth and still provide an adequate quantity of seed for reproduction.

Karl F. Wenger
Tidewater Research Center

[1] Trousdell, K. B. Seed and seedbed requirements to regenerate loblolly pine. Station Paper No. 8. 1950.

Number of released loblolly seed trees needed per acre for satisfactory reproduction in 1949

D.b.h. (Inches)	Fruitfulness before release, 1946 - 1948	Fruitfulness after release, 1949	Type of seedbed		
			Undisturbed	Burned	Disturbed
	Number of cones	Number of cones	Number of trees		
10.5	10	37	75 - 108	30 - 36	15 - 28
15.2	30	80	34 - 49	14 - 16	7 - 13
17.9	50	124	20 - 29	8 - 10	4 - 7



Trend of annual cone crops of released and control trees.

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 46 January 1954

TRENDS IN THE PRICE OF SOUTHEASTERN PINE PULPWOOD

Rough pine pulpwood, which now sells for $13.75 a cord f.o.b. railroad cars in the Southeast, brought only $7.15 ten years ago and only $3.55 fifteen years ago. These prices and the others in the table below are averages based on reports from seven representative paper mills that purchase half the pine pulpwood currently produced in the five states of Virginia, North Carolina, South Carolina, Georgia, and Florida.

Two price series have been prepared--one for wood f.o.b. railroad cars, the other for all wood purchased. The "all-wood" figures are weighted averages of the prices paid for wood loaded on cars, wood delivered to barge landings, and wood delivered directly to pulpmills by truck. Ordinarily, truck wood brings the highest price and barge wood the lowest, while rail wood (which makes up the largest volume) is intermediate. The rail price series is more suitable for showing trends, since the all-wood series reflects not only changes in price but changes in the proportions of rail, barge, and truck wood from year to year. On the other hand, the all-wood prices are the ones applicable to total regional volumes of production or consumption.

Year	Price 1/	
	Rail wood 2/	All wood 3/
	Dollars	Dollars
1938	3.55	3.60
1939	3.75	3.90
1940	4.00	4.15
1941	4.50	4.60
1942	5.90	6.00
1943	7.15	7.25
1944	8.15	8.20
1945	8.35	8.45
1946	9.90	10.10
1947	10.80	10.95
1948	11.65	11.70
1949	10.85	11.00
1950	11.85	11.90
1951	13.65	13.85
1952	13.70	13.90

1/ Per cord of 128 cubic feet of 5-foot wood with bark. Includes dealer's allowance.
2/ F.o.b. railroad car.
3/ Weighted average of all wood loaded on railroad cars, delivered to barge landings, and trucked to pulpmills.

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U. S. Department of Agriculture - Forest Service

RESEARCH NOTES

SOUTHEASTERN FOREST EXPERIMENT STATION

Asheville, North Carolina

Number 47 January 1954

GUM YIELDS OF SOUTH FLORIDA SLASH PINE

During the peak period of turpentining in Florida a score or more years ago some gum producers migrated to the southern portion of the State. But after a few years they withdrew from the region south of Citrus, Sumter, Lake, and Seminole Counties because of the relatively low yields of gum. These hardy pioneers did not know it at the time, but the virgin trees they boxed were a separate and distinct variety of slash pine, recently officially recognized by Federal scientists as south Florida slash pine (Pinus elliottii var. densa Little and Dorman).

Information about the yield of gum that can be obtained from south Florida slash pine is not available in naval stores literature. Therefore, a small test to obtain these data was undertaken in 1952 near Immokalee, Florida, in cooperation with the Collier Company of Everglades, Florida.

Spiral gutters attached with double-headed nails were used for virgin installation on 25 second-growth trees from 9 to 14 inches in diameter at breast height. Bark chipping and acid treatment started on March 24, 1952 and continued at 14-day intervals until the final dipping on November 10, 1952. Whenever the 2-quart cups became full, the gum was dipped and weighed for all trees in the aggregate.

Table 1.--Gum yields of south Florida slash pine

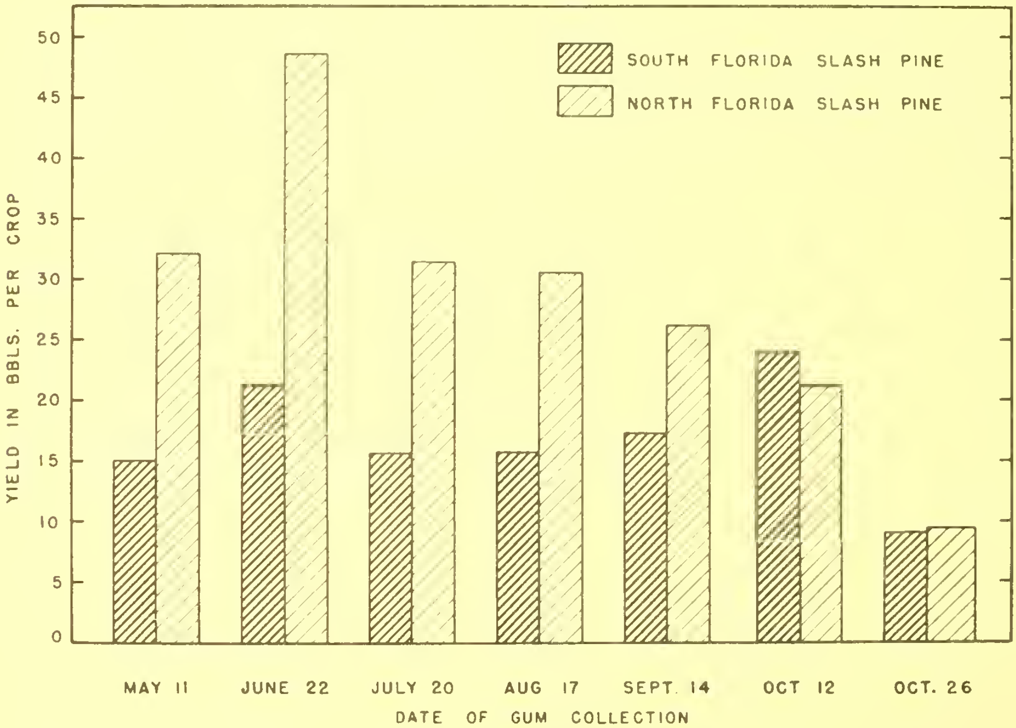
Streak number	Gum yields	
	Barrels per crop	Average no. barrels per streak per crop
1-4	15.1	3.8
5-7	21.4	7.1
8-9	15.7	7.9
10-11	15.8	7.9
12-13	17.4	8.7
14-15	24.0	12.0
16	9.2	9.2
Total	118.6	Average 7.41

The gum yield from a crop (10,000 faces) of south Florida slash pine --118.6 barrels (table 1)--is considerably lower than the 150-250 barrel yields obtained from the common slash pine of north Florida and south Georgia.

For comparison, yields by dippings of the two varieties of slash pine are shown in the figure. The higher yield of the northern variety is quite striking; also the difference in time of peak yields--2nd dipping (7th streak) for north Florida, and 6th dipping (14-15th streak) for south Florida slash pine.

Gum yields for the first four streaks in this study were very low--about half that obtained during the remainder of the season. An explanation of this low yield at the beginning of the season seems to lie in rainfall and soil moisture conditions, which in turn affected tree growth and gum flow. Rainfall, as usually happens in south Florida, was deficient during March, April, and early May. This probably explains the low gum yields of the first four streaks. These observations indicate that the initial streak of the season should not be made until the latter part of May or the beginning of the summer rainy season, and that chipping might be prolonged in the fall. By so doing, the average yield per streak could be raised, and the total yield for the season might be greater.

It is apparent from this study that south Florida slash pine is not a high-gum-producing tree under present systems of working. Therefore, commercial turpentining of this tree in south Florida is not recommended.



O. Gordon Langdon
Lake City Research Center

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 48 January 1954

A COMPARISON OF TWO SYSTEMS OF MEASURING STOCKING OF LOBLOLLY PINE SEEDLINGS

In silvicultural research it is customary to measure the adequacy of seedling reproduction in terms of the percent of milacre quadrats that are stocked. But in forest inventories and cruises, it is more convenient to record the number or stocking of seedlings on a central circular plot of perhaps 1/100 acre, located within a larger cruise plot. This note describes a method of judging stocking on 1/100-acre circular plots, and shows how the stocking percentages compare with those from the conventional milacre tallies used in silvicultural research.

The comparison of stocking estimates using plots of both 1/100-acre and milacre size was made from 22 surveys on 15 separate compartments within the Bigwoods Experimental Forest.[1/] The seedbeds were fairly uniform, inasmuch as those on most of the compartments were prepared with prescribed fire, disking, or poisoning of hardwoods. On the milacre plots the plot was considered stocked if it contained one seedling judged free to grow. On the 1/100-acre plot a maximum of 10 seedlings was counted if spaced at least 2 feet apart and judged free to grow. Fractional stocking resulted when there were less than 10 countable seedlings on the 1/100-acre plot.

A regression analysis indicated that $Y = -17 + 1.1057(X)$ when Y is the percent of milacres stocked and X is the percent of 1/100 acres stocked. The relationship is shown graphically in figure 1.

Although stocking can be translated from one system to the other with the aid of this chart, we do not know exactly what minimum level

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1/ Maintained by the Southeastern Forest Experiment Station in cooperation with the Camp Manufacturing Company, Inc., Franklin, Virginia.

of stocking of seedlings is needed to provide an acceptable stand of older trees. Stand development studies are now under way at the Bigwoods Experimental Forest to follow the future stocking of seedling stands having different degrees of initial stocking. These studies should result in sounder standards for judging the adequacy of reproduction in the seedling stage.

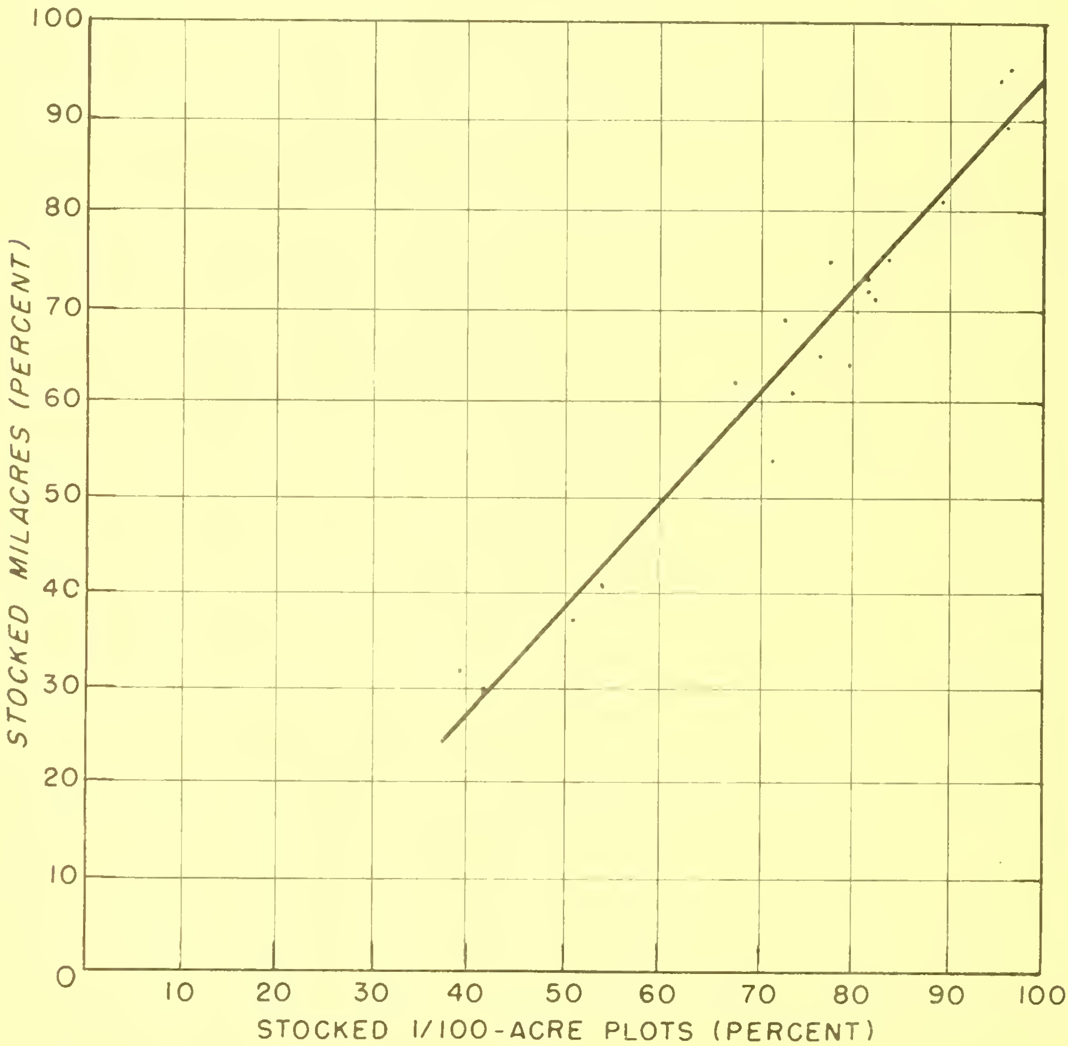

Figure 1.--The relationship of percent stocking by milacres to percent stocking of 1/100 acres.

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Tidewater Research Center

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 49 January 1954

GRAZING LONGLEAF-SLASH PINE FORESTS

In the flatwoods forest area of south Georgia and north Florida, where there is little cultivated land, beef cattle are often grazed yearlong on "wiregrass." To investigate possibilities for improving range cattle production and thereby making more effective use of the forest range resource in such areas, the grazing habits and yearlong performance of breeding herds were studied for 5 years. Four fall and winter feeding management procedures were also studied.

Both native, or "piney-woods," cows and good grade Herefords were included in the herds. All cows were bred to purebred Hereford bulls. One-third to one-half of each range was prescribed-burned in winter and the cattle were held off the burned range during February and early March while sufficient new growth was developing to support the herds. During this period they were maintained in feed lot or on separate unburned range.

From March to September cattle gains were influenced by the amount of burned range. After September, the forage on current burns had lost its advantage in palatability and the cattle were more willing to graze unburned areas. It appears that grazing capacity during the spring and summer should be based entirely on the burned acreage; at least 6 acres per cow seemed to be needed for this period under the conditions studied.

The range forage was deficient in protein and minerals most of the year. Only in March did the protein content satisfy the estimated requirements for growing animals or lactating cows. Special measures were required to induce the cows to eat enough mineral supplement to keep blood phosphorus above the critical level after midsummer when they were suckling calves.

At breeding time, cows suckling calves had regained only a small proportion of the weight losses of winter or those associated with calving, and were generally losing or barely maintaining their weight during the breeding period (see graph). Most of these cows failed to calve the following year. Dry cows, on the other hand, gained weight during the feed-lot period and before and during the breeding season, and usually bred successfully. The average calf crop of cows that produced calves the previous season was only 16 percent. In comparison, the average calf crop of cows that were dry the previous year was 91 percent. The average calf crop for the 54 cows that remained in the study for the full 5-year period was 58 percent. The low quality of range forage appears to be the underlying cause of the low calving percentage of cows suckling calves.

Four procedures of fall and winter management, involving supplemental feeding of protein meal at three levels from mid-October through January, and feed-lot maintenance (on a ration of 20 to 25 pounds of chopped sugarcane and 2 pounds protein meal) vs. supplemented unburned range from February 1 to March 20, were compared in separate breeding herds.

The fall and winter feeding procedures affected weights and death losses of cows, and birth weights and weaning weights of calves, but did not influence the percentage calf crop sufficiently to be statistically significant.

Marked differences in cow gains (or losses) during fall and winter were directly related to the level of feeding, but differences tended to disappear the following spring when the thinnest cows gained most weight. There was, however, a cumulative effect in favor of the higher levels of feeding.

The minimum acceptable levels of supplemental feeding on wiregrass range appeared to be: (a) 1 pound for native cows, or 2 pounds for Herefords, of protein meal per head per day from mid-October through January and feed-lot maintenance during February and early March; or (b) 2 pounds of protein meal continuously from mid-October to mid-March, and separate unburned range during the February-March period (while forage is developing on burned range). At these levels, weaning weights of calves averaged around 280 pounds. Calves from Hereford cows were smaller at weaning time than those of native cows except at the highest level of supplementation, where they were similar.

A lower level of supplemental feeding was unsatisfactory. One herd was intended to receive no supplement on range, but to be maintained in feed-lot during February and early March. However, in 2 of the 5 years this herd had to be fed during December and January to prevent an estimated 80 percent death loss. Calves were smallest in this herd and cow death losses from starvation averaged 7 percent per year. Death losses were proportionately greater for Hereford cows than for natives. The calf crop also tended to be smaller in this herd because of stillbirths and mortality of young calves.

Results from the native cows in the herds maintained at acceptable levels provide an illustration of what might be expected from such low-cost management of range cattle. With a 50-percent calf crop during the years 1944 to 1947, following a high calf crop in 1943, average annual production was approximately 140 pounds of calf per cow. The yearly feed investment per cow for the four-year period was 210 to 320 pounds of cottonseed or peanut meal, 130 pounds of minerals (including salt), and 1,100 pounds of chopped sugarcane (or 3 to 4 acres of additional winter range). At prices prevailing during the study, average feed costs ranged from 7-1/2 to 10 cents per pound of calf produced. Additional costs, not evaluated in this study, would include fencing, death losses (1 or 2 percent), interest, and miscellaneous management expenses including the cost of burning if this were done primarily to improve the forage.

Increasing the percentage calf crop offers most promise for improving the productivity of range herds. A higher level of yearlong nutrition than was provided in this experiment will be required to induce a high percentage of cows suckling calves to breed, and hence to obtain a high sustained calving percentage. In addition to providing a larger amount of range forage for each animal--especially winter-burned range in adequate amounts for spring and summer grazing--the native forage will apparently need to be supplemented with other forage or feed much of the year if a high level of herd productivity is to be obtained.

Further details of this study are given in USDA Circular 928, "Grazing Longleaf-slash Pine Forest," by Weldon O. Shepherd, Byron L. Southwell, and J. W. Stevenson, of the U. S. Forest Service, Georgia Coastal Plain Experiment Station, and Bureau of Animal Industry, respectively. Copies are available from the Southeastern Forest Experiment Station and the Georgia Coastal Plain Experiment Station.

Weldon O. Shepherd
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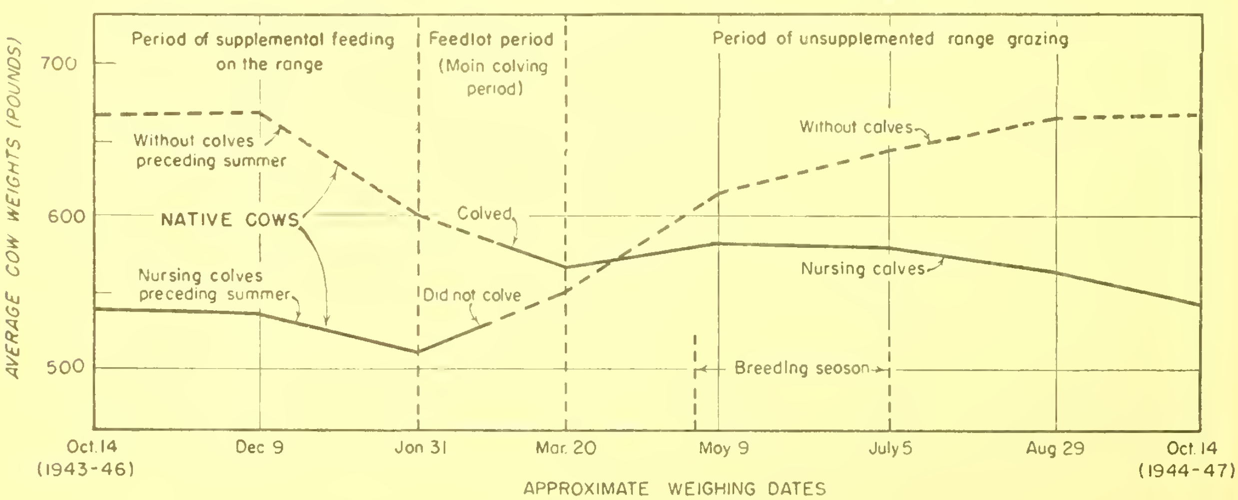

Seasonal trends in weights of native cows with calves and those without calves (average of all herds for 4 years). Weights of Hereford cows were about 200 pounds higher but showed the same trends.

RESEARCH NOTES

SOUTHEASTERN FOREST EXPERIMENT STATION

Asheville, North Carolina

Number 50 January 1954

SITE INDEX OF THE MAJOR PINE FOREST TYPES IN THE SOUTHEAST

Site index is the best single measure of the productivity of forest lands. Knowledge of average site index by forest type and locality, and the proportion of the forest type areas in the various site classes is useful to foresters in many ways. The following table, covering the major pine forest types in the Southeast should help guide land acquisition for forest management, aid in the analysis of forest conditions and problems in states and physiographic regions, and provide data needed in estimating future timber yields.

State	Coastal Plain					Piedmont					Average site of type
	Site Index Class[1/]				Avg. site	Site Index Class[1/]				Avg. site	
	50-	60	70	80+		50-	60	70	80+		
	- -	Percent	- -		Feet	- -	Percent	- -		Feet	Feet
LOBLOLLY PINE TYPE											
Virginia	8	16	50	26	70	6	30	34	30	70	70
North Carolina	1	19	58	22	71	-	9	55	36	73	71
South Carolina	-	8	46	46	76	2	15	55	28	72	75
Georgia	-	8	26	66	80	-	11	54	35	73	75
Florida	-	14	23	63	80	-	-	-	-	-	80
Entire type	2	14	48	36	73	Negl.	12	54	34	73	73
SHORTLEAF PINE TYPE											
Virginia	30	40	30	-	60	41	35	18	6	58	58
North Carolina	37	46	17	-	57	26	58	15	1	59	59
South Carolina	32	57	9	2	58	42	51	7	-	56	56
Georgia	-	-	-	-	-	20	59	19	2	60	60
Entire type	33	48	18	1	58	31	53	14	2	58	58
VIRGINIA PINE TYPE											
Virginia	30	46	24	-	59	50	37	12	1	55	56
North Carolina	-	-	-	-	-	49	43	8	-	55	55
South Carolina	-	-	-	-	-	83	17	-	-	49	49
Entire type	30	46	24	-	59	51	38	10	1	55	56
LONGLEAF PINE TYPE											
North Carolina	29	67	4	-	57	-	-	-	-	-	57
South Carolina	24	55	19	2	60	-	-	-	-	-	60
Georgia	3	43	44	10	66	12	54	31	3	62	66
Florida	34	45	17	4	59	-	-	-	-	-	59
Entire type	25	47	23	5	60	12	54	31	3	62	61
SLASH PINE TYPE											
South Carolina	2	20	51	27	70	-	-	-	-	-	70
Georgia	1	31	50	18	69	-	-	-	-	-	69
Florida	18	48	25	9	62	-	-	-	-	-	62
Entire type	11	40	36	13	65	-	-	-	-	-	65
All types	15	36	33	16	65	22	36	29	13	63	65

1/ The height of dominant and codominant trees at 50 years of age.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 51 April 1954

LABOR REQUIREMENTS AS INFLUENCED BY VOLUME CUT PER ACRE ON THE BENT CREEK EXPERIMENTAL FOREST[1]

A knowledge of the relationship of logging cost to volume cut per acre is essential to the forest manager and timber operator. A study of time reports kept during the past 4 years of cutting on a large-scale test of management systems on the Bent Creek Experimental Forest indicated that time per M b.f. for felling and bucking decreased as the cut per acre increased. Skidding time, however, was apparently not affected by cut per acre. The gross cut per acre varied from a low of 1.8 M b.f. per acre to a high of over 6 M b.f. The residual volumes ranged from zero M b.f. to nearly 10 M b.f. per acre. Timber cutting methods included both hand and power operations. Skidding was largely by tractor.

In the table on the reverse side of this sheet the compartments are arranged by sale areas. Consequently, comparisons made between compartments within the same sale are sound, since the same crews usually worked the entire sale area. Because there were frequent changes in crews between sales, comparisons between sales are not as dependable as those between compartments on the same sale. Furthermore, separate and detailed time studies have shown greater differences between individual crews and their efficiencies than between the other variables studied, including tree size, log lengths, etc. In addition, this series of sales is a relatively small sample for a reliable statistical check. Nevertheless, the following indications of time and cut per acre are adequate to show trends, even though they are probably not reliable enough for predicting time on other sales.

Felling and bucking by hand was closely associated with cut per acre as shown in the attached diagram, which is based on a regression analysis. This analysis also showed that felling and bucking time was not significantly affected by residual stand per acre, cull percent or d.b.h. of the average tree. As the diagram shows, felling and bucking with hand tools took about 3 man-hours more time per M b.f. than with power saws.

The time requirements shown in the chart are higher than those shown in Station Paper No. 30 for the same operations.[2] The earlier data are based on piece-rate work, which resulted in lower time requirements than the hourly wage used in the studies reported here.

1/ Near Asheville, N. C. One of the study areas of the Southern Appalachian Research Center.

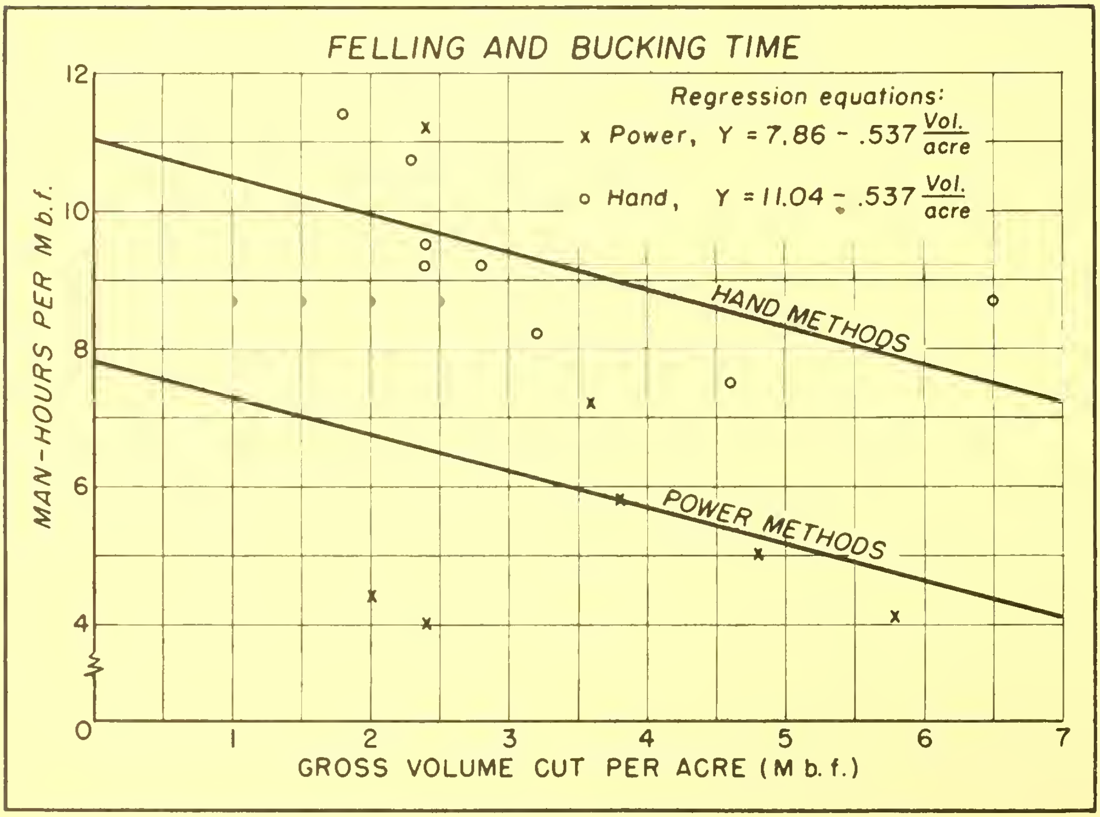
2/ Campbell, R. A. Logging methods and costs in the Southern Appalachians. October 1953.

Labor requirements Bent Creek sale areas

POWER METHODS

Compartment number	Area in acres	Volume cut per acre[2]	Time per thousand b.f.[1]	
			Felling and bucking	Skidding
		M b.f.	Man-hours	Man-hours
15	120	5.8	4.1	4.4
13	76	4.8	5.0	3.3
21	96	2.4	4.0	3.7
19	116	2.0	4.4	2.5
5	58	3.8	5.8	3.2
6	91	2.4	11.2	5.0
14	70	3.6	7.2	5.1
Average		3.5	5.8	4.0
HAND METHODS				
25	88	2.4	9.2	4.7
26	105	2.8	9.2	4.7
27	75	2.3	10.7	6.1
28	132	2.4	9.5	5.0
29	133	4.6	7.5	5.2
30	88	1.8	11.4	7.1
31	82	3.2	8.2	5.3
32	99	6.5	8.7	5.9
Average		3.2	8.9	5.6

1/ Int. 1/4 inch log rule.
2/ Gross.



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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 52 April 1954

SPRAYING LOGS OF OAK WILT TREES TO REDUCE INFECTION HAZARD

Wilt caused by the fungus Endoconidiophora fagacearum is a major killing disease of oaks in the United States. The fungus spreads locally through root connections between infected and healthy trees. It is not yet known how the disease spreads overland. Experiments show, however, that insects such as nitidulid beetles can carry enough inoculum from mats of the wilt fungus to cause infections through fresh wounds on healthy trees. Mats form beneath the bark of some dead infected trees; they are subsequently exposed to insects by bark cracks. Thus insects are suspected of being agents of oak wilt spread.

Trees infected with the wilt fungus should therefore be treated to reduce the possibility of spread of the disease from them by insects. It is sometimes not practicable to burn them or to utilize them quickly. Although felling and peeling the bark from infected trees reduces insect activity in and on them, as well as decreases or prohibits wilt fungus mat formation, it is laborious. Tests of an alternative method, spraying unbarked logs of felled trees with a chemical mixture, are in progress.

Fifty-two wilting oaks up to 25 inches d.b.h. were felled in western North Carolina and eastern Tennessee in the summers of 1952 and 1953. The stems were bucked into 6- to 10-foot logs. Half of the logs were sprayed with the chemical mixture;[1] half were left unsprayed.

The data obtained from trees cut in 1953 illustrate the effect of the treatment. Two months after treatment the bark was peeled back one linear foot from the end of each log of 25 trees. The living cambial insects[2] and pinholes were counted. Table 1 shows the marked reduction in numbers of insects in the sprayed logs.

Table 1.--Cambial insects and pinholes in sprayed and unsprayed logs

Treatment	Bark area examined	Total cambial insects	Total pinholes
	Square feet	Number	Number
Logs sprayed	244	127	8
Logs unsprayed	244	1,533	481

1/ 1 percent BHC, 5 percent DDT, 5 percent pentachlorophenol in No. 2 fuel oil.

2/ Identified by the Division of Forest Insect Investigations as members of Buprestidae, Cerambycidae, Cucujidae, Platypodidae, Scolytidae, Staphylinidae, and Synchroidae.

Exposed wilt-fungus mats were found on logs of five trees in the fall of 1953. Many of these mats were infested with insects, mostly nitidulid beetles. Table 2 shows that fewer living insects were found on mats on sprayed logs.

Table 2.--Living insects on oak wilt fungus mats on sprayed and unsprayed logs

Type of mat and log treatment	Total mats	Area of mats	Insects per square foot of mats
	Number	Square feet	Number
Sprayed logs			
Fresh mats	15	2.1	20
Old mats[1/]	15	1.0	8
All mats	30	3.1	16
Unsprayed logs			
Fresh mats	33	3.3	117
Old mats	6	0.4	210
All mats	39	3.7	127

1/ Mats old but neither overrun by secondary molds nor decomposed.

A similar result was obtained in 1952 when, by fall, only one out of 23 felled wilted trees produced mats. There were 2.9 living insects per square foot of mat on sprayed logs compared with 105 per square foot of mat on unsprayed logs of this tree.

Pentachlorophenol was incorporated in the spray because of its fungicidal properties, but it did not inhibit mat formation under the bark. It has a place in the spray mixture, however, in inhibiting fungus growth on the log ends.

The above study shows that spraying unbarked logs of oak wilt trees is a promising treatment for reducing the possibility of insect spread of the disease.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 53 April 1954

A PRACTICAL SCHEDULE FOR PRUNING PLANTED SLASH PINE

The results of a study conducted on the George Walton Experimental Forest, Dooly County, Georgia, suggest a practical two-stage schedule for pruning planted slash pine which will keep enough crown on the trees to maintain reasonably rapid diameter growth.

In a plantation of 10-by-10-foot spacing, 5 years of age averaging 15 feet in height and 3.9 inches d.b.h., the following five degrees of live-crown removal were applied: none (control); 35 percent; 50 percent; 65 percent; and 80 percent. A total of 250 trees, with an average ratio of crown to total height of 89 percent before pruning, were included in the study. Average annual diameter and height growth figures for the first 4 years after treatment are given below:

Live crown removed (Percent)	Average crown ratio after pruning	Diameter growth	Height growth
	Percent	Inches	Feet
0	88.8	0.57	3.92
35	49.9	.55	3.84
50	38.4	.52	3.84
65	26.5	.44	3.66
80	12.4	.40	3.59

Although upper extremes of pruning resulted in some reduction of diameter growth, 35 percent green crown removal had a very slight effect. The average loss for the 4-year period was only 3.5 percent. The effect on height growth was even less pronounced.

Removing 35 percent of the live crown gave a cleared bole of 7.3 feet and left the tree with a crown ratio of 50 percent, which is adequate for rapid growth. Five years later, when heights averaged 33 feet, the base of the live crown had moved to 14 feet above ground, and the average crown ratio was about 60 percent. To reach the 17-foot level at this age, only 3 feet of the live crown, or 16 percent, need be removed, and the tree will be left with a crown ratio of about 50 percent.

From these facts a practical schedule for pruning slash pine plantations of this type can be phrased as follows:

1. At 5 to 6 years of age, when heights can be expected to average 15 to 18 feet and crown ratios 80 percent or more, prune to 8 feet. To

reach this height, removal of not more than 35 percent of the live crown should be required while maintaining a crown ratio of about 50 percent.

2. Five to six years later, when heights should average 33 to 36 feet and crown ratios about 60 percent, return and prune to 17 feet. This will again permit maintenance of a crown ratio of about 50 percent.

The main advantage of two-phase pruning over one-phase is a greater yield of clear material; the knotty core is held to a minimum size. Also, the smaller branches are removed faster and smaller knots heal over sooner. Although complete cost records are not yet available, studies elsewhere indicate that two-stage pruning costs little or no more than pruning to 17 feet in one operation.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 54 July 1954

LOW-COST RANGE IMPROVEMENT PAYS IN THE SOUTHEAST

Common practice in cut-over longleaf-slash pine is to stock the land with cattle during the interim between logging and re-establishment of a new timber stand. A recent study in south Georgia shows that re-vegetation with improved forage on such areas markedly increases this supplemental income from beef. The study was conducted cooperatively by the Forest Service and Agricultural Research Service of USDA, and the Georgia Coastal Plain Experiment Station. Annual returns from grazing were increased approximately threefold by range improvements in this study, from $2.10 to $6.14 per acre (see table).

Range improvement was begun in the late fall with the burning of litter and slash on a recently logged area which has been left with 6 to 8 seed trees per acre. This initial burn was the only seedbed preparation and was not repeated thereafter. Following the application of

Average annual range cost1/ and return from grazing cattle (1951-1953) per-acre

Item	Range seeded to carpetgrass and lespedeza	Unimproved forest range
	Dollars	Dollars
Cost		
Fertilizer	4.80	--
Seed2/		
Carpetgrass	.18	--
Lespedeza	.75	--
Labor	1.00	--
Burning2/	.03	0.15
Total	6.76	0.15
Return		
Gross from beef at $.15/lb.	12.90	2.25
Net	6.14	2.10

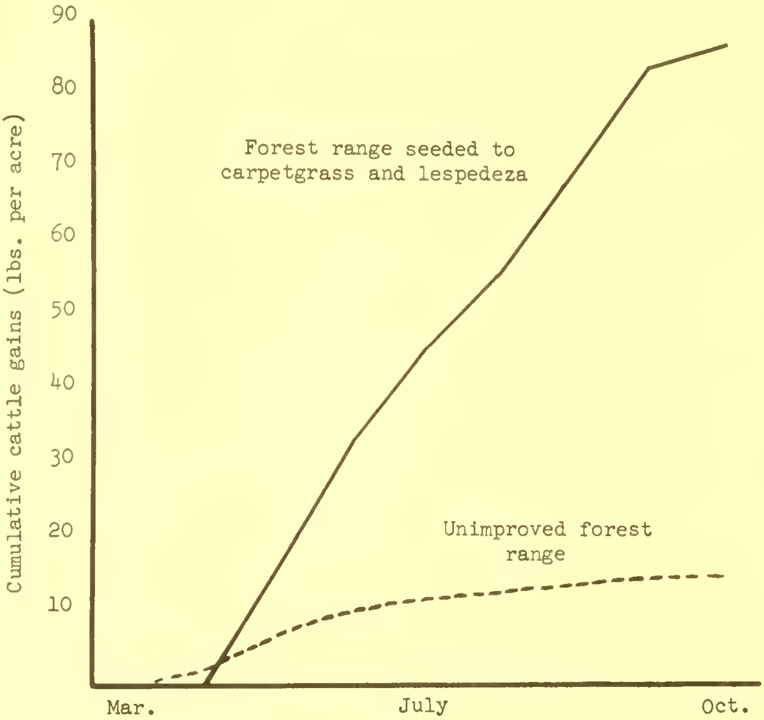
1/ Does not include cost of fencing, care of livestock, or interest on investment.

2/ Costs of seed and of initial burn on improved range were prorated over 5 years; unimproved range was burned every year.

400 pounds per acre of 0-14-14 commercial fertilizer, carpetgrass and common lespedeza were broadcast seeded in the spring at the rate of 3 and 5 pounds per acre, respectively. During the spring and summer, cattle grazed the native bunch grasses, reducing their abundance and promoting the establishment of the improved plants.

To maintain vigorous stands of the reseeded species, 200 pounds per acre of 0-14-14 fertilizer was applied annually. One reseeding of lespedeza at half the original rate was necessary to increase the number of plants. In such cases, reseeding is sometimes required because late winter freezes kill young seedlings which have sprouted during earlier warm weather.

Cattle numbers were varied to correspond to seasonal forage production, and maximum gains resulted. From 2 to 3 acres were allowed for each animal (500 pound heifer) for the grazing season, April to mid-October.



Yearling gains on improved range were greater and continued later in the season than on unimproved range.

Carpetgrass and common lespedeza, being warm-season plants, produced consistent cattle gains from April through September. After September the gains were considerably less. On the other hand, unimproved burned "wiregrass" furnished grazing a month earlier but nearly all the animal gain was made by July. Thus, the productive grazing season was extended several months by use of the improved species.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 55 July 1954

REDUCTION IN GROWTH OF INTERPLANTED SLASH PINE

When the survival in a new plantation falls below an acceptable standard in the first year, many people replant during the second year to bring up the stocking. Such replanting involves a risk that the seedlings planted the second year may be suppressed by survivors of the original planting. Some evidence on the extent of this risk in slash pine is provided by recent plantation inventory data on the George Walton Experimental Forest, Dooly County, Georgia. These data show that a difference of only 1 year in age of planted slash pine can be sufficient to result in suppression of the younger trees.

In 1945 cooperator Holt E. Walton planted several fields to slash pine, using a spacing of 15 x 15 feet. One year later, reasoning that the spacing was wasteful, he interplanted in one direction. The spacing was thus converted to 7-1/2 x 15 feet, and almost as many trees were set out as in the original planting.

Eight years after the interplanting, a 100-percent inventory of diameter classes was made on two plantations and a random sample of heights taken. The disparity in growth between the interplanting and the original planting was so evident that each was tallied separately. These data appear below:

D.b.h. (Inches)	Plantation I		Plantation II	
	First planting	Interplanting	First planting	Interplanting
	Number trees	Number trees	Number trees	Number trees
1	10	169	4	85
2	56	510	67	275
3	196	724	148	456
4	350	216	267	214
5	717	19	451	23
6	683		440	
7	191		81	
8	19		4	
Total	2222	1638	1462	1013

The marked difference between average size of interplants and first plantings is summarized as follows:

	Average d.b.h. (Inches)	Average height (Feet)
Plantation I		
First planting	5.1	27.6
Interplants	2.6	19.1
Plantation II		
First planting	4.9	29.7
Interplants	2.8	21.3

Figures for the total number of trees show the interplants to have 26 percent fewer trees in Plantation I and 31 percent less in Plantation II. The practice of leaving unplanted rows at intervals for firelanes accounts for one-third of the blanks in the interplants. The remaining blanks have been caused by mortality. As shown by the heights tabulated above, the interplants are now definitely below the main canopy level. They are being crowded more each year by the larger original trees, and heavy mortality can soon be expected.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 56 July 1954

BURNING AND GRAZING HAVE LITTLE EFFECT ON CHEMICAL PROPERTIES OF COASTAL PLAIN FOREST SOILS

Contradictory results have been noted by various workers regarding burning and grazing effects upon the soil organic matter and nutrient content. Inherent fertility, physical makeup of soil, and climate provide reasonable explanations for these variations. Recent tests indicate that the chemical characteristics of the relatively infertile, sandy soils of the Coastal Plain region are not materially affected by either grazing or burning (see table).

These studies[1/] were conducted on a series of forest grazing units located at the Alapaha Experimental Range near Tifton, Georgia. Comparisons were made between grazed and ungrazed ranges which had been subjected to several rotations of winter burning. Two soil samples representing each condition were collected at each of two depths (0 to 3 inches and 3 to 10 inches) during the winter, 8 years after treatments were initiated. These samples were later composited and analyzed for organic matter, phosphate, potash, and soil acidity according to procedures outlined in the table. Differences in these elements between grazed-ungrazed and burned-unburned areas were not statistically significant.

Topography of this region is nearly flat (0-2 percent slope). Predominant soil types are the imperfectly drained Lynchburg loamy fine sand and poorly drained Plummer sand. The cover consists of a scattered stand of longleaf and slash pine, with an understory of ericaceous shrubs and wiregrass.

1/ Conducted by the Forest Service in cooperation with Agricultural Research Service, USDA, and Georgia Coastal Plain Experiment Station.

Composition of coastal plain soils after burning and grazing

COMPOSITION AT 0 TO 3-INCH DEPTH

Treatment	Organic matter[1]	Phosphate (P_2O_5)[2]	Potash (K_2O)[2]	Acidity[3]
	Percent	Lbs. per acre	Lbs. per acre	pH
Burned				
Grazed	2.7	50.6	74.7	4.7
Ungrazed	2.8	46.9	75.1	4.7
Unburned				
Grazed	2.6	62.7	68.4	4.7
Ungrazed	2.8	74.3	61.5	4.7
COMPOSITION AT 3 TO 10-INCH DEPTH				
Burned				
Grazed	1.2	47.3	28.0	4.9
Ungrazed	1.2	45.0	33.7	4.9
Unburned				
Grazed	1.3	62.5	36.5	4.9
Ungrazed	1.2	69.3	33.4	4.8

1/ Procedure followed is described by A. Walkley and I. A. Black in "An Examination of the Degtjareff Method for Determining Soil Organic Matter, and a Proposed Modification of the Chromic Acid Titration Method," in Soil Sci. 37: 29-38, 1934.

2/ Extracted with a solution .025 N HCL and .05 N H_2SO_4.

3/ Beckman glass electrode.

Since little or no change occurred in soil organic matter, phosphate, potash or acidity, indications are that burning and grazing do not appreciably influence timber or other vegetative growth on these soils.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 57 July 1954

ESTIMATING THE LITTLELEAF HAZARD IN SOUTH CAROLINA PIEDMONT SHORTLEAF PINE STANDS BASED ON SITE INDEX

A South Carolina soils-littleleaf survey was conducted in 1949-50 to determine whether or not a relationship existed between certain soil characteristics and the incidence of littleleaf. This survey was limited to fairly well-stocked stands of shortleaf pine from 30 to 65 years of age. Within this age spread, site indices ranging from 40 to 85 feet were encountered. The mean site index for the 158 plots examined was 60.3 ± 0.49 feet. A simple regression analysis between the percent of littleleaf-diseased trees on a given plot and site index showed that as site index increased, littleleaf incidence decreased. This relationship was highly significant at the 1-percent level. The derived regression equation follows: $Y = 62.53 - 0.816\ X$, where Y is the percent of littleleaf trees and X is site index in feet.

The soils from the 158 plots were grouped into either sandy soils or clay soils. A regression analysis between the percent of littleleaf trees and site index showed a highly significant correlation between these two variables for each group of soils. However, a statistical test failed to show that these equations varied significantly from the previous one derived for all soils; hence they are omitted from this discussion.

Stunted trees with chlorotic foliage often found on poor sites should not be confused with littleleaf. Such trees may live for many years but make no appreciable growth; neither do they die from the base of the crown upward. Their crowns do not become progressively sparse (in the manner characteristic of littleleaf) as the disease becomes worse. The cause of stunting in this case is chiefly low fertility. Sufficient evidence is available to show that littleleaf may occur on good as well as poor sites wherever wet soil conditions exist favoring a sufficient build-up of *Phytophthora cinnamomi* to cause excessive root mortality. Thus, some care is needed to distinguish littleleaf from purely nutrient deficiency.

Expected littleleaf incidence in relation to site index

Stand site index	Expected littleleaf incidence
Feet	Percent
40	29.9
45	25.8
50	21.7
55	17.7
60	13.6
65	9.5
70	5.4
75	1.3
80	0

The tabulation given here is derived from the regression equation showing the relationship between the incidence of littleleaf and site index. Field forestry personnel may find the data of assistance in estimating the littleleaf expectancy in established shortleaf pine stands in the South Carolina Piedmont within the ages covered by this survey. Additional methods for estimating littleleaf potential, based on soil characteristics, are given in Station Paper 25.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 58 July 1954

THE EFFECT OF GRAZING ON SLASH PINE SEEDLING SURVIVAL

Under certain conditions forest landowners who combine timber and livestock production need not exclude cattle from interplanted wild areas because of any detrimental effect on first-year survival of slash pine seedlings. This fact was established by a recent study on a moderately stocked forest range on the George Walton Experimental Forest, Dooly County, Georgia.

In February, 1952, approximately 80 acres of understocked longleaf pine land within a 1000-acre timber tract were prescribe burned to control brown spot disease, to release longleaf seedlings in the grass stage, and to improve seedbed conditions for the coming fall. Although an excellent burn was obtained, there were insufficient seedlings released or otherwise established from seed to provide adequate stocking. This prompted interplanting to slash pine one year later, at a 6- by 8-foot spacing, on about 50 percent of the previously burned area.

Livestock production has always been an integral but secondary aspect of land use in this experimental area. Therefore, an excellent opportunity was afforded to study the effects of grazing on survival, growth, and development of the planted pines. With this in view, grazed and ungrazed plots were established on the two main forage types, wiregrass and carpetgrass, where pines were planted. Following the planting in February, 53 cows and 41 calves grazed the 1000-acre tract, of which the planted area was a part, from mid-March to mid-November. Seedling survival and degree of forage utilization were measured one year after planting.

The size of the area permitted unrestricted movement of the cattle. They were thus permitted great selectivity in forage while avoiding forced concentrations. Although the "wiregrass" type of forage was lightly grazed and carpetgrass was cropped closely, there was no correlation between intensity of grazing and seedling survival. Response was similar on both forage types. These facts are illustrated in the following table.

Pine seedling survival and degree of forage utilization on interplanted timberlands on the George Walton Experimental Forest

Forage type and plot number	Forage utilization	Pine seedling survival	
		Grazed	Ungrazed
	Percent	Percent	Percent
Wiregrass			
4	45	52	51
1	(1/)	33	47
5	(1/)	50	51
Carpetgrass			
3	95	50	50
2	91	53	44
6	79	56	68

1/ Forage utilization was not evident on these plots.

In this study factors other than grazing appeared to be more important in obtaining good first-year survival of planted slash pine. Subsequent observations will permit further evaluation of grazing on the growth and development of the planted trees.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 59 July 1954

GRAFTING SUCCULENT SLASH PINE SCIONS

Grafting by accepted techniques is best done on slash pine in late winter before leader growth starts. This is also the period of flowering, when breeding work must be done. The result is a seasonal overload of tree improvement work requiring the attention of trained personnel. The season of flowering cannot be controlled, but a new technique that would permit slash pine scions to be grafted successfully during the growing season would extend the work period and permit technicians to do more breeding and grafting each year.

Steps in this direction were taken during the middle of April, 1953 when a test was started to graft succulent slash pine scions directly on wildling slash pines. Before the grafting was begun, a shadehouse was built over the seedlings that were to serve as rootstocks. Seedlings used as stocks ranged from 1 to 3 years old. At the time of grafting, the leaders had added up to 6 inches of growth and the newly formed tissue was succulent and tender. All the grafting for this study was done into the leader of the stock. The needles of the scion material had already ruptured the sheath but had not developed fully as yet. The scions were 1 to 1-3/4 inch in length, and were collected from the side branches of trees of various ages. Some scions were collected from large trees, and their diameter was larger than that of the stock. The new growth of the stock plant was cut at about 1-1/2 to 2 inches above its base and split longitudinally about 2/3 inch with a sharp grafting knife. The wedge-shaped base of the scion was inserted in the cleft of the stock and the respective growth layers of the partners were aligned carefully. A narrow grafting band was used to tie the union, after which it was sealed over with grafting wax. A bag was tied over each graft to exclude wind movement and maintain a high relative humidity around the scion.

Three types of bags were tested: plastic sausage casing, polyethylene plastic, and glassine.

The plastic sausage casings, 4.5 inches wide and 15 inches high, had enough stiffness to maintain the desired shape. The walls of the glassine bags were separated by filling them with air. The polyethylene bags used had very soft walls which were impervious to moisture. Moisture from transpiration condensed along the walls and made them stick together. This difficulty was overcome by placing a forked stick inside the plastic bag. In addition to the cleft grafts described, three approach bottle grafts were attempted; the cut was made in the new growth of the leader.

Beginning 4 weeks after grafting, the bags were removed gradually. First, one of the upper corners of the bag was cut off to let outside air into the bag. The grafting rubbers were removed 6 weeks after grafting, at which time the remaining part of the bag was taken off.

A comparison of attempted and successful unions 8 months after grafting is summarized as follows:

Number of attempted and successful grafts made during the succulent stage

Type of bag	Cleft graft		Bottle graft	
	Attempts	Success	Attempts	Success
Polyethylene bag	16	15	1	1
Plastic sausage casing	4	2	2	2
Glassine (full shade)	7	4		
Glassine (short period of sunlight daily)	6	1		

Water which was lost through transpiration from the needles condensed on walls of the moisture-proof polyethylene bags and finally collected in the folds at the base. Hence the needles of the scion were covered with droplets of water during most of the day. The plastic sausage casings and glassine bags were not impervious to moisture. These bags, however, were helpful in decreasing the transpirational loss by hindering wind movement around the needles.

The high number of successful cleft grafts obtained with polyethylene bags can probably be attributed to the high humidity around the scion. The atmosphere around the wound was saturated with water vapor, and this decreased the transpirational loss from the scion. Shaded cleft grafts covered with a plastic sausage casing or a glassine bag were not as successful. The scion dried from the tip downward. In some instances the upper part had already withered while the lower needles of the scion were still green and succulent. The three bottle grafts were successful, and developed into vigorous graft combinations.

Direct sunlight on the grafts, even for a daily 2-hour period, was harmful. Of six such attempts, only one survived. The scion of the graft which survived had died back to the union and a side bud developed from the base of a needle fascicle which was enclosed in the union by the two wings of the stock. The temperature within the glassine bags under the shadehouse was as much as 28^{o} F. lower than that of the atmosphere within the bags exposed to the direct sunlight. This higher temperature decreased the relative humidity within the exposed bags, speeded up the transpiration of the scion, and increased the diffusion pressure deficit at the union.

The results indicate that grafting slash pine scions in the succulent stage is a promising method of obtaining a large number of successful unions and prolonging the grafting season for several months.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 60 July 1954

SOUTHERN PULPWOOD PRODUCTION INCREASED IN 1953

In 1953 the production of pulpwood from Southern forests was 16,127,000 cords. This was 10.7 percent more than in 1952 and 14.7 percent more than in 1951. Production of pine was 9.7 percent greater than in 1952 and of hardwood 13.4 percent greater. Chestnut production was one-third less.

In addition to the pulpwood cut from standing timber, 75,900 cords of plant residues from other forest industries were used for pulp. Chipped slabs and edgings from sawmills totaled 25,700 cords; the rest was chiefly veneer cores.

Pulpwood production in the Southern States, 1953

State	1953 Production				Change from 1952
	Pine	Hardwood	Chestnut	Total	
	Cords	Cords	Cords	Cords	Percent
Florida	1,671,200	3,700	--	1,674,900	+ 5.8
Georgia	2,748,900	124,600	5,700	2,879,200	+14.6
South Carolina	1,273,400	172,800	--	1,446,200	+13.4
North Carolina	1,263,100	246,500	19,300	1,528,900	+14.8
Virginia	1,033,600	232,600	1,100	1,267,300	+18.5
Southeast	7,990,200	780,200	26,100	8,796,500	+13.2
Alabama	1,726,200	38,900	--	1,765,100	+ 9.7
Arkansas	673,200	107,800	--	781,000	+26.0
Louisiana	1,179,000	196,500	--	1,375,500	+11.4
Mississippi	1,273,400	649,600	--	1,923,000	+ 3.1
Oklahoma	41,000	--	--	41,000	+17.5
Tennessee	105,300	93,900	35,000	234,200	-12.8
Texas	1,159,300	51,400	--	1,210,700	+ 4.4
Lower South	6,157,400	1,138,100	35,000	7,330,500	+ 7.9
Total South	14,147,600	1,918,300	61,100	16,127,000	+10.7
Percent	87.7	11.9	0.4	100.0	--

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 61 July 1954

LOBLOLLY PINE TOPWOOD VOLUMES

The amount of topwood available for pulpwood above the logs of saw-log trees is commonly estimated from tables based on average top diameter limits of utilization for saw logs and for pulpwood. To cover operations in which larger or smaller top limits are used, more detailed tables were needed.

For this purpose, taper measurements of 310 trees at the Westvaco and Santee Experimental Forests[1] were analyzed to determine the influence of several factors on topwood volume of loblolly pine. This volume will vary according to the diameter, form class, and height of trees cut, and the degree of utilization practiced. Small volume differences occur by form class and height, but large differences are found by tree diameter and degree of utilization. Since the former are difficult to measure, it is practical to eliminate them in this case. Cubic-foot volumes by tree diameter class to certain common sawtimber and pulpwood top limits are given in table 1. All volume figures in the analysis have been averaged by diameter class and read from smoothed curves.

Table 1.--Loblolly pine topwood volume per tree, by top limits according to diameter class

Top d.i.b. of --		Tree diameter (inches)					
Sawtimber	Topwood	10	12	14	16	18	20
Inches	Inches	- - - -	Cubic feet inside bark	- - - -			
6	4	2.3	1.6	1.2	--	--	--
6	5	1.8	1.1	.8	--	--	--
8	4	7.8	5.8	4.6	--	--	--
8	5	7.1	5.2	3.8	2.9	2.3	2.1
8	6	--	--	--	2.2	1.7	1.6
10	5	--	--	--	8.1	6.2	5.0
10	6	--	--	--	7.3	5.3	4.3

A useful measure of topwood volume is the ratio of cubic feet of topwood per thousand board-feet of sawtimber. This measure, unlike that on a per-tree basis, accounts for form class and height variations. As form class and height vary within a diameter class, so do sawtimber board-foot and topwood cubic-foot volumes, but the ratio between the two tends

1/ Operated by the West Virginia Pulp and Paper Company near Georgetown, S. C., and the Southeastern Forest Experiment Station near Charleston, S. C., respectively.

to remain constant. Cubic feet of topwood per thousand board-feet of sawtimber by the International 1/4-inch and Scribner log rules for loblolly pine are given in table 2.

Table 2.--Loblolly pine topwood volumes per thousand board-feet of sawtimber

BY INTERNATIONAL 1/4-INCH RULE

Top d.i.b. of --		Tree diameter (inches)					
Sawtimber	Pulpwood	10	12	14	16	18	20
Inches	Inches	- - - Cu. ft. i.b. per M bd.-ft. - - -					
6	4	34	14	7	--	--	--
6	5	27	10	4	--	--	--
8	4	186	60	27	--	--	--
8	5	169	54	23	11	7	5
8	6	--	--	--	9	5	4
10	5	--	--	--	36	19	12
10	6	--	--	--	33	16	11

BY SCRIBNER RULE

6	4	50	18	8	--	--	--
6	5	39	12	5	--	--	--
8	4	223	75	34	--	--	--
8	5	203	68	28	13	8	6
8	6	--	--	--	10	6	4
10	5	--	--	--	42	21	14
10	6	--	--	--	37	18	12

Thus, for a given set of utilization standards, an estimate of cubic feet of available topwood can be made from table 1 using number of trees by diameter class, or from table 2 using board-foot volume by diameter. Studies by other workers indicate that conversion to rough standard cords can be approximated upon dividing the tabular values by 65.

An important point for a sawtimber seller to bear in mind is that additional income can be obtained from topwood of pulpwood size. Many sawtimber stands are cruised and sold on the stump using volumes taken from tables based on an 8-inch top, but the saw-log operator often cuts to a 6-inch top in order to gain some extra volume. In this case, the seller loses some 80 percent of the topwood volume in these trees and as a result may not even have an operable topwood sale.

If a seller of sawtimber stumpage is going to sell by tree measure, he should determine the top d.i.b. on which the sawtimber volume estimate is based and specify that the buyer must not, in general, cut below this top diameter. An estimate of the available topwood can then be determined and used as a basis for a pulpwood sale.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 62 October 1954

VARIATION IN 2-YEAR-OLD SLASH PINE SEEDLINGS

During December 1952, an outplanting of slash pine seedlings from five different geographic origins was established in Baker County, Florida. This plantation is part of the Cooperative Study of Geographic Sources of Southern Pine Seed sponsored by the Committee on Southern Forest Tree Improvement. The plantation is located on a good site (Plummer soil) on a 40-acre tract provided by the National Turpentine and Pulpwood Corporation for research in forest tree improvement. This site previously supported a good stand of longleaf pine. After clear-cut logging, the area was control-burned and rolled with a brush-cutter before planting.

Planting followed the design outlined in P. C. Wakeley's working plan for the Cooperative Study, there being 484 seedlings for each of the five sources, planted with a dibble on a 6-by-6-foot spacing. For analytical purposes the central 49 seedlings in each of the 20 measurement blocks were used.

The inventory of the plantation at the end of the first growing season showed that the five sources of seedlings were not equally well adapted to north Florida conditions (fig. 1).

The overall survival of the five sources was good, averaging 91.6 percent. Source of planting stock or site difference in plantation had no statistically significant effect on survival.

Analysis of the data on total height showed that seedlings raised from seed collected in Polk County, Florida, were significantly shorter than those from any other seed source.

Under north Florida conditions, slash pine seedlings turn a brown to purplish color when cold weather sets in. The Polk County, Florida, seedlings did not turn color, but stayed light green all through the winter. They did not show any outward signs of frost hardening. There was a high incidence of frost damage to these seedlings; and they did not start to bud out until seedlings from other sources had added as much as 3 inches of height growth. A large percentage of the Polk County seedlings differed from the typical slash pine (Pinus elliottii var. elliottii) seedlings in general appearance. The stem was much heavier and the needles crowded, giving a tuftlike appearance similar to that of South Florida slash pine, which has recently been established as a separate variety, Pinus elliottii var. densa.

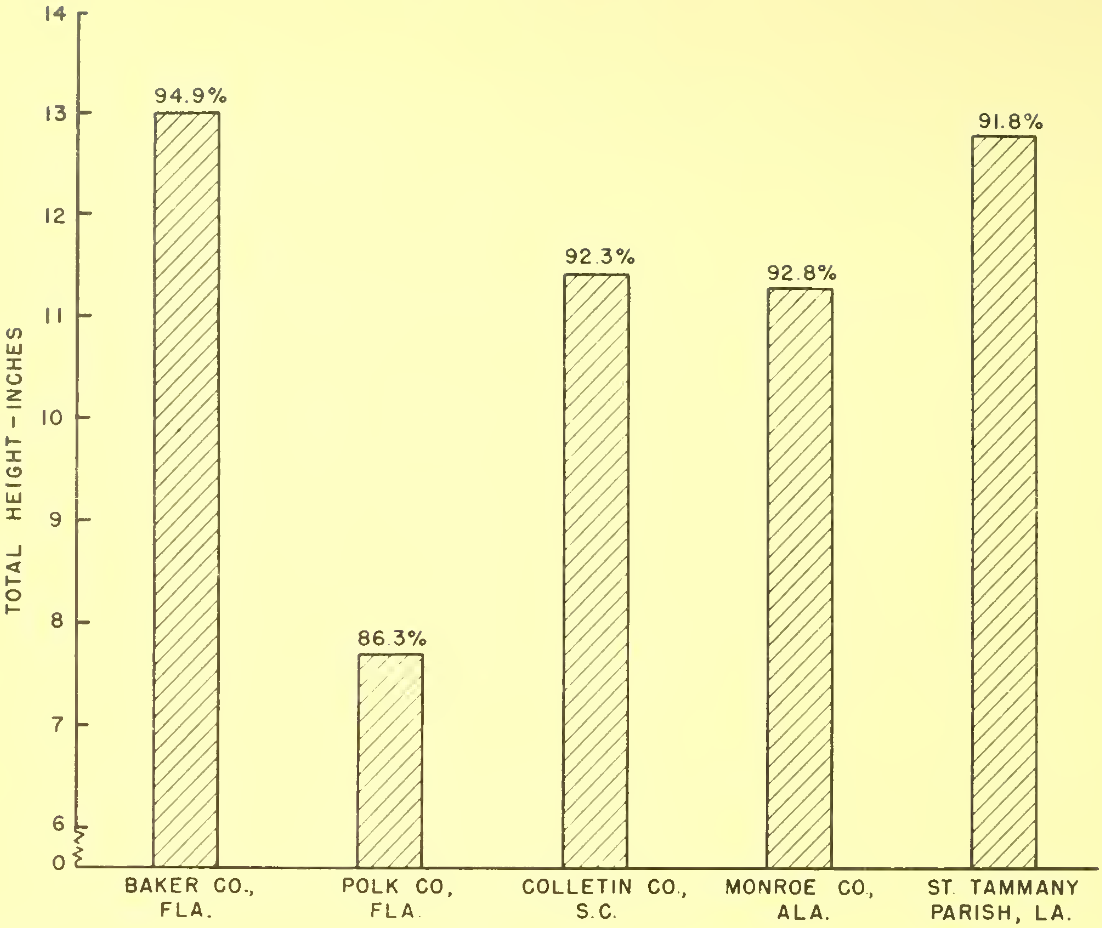

Figure 1. --Total height and survival of slash pine seedlings from five geographic sources outplanted in Baker County, Florida.

Polk County, Florida, constitutes the southern limit of the natural range of typical slash pine and the northern range of South Florida slash pine. From observations of true hybrids obtained through controlled pollinations of typical slash pine x South Florida slash pine, it appears that the Polk County seedlings are "hybrids" between var. elliotii and var. densa. In the tension zone between closely related species or varieties, hybridization can occur.

The variations which appeared in this outplanting should not be considered as final evidence that there are variations of economic importance in Pinus elliottii var. elliottii. They contribute merely an interesting observation and represent a point on the general growth curve which will be completed as the trees grow older and mature.

The fact that hybridization can occur in the transition zone indicates that uncontrolled seed collection from this zone may result in plantations of unpredictable heredity.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 63 October 1954

WEEVILS ATTRACTED TO BUD-PRUNED WHITE PINE

The conventional methods of pruning forest trees are generally accepted as a means of increasing grade yield of crop trees. A small study at the Bent Creek Experimental Forest, near Asheville, North Carolina, shows that bud-pruning white pine (in contrast to conventional pruning) may be a losing proposition because of the increased incidence of weeviling.

In the spring of 1950, alternate rows in a 5-year-old white pine plantation were bud-pruned, and intervening rows were left unpruned.[1/] At the time, the trees were about 6 feet in height and the pruned trees had all of the branches and lateral buds removed except on 1½ to 2 feet of stem at the base of the trees. Each succeeding year, all the new lateral buds were either rubbed off or cut off, leaving an erect stem terminating in a single living bud. The plan was to continue pruning until at least one log-length of stem was entirely free of branches. By the spring of 1954, the pruned trees averaged about 15 feet in height and the unpruned trees only slightly more.

Ordinarily the white pine weevil is not a serious problem in Western North Carolina. The bud-pruned trees, however, seem to have an unusual attraction for weevils. The following table shows the higher incidence of weevils on pruned trees as compared to unpruned trees for the past 2 years.

	Number of white pine trees		
	Weeviled	Not weeviled	Total
Bud-pruned	[1/] 21	147	168
Unpruned	3	196	199
Total	24	343	367

1/ Chi-square tests indicate statistical significance at the 1-percent level of probability.

1/ The study was established by W. G. Wahlenberg.

U. S. Department of Agriculture - Forest Service

Only 1.5 percent of the unpruned trees have been attacked by the weevils, whereas 12.5 percent of the pruned trees have been so damaged. To make matters worse, when a bud-pruned terminal is killed by weevils, there may be no lateral buds or branches left to take its place, in which case the tree is lost from the stand. On the other hand, not only are fewer unpruned trees weeviled, but when weeviling does occur there is an excellent chance that a lateral branch will assume the place of the dead leader.

Why the weevils prefer bud-pruned white pine is not fully understood, although it is fairly well established that unshaded and open-grown pine are more frequently attacked by weevils than those grown in densely stocked stands or those grown under a hardwood overstory. It may be that bud-pruning opens up the stand enough so that the fully exposed leaders of the pruned trees are just that much more vulnerable.

In addition to weeviling there are other interesting features about bud-pruning white pine. Many of the pruned trees have a tendency to develop spindly and crooked boles. However, it is probable that the trees will outgrow these unusual bole forms once the pruning is finished. Also, bud-pruning white pine turns out to be a time-consuming job because of prolific lateral budding at the uppermost whorl after pruning. In order to maintain the bud-pruning principle it is necessary to remove the lateral buds about three times each growing season. Perhaps a better plan would be to let the buds grow and remove them only once each year with shears or nippers.

After considering all of the factors involved in bud-pruning white pine, it is believed that there are more advantages in the conventional pruning methods, using either a hand saw and ladder or a hand saw and a pole saw. In conventional pruning the severity of pruning and the timing may be varied. For example, we can wait until the trees are about 20 feet in height, and prune the lower limbs to a height of about 8 feet. Four or five years later, we can prune another 8 feet, thereby obtaining one 16-foot log length free of limbs. Or, if it is preferred, pruning can be deferred until the trees are tall enough so that the entire 16 feet can be pruned in one operation--usually when the trees are 30 to 35 feet in height.

Whether bud-pruning or conventional pruning is employed, it is wise to prune only about 100 to 200 crop trees per acre.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 64

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PITYOPHTHORUS PULICARIUS (ZIMM.), A BARK BEETLE ATTACKING SCIONS OF GRAFTED SLASH PINES

By attacking the scions of slash pine grafts a small bark beetle, Pityophthorus pulicarius (Zimm.), may join the ranks of noxious forest insect pests. This new damage by the beetle was demonstrated during the past season's grafting work of the Forest Genetics Project at the Southeastern Forest Experiment Station's Lake City, Florida, Research Center. The damage to grafted stock being prepared for seed orchard establishment was extensive and the cause of considerable concern.

Under normal conditions the small bark beetle, 1.3 to 2.0 mm. long, is usually content to attack the tips of newly felled or dying pines and the tips of branches which are in the process of natural pruning. Thus, in the past it has been of little importance. However, fresh scions apparently meet its requirements for attack. Scions were attacked in the lath house and in the field replicate 10 to 12 miles away, with losses of approximately 25 percent and 15 percent, respectively.

The grafts were made during the latter part of January and the early part of February. A bottle-graft technique was used with the dormant scions collected from trees selected for high gum yield and superior qualities of growth and form.

In late March and April the buds of the scions began to elongate and the unions seemed successful. At this time the attacks were noticed. They were chiefly located in the old growth of the scion above the union, though an occasional entrance hole was noted in the elongating tip. A few scattered unsuccessful attacks were also observed in the tips of the stocks where the beetles had been pitched out by vigorous growth of the stock.

The first sign of attack is the frass which the beetle pushes out as it bores into the tip. This may be easily overlooked, since it is inconspicuous. The entry is quite often made at the base of a needle or through an old needle scar. The first easily noticed evidence is the dying of the old needles, usually starting at the bottom of the scion just above the union. The elongating tip remains green for some time. The scion wood at the union may remain healthy up to three months after the upper portion has died. In one particular instance the scion below the union sprouted a new bud.

The attacking beetle bores through the bark and wood to the pith, where a nuptial chamber is constructed. The egg galleries run out from it, generally parallel to the wood. Eggs are laid singly in side niches in the wood and pith. The larvae feed in the wood, though often meandering a bit to feed just beneath the bark. The mature beetle bores out through the bark to start another generation. In all probability the life cycle is less than 2 months under favorable conditions.

One of the curious aspects of this particular incidence is that there appeared to be a definite relationship between the source of the scion and its susceptibility to attack. Scions from one particular tree were unsuccessfully attacked, and 100 percent of the grafts, both in the lath house and field, were successful.

The insect is indigenous to pine areas--an important aspect since work will usually be accomplished near the forest. Moreover, the "production" phase of species improvement will entail extensive grafting. Thus, this insect may cause serious losses unless corrective measures are taken. From experiences with other bark beetles, benzene hexachloride should be one of the best insecticides to prevent attacks. In working with grafts frequent applications in dust form would probably be advisable.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 65 October 1954

RELEASE OF LOBLOLLY PINE BY VARIOUS WEEDING METHODS

The uncertainty of successful release is one reason why weeding has not been generally accepted as a cultural treatment in the coastal loblolly pine type. A test[1/] conducted on the Santee Experimental Forest near Charleston, S. C. shows that the conventional method of weeding on good sites is less costly and nearly as effective as weeding with chemicals.

The study was made on a flatwoods loblolly pine site having an index of about 90 feet. After the peak of seedfall in 1946, all sawtimber except eight seed trees per acre was removed. Three years after cutting, the area contained an abundant stand of pine seedlings in heavy competition with the former hardwood and brush understory which ranged from 3 to 12 feet in height.

The weeding study was carried out on 1/40th-acre plots from which all pines were eradicated except 40 overtopped 3-year-old-seedlings averaging $2\frac{1}{2}$ feet tall. Using a mixture of 2,4,5-T and kerosene (1 part 2,4,5-T, containing 4 lbs. of acid per gallon, to 29 parts of kerosene) several control treatments were applied, plotwise, to the competing stems. Also compared was the conventional method of cutting back competitors with a machete. Results after four growing seasons are summarized in table 1.

Under site conditions similar to those of this experiment, some overtopped seedlings (one out of five) can free themselves from hardwood competition without release. However, a much larger number can be freed (70 percent or more) if the hardwood competitors are weeded from the stand. This may be accomplished by any of the methods tested. The most complete release (97 percent) results from cutting back the competing hardwoods and spraying the stumps with chemical. On the other hand, by simply cutting back competitors with a machete or comparable tool, a satisfactory degree of release is obtained at about one-half the cost. Although this treatment does

1/ Commenced by L. E. Chaiken, former Project Silviculturist, and completed by research staff of Santee Research Center, Charleston, S. C.

Table 1. --The relative success of various weeding treatments after four growing seasons

Treatment 1/	Relative cost 2/	Seedlings free to grow	Average total height 3/
	Index	Percent	Feet
Check, no treatment	0	22	4.9
Cut competing stems, no chemical	100	71	6.7
No cutting, basal spray with 2,4,5-T	124	80	7.2
No cutting, brush 2,4,5-T on stems	188	70	7.6
Cut competing stems and spray 2,4,5-T on stumps	194	97	8.8

1/ Each treatment replicated 3 times on 1/40th-acre plots.
2/ Includes labor and chemical charges, relative to each other.
3/ Based upon the best 75 seedlings for each treatment.

not thoroughly eliminate resprouting, it delays it long enough to allow most of the pine to become dominant. There is no need for a second weeding, and the cost of chemical does not appear justified in terms of increased survival and growth of released loblolly pine seedlings. It is interesting to note that the conventional method produces virtually the same number of free seedlings as the brush stem treatment but without the additional cost of chemicals.

On some areas the hardwoods and brush may give the pine seedlings more serious competition for one reason or another. There may be fewer pines and more brush, or the hardwoods may have more of a headstart because of delayed establishment of pine. On such areas the somewhat more expensive but more thorough basal-spray method may be preferable.

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Research Notes

SOUTHEASTERN FOREST EXPERIMENT STATION

Asheville, North Carolina

Number 66 October 1954

SLASH PINE CONE PRODUCTION IS INCREASED BY SEED-TREE RELEASE

Forest landowners in the Southeastern United States depend upon good seed production for regeneration of slash pine stands. But well stocked even-aged stands produce relatively few seed per tree. Unless provision is made to provide adequate seed supply at time of timber harvest, the land may be nonproductive for several years. The chain of production need not be broken; increased seed production and adequate regeneration can be made to coincide with timber harvest through a release cutting three or four years prior to final harvest of the stand.

Such an inference can be drawn from current studies at the Alapaha Experimental Range in the Coastal Plain of Georgia. This information on slash pine supports recently reported studies on other southern pines, loblolly [1] and longleaf [2].

In the summer of 1949 a medium stocked forest area of 40 acres was subjected to a seed-tree cutting. Five to six slash pine trees per acre (average d. b. h. 11 inches) were left for potential seed production. Comparable dominant trees from a 24-acre uncut timber stand (basal area 50 square feet per acre) were used as a check. Cone counts were then made for four successive years, beginning with the fall of 1950. Both areas after being fertilized with moderate applications of phosphate and potash were utilized for cattle grazing trials.

Cone production in the uncut timbered areas during the four years of study was light but fairly consistent. Response to release, on the other hand, was immediate. Increased incidence of flower fertilization took place the first growing season after cutting, and there was a substantial increase in cones the third year after cutting (fig.1). The effect of release was carried over to the fourth year. This suggests that the harvest cut need not be made the first year of increased seed crop but may extend for at least one more year, assuming ground-cover conditions are still equally satisfactory for reproduction.

1/ Wenger, K. F. The stimulation of loblolly pine seed trees by preharvest release. Jour. Forestry 52(2): 115-118. 1954. Also reported in Southeastern For. Expt. Sta. Res. Note 45. 1953.

2/ Allen, R. M. Release and fertilization stimulate longleaf pine cone crop. Jour. Forestry 51(11): 827. 1953.

Release increased the number of cones per year by the end of the third year from about 20 to 55. The released trees produced approximately 20,000 seed per acre, compared with 7,000 produced by the corresponding unreleased trees in the check area. The increase was realized with relatively small trees. Retention of larger trees, or more trees per acre where available, would promise greater seed production.

Figure 1. --Slash pine cone production is increased the third year after seed trees are released.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 67 October 1954

SELF-FERTILIZATION IN SLASH PINE REDUCES HEIGHT GROWTH

In nature, selfing occurs among a large score of plants without bringing about deleterious effects in the progeny. However, controlled self-pollination in Gymnosperms and particularly the genus pinus frequently results in inferior characteristics such as poor seed set, low germination, reduced vigor, deformed growth, retarded flowering, and various degrees of albinism. Some tree species or individual trees within a species are self-incompatible, which precludes inbreeding and favors outbreeding or cross-fertilization. Controlled inbreeding, however, can be used to increase the degree of genetic uniformity in trees and thereby bring to light recessive genes which otherwise would be concealed by dominant traits or influences from other parents. This is important in evaluating the tree genetic make-up (genotype) of selected trees.

During the normal course of the controlled breeding program at Lake City, Florida, a high-gum-yielding slash pine was self-pollinated under controlled conditions to observe the effect of inbreeding on the progeny.[1/] In addition to the selfing, control-pollinations were made on the same tree with pollen gathered from two other trees. The trees used as male parents for the crosses grew at least 10 miles from the female parent. The pollinations were carried out during the spring of 1947, and the cones resulting from these crosses were collected in the fall of 1948, along with cones from open (wind) pollination. The seed was sown in a greenhouse during the summer and fall of 1949, and the seedlings were transplanted to a nursery bed during April of 1950. In the winter of 1951, the seedlings were outplanted in a cleared area on the Olustee Experimental Forest. The outplanting followed a randomized plot design with four complete replications. Spacing of the trees was 12 feet by 18 feet. The outplanting is located on a Leon fine sand site and the seedlings had to be fertilized at various times and watered during the critical initial establishment period. The trees were fertilized to correct the effects of mineral deficiency of the poor site.

Total height of the 5-year-old progeny in June 1954 are given in table 1. An analysis of variance indicated that height growth from the selfed progeny differed significantly from that of the trees resulting from

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1/ Controlled pollination, seedling production, and plantation establishment were made by K. W. Dorman, A. A. Downs, and A. G. Snow, Jr., respectively.

the two cross-pollinations and from the natural (wind pollinated) progeny. The over-all inbreeding depression of height growth was very pronounced but a few individual inbred seedlings were as tall as cross- or wind-pollinated ones. Differences between natural progeny and seedlings of the controlled cross-pollinations were not apparent. This indicates that the process of controlled breeding per se did not bring about the markedly smaller trees of the selfed progeny. It will be interesting to observe the behavior of the selfed slash pines as they approach maturity. From evidence with other inbred plants, reduction in growth of these 5-year-old slash pines probably is a "fixed" character and will change only relatively in the coming years.

Table 1. --Total height of 5-year-old slash pines

Type of pollination	Average height	Trees
	Feet	Number
Wind	4.6	27
Cross (xG5)	4.6	69
Cross (xG11)	4.8	68
Selfed	3.7	25

Besides being of great interest to the forest geneticist, these results have application in silviculture and in seed collection. In planning seed-tree cuttings, attention should not only be paid to adequate seed dispersal but also to abundant cross-pollination. Enough trees of good phenotypic qualities should be left in a cutting operation to enable good cross-pollination, allowing for such factors as erratic flowering, and male or female sterility. Inadequate cross-pollination can be overcome by leaving small groups of trees. Isolated slash pines often bear heavy crops of cones with a low yield of viable seed per cone. These trees should be avoided, as they have not been adequately cross-pollinated.

Additional selfings with slash and longleaf pine were made during the 1953 and 1954 breeding seasons to obtain further information on self-incompatibility and effect of inbreeding on individuals of these species. The present information, namely that slash pine seed resulting from selfed fertilizations can bring about trees of lower than average vigor, should be considered when regenerating stands and when seed is collected for reforestation.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 68 October 1954

PEAK POPULATION OF SEED-EATING RODENTS AND SHREWS OCCURS 1 YEAR AFTER LOBLOLLY STANDS ARE CUT

The population of small mammals within a pine forest in the coastal plain builds up rapidly after a logging operation. This became apparent in a trapping study on the Bigwoods Experimental Forest[1/] where previous work[2/] has shown that it takes a progressively larger number of loblolly pine seed to produce a given number of seedlings in subsequent years following logging. One factor contributing to this poorer utilization of seed is the rapid development of competing vegetation, which reduces the area of good seedbed available for pine. Another factor might be an increase in the population of seed-eating or seed-destroying animals.

An animal trapping study was installed on the Experimental Forest to see whether there was a change in the small mammal population following clear cutting. Sixty traps[3/] were located in each of five stands representing different conditions ranging from an uncut mature loblolly pine stand through reproduction stands of 1-, 2-, 3-, and 4-year-old seedlings. The reproduction stands were the result of natural establishment following disking the seedbed, logging, and poisoning the larger residual hardwoods. In these uniform stands practically all competing vegetation was of seed or sprout origin. The traps were set and operated for a 3-day period in each of 3 months, December, January, and March. The results of 540 trap-days in each stand are shown in table 1.

Table 1. --Rodents and shrews per 3-day trapping period
(In number caught)

Time of trapping	Age of pine stand (years)				
	60+, uncut	1	2	3	4
December	0	13	8	10	1
January	1	32	35	26	17
March	0	11	11	5	10
Total	1	56	54	41	28
Per 100 trap days	.19	10.37	10.00	7.59	5.19

1/ Maintained by the Southeastern Forest Experiment Station in cooperation with the Camp Manufacturing Co., Inc., Franklin, Virginia.
2/ Trousdell, K. B Favorable seedbed conditions for loblolly pine disappear 3 years after logging. Jour. Forestry 52: 174-176. 1954.
3/ Animal traps loaned by Duke University, Durham, North Carolina.

U. S. Department of Agriculture - Forest Service

Of the 180 animals caught, 159 were white-footed mice (Peromyscus) or harvest mice (Reithrodontomys). The remainder were pine mice (Microtus), cotton rats (Sigmodon), and two species of short-tailed shrews (Blarina).

Figure 1 shows that in successive years after harvest cutting the number of seeds required to establish one pine seedling steadily increases, while the population of small mammals peaks during the first growing season and then gradually declines. The divergence of the two trends indicates that factors other than the mammal population are involved in the successively poorer utilization of pine seed.

This study showed that in the uncut forest or immediately following cutting (by inference) the rodent population was small. This low population coincides with the best period for the germination and survival of pine seedlings. By the time the second crop of seed is on the ground, the population was at a peak. There was a relatively high though decreasing rodent population through the regeneration period.

It is evident that under conditions represented by this study seed-eating mammals are not primarily responsible for the increasing difficulty of getting seedlings established several years after harvest cutting.

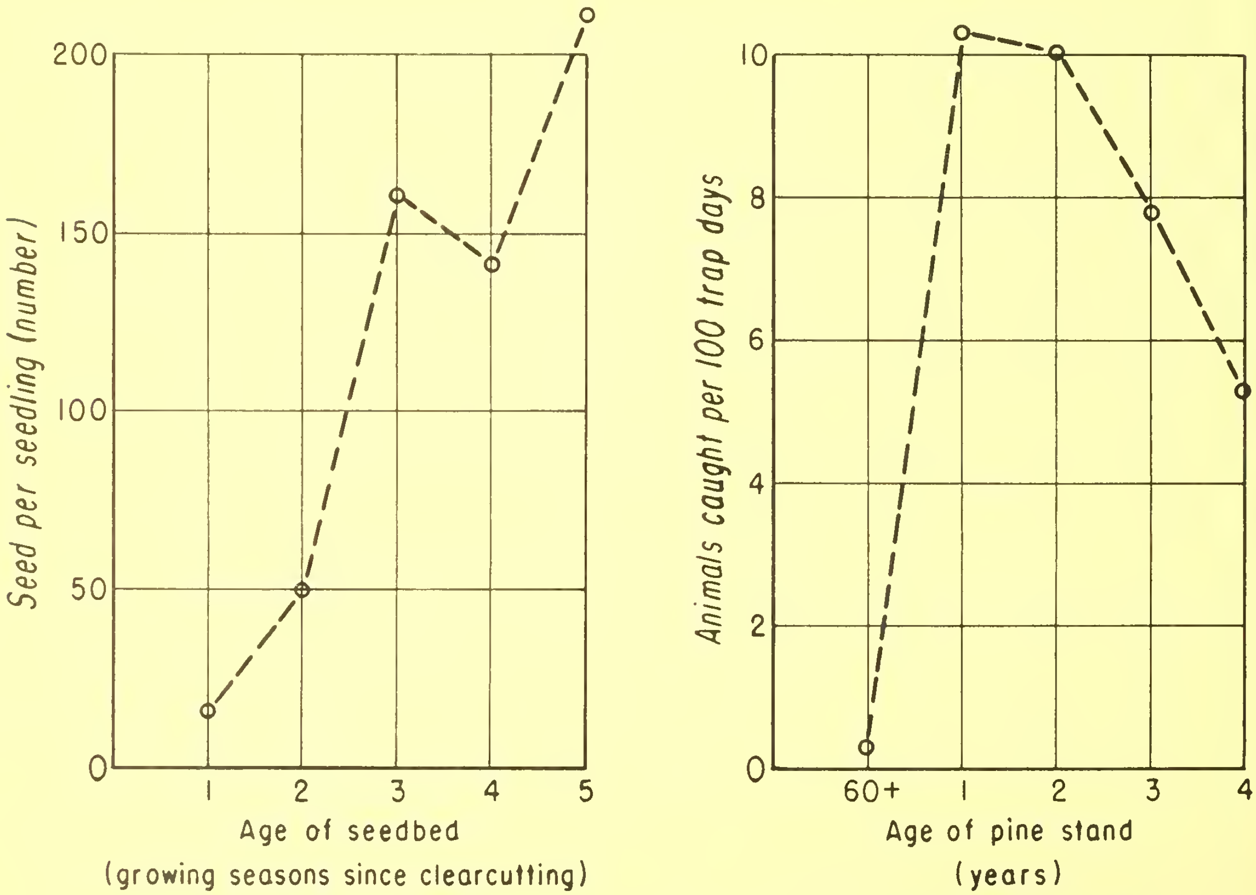

Figure 1. --Trends of seedbed deterioration and rodent population for comparable periods.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 69 October 1954

GUM-YIELD TABLES FOR SLASH AND LONGLEAF PINE ON POORER THAN AVERAGE SITES

Large, fast-growing slash and longleaf pine trees with big crowns have high gum yields and are very profitable to work in a naval stores operation. Experienced gum producers have known this for years, but the data presented here show for the first time just how much gum can be expected from trees of a certain diameter and crown-length ratio when trees are worked using bark chipping and acid treatment. On poorer than average sites, the data show that gum yield from trees 9 to 10 inches in diameter are too low to be profitable.

Previous gum-yield tables were based on diameter alone and were made for wood chipping. The accuracy of the predicted gum yields in table 1 is improved greatly by considering crown-length ratio in addition to diameter. The new data also account for the higher gum yields obtained on longleaf pine when bark chipping and acid are used in place of wood chipping.

Table 1. --Average annual gum yields by diameter and crown-length ratio classes for trees worked with bark-chipped, acid-treated streaks 5/8 inch high

D. b. h.	Crown-length ratio							
	.20	.25	.30	.35	.40	.45	.50	.55
Inches	Gum yields in barrels per crop							
	SLASH PINE, SITE INDEX 70 FT.							
9	92	112	131	151	170	190	209	--
10	120	140	159	179	198	218	237	--
11	149	158	188	208	227	247	266	--
12	177	197	216	236	255	275	294	--
13	206	225	245	265	284	304	323	--
14	234	254	273	293	312	332	351	--
	LONGLEAF PINE, SITE INDEX 65 FT.							
9	--	94	113	132	150	168	186	204
10	--	120	138	156	175	193	211	229
11	--	144	163	182	200	218	236	254
12	--	170	189	208	226	244	262	280
13	--	195	214	232	251	269	287	305
14	--	220	239	258	276	294	312	330

Diameter and growth rate as expressed by the number of annual rings in the last inch of radial growth can also be used to predict gum yields. These data, presented in table 2, are probably applicable to any site, because the number of annual rings in the last inch of radial growth is affected by both site quality and crown size. Use of this table, however, requires more work because cores of wood must be removed from the trees for counting the rings.

Within the range of diameter, growth rate, and crown ratios encountered in this study, the tables can be summarized as follows:

1. An increase in diameter of 1 inch will increase gum yields by 27 barrels per crop.

2. An increase of 0.01 inch in the average width of annual rings in the last inch of radial growth will increase gum yields by 11 barrels per crop.

3. An increase of 0.10 in crown-length ratio will increase gum yields by 38 barrels per crop.

New studies are being planned to determine gum yields for the entire range of site quality in the slash and longleaf pine type.

Table 2.--Average annual gum yields by diameter and growth-rate classes for trees worked with bark-chipped, acid-treated streaks 5/8 inch high.

D. b. h.	Number of rings in last inch of radial growth						
	6	7	8	10	12	14	18
Inches	Gum yields in barrels per crop						
SLASH PINE, SITE INDEX 70 FT.							
9	197	171	151	124	106	93	--
10	225	199	179	152	134	121	--
11	254	227	208	181	163	150	--
12	282	256	236	209	191	178	--
13	311	285	265	238	220	207	--
14	339	313	293	268	248	235	--
LONGLEAF PINE, SITE INDEX 65 FT.							
9	--	--	195	166	147	133	115
10	--	--	221	192	173	159	142
11	--	--	248	219	200	186	168
12	--	--	275	246	227	213	195
13	--	--	301	272	253	239	222
14	--	--	328	299	280	266	248

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 70 October 1954

A LEAF-CHEWING BEETLE CAUSES CYPRESS FOLIAGE TO DISCOLOR IN MID-SUMMER

Mid-summer discoloration of cypress foliage in parts of the southeastern United States has commonly been considered a direct result of drought. However, ecological studies during the past season in northeast Florida indicate that a small leaf-chewing beetle, Systena marginalis (Illinger.) (Chrysomelidae) may be wholly or partly the cause of this condition.

The beetle is small, 1/8 to 3/16 inch in length and about half as wide, with a basic yellowish tan color. There are two parallel thin black lines along the front margin of the elytra and one such line along the hind margin. When the wings are folded, the two single lines along the hind margins appear as a single line down the middle. All these lines fade before reaching the apex.

Apparently, only the adult feeds on the foliage of cypress. The feeding can be classified as gouging which merely causes the leaf or leaflet to discolor without changing the gross structure. The gougings are predominantly linear shaped and seldom pierce both leaf surfaces. The beetle is found in large swarms of several thousand each, which move about, spending one to three days on a single tree. A single swarm might encompass from one to 16 trees. If there is sufficient feeding, the leaf quickly turns red, while less extensive feeding results in a partial discoloration.

Cypress is a desirable forest tree. Though many stands are in poor condition because of logging practices, there are extensive stands of young, well-formed, vigorous trees in the South. This insect, and possible related factors, may threaten the future growth and composition of these stands.

Since these observations were of a preliminary nature, other factors such as the transmission of a disease or the presence of another insect cannot be eliminated. In fact, there is reason to suspect both.

The exact cause of summer discoloration of cypress in the past may never be known, but it is interesting to speculate on the possibility that an insect is largely responsible.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 71 January 1955

SUMMER FIRES KILL UNDERSTORY HARDWOODS

Prescribed summer fires offer a promising though still experimental method for killing understory hardwoods on pine sites. Repeated at short intervals, such fires provide a means for drastic reduction of the understory just before reproduction is to be obtained by harvest cutting in loblolly pine.

Chaiken [1/] reported killing out a large proportion of the hardwood understory with four annual summer fires in the loblolly pine flatwoods of the Santee Experimental Forest near Charleston, S. C. Additional experiments were started in 1951 on the same forest to compare the effectiveness of different numbers of annual fires, and also to compare annual and biennial fires. The study has several more years to run, but some interesting preliminary results are shown in table 1.

The best kill apparently results from successive annual summer fires. In the South Carolina flatwoods the most susceptible species seem to be sweetgum and myrtle, which are respectively the commonest tree and shrub of the understory in loblolly pine stands. In many situations two or three successive fires should provide good control. On the other hand, where mixed oaks and blackgum dominate, a lesser degree of kill seems probable. Whether this can be increased substantially by more fire is still a question, inasmuch as a third fire did not add to the number of dead stems. As yet, we don't know why the third fire was ineffective. Except for the number of days since ½ inch or more of rain, burning conditions were similar for both the second and third fires. In both cases only a 1-year rough was involved. Soil moisture may have been a factor, but since it was not measured we can only conjecture as to its significance.

Less effective control apparently results from a succession of biennial summer fires (table 1). This type of result is to be expected when bad weather or scheduling prevent a succession of annual fires.

Summer burning at the Santee has been done on a plot-wise basis for 8 consecutive years (though not on identical plots). With each fire, weather and related observations have been made. Information on the range of burning conditions encountered is summarized in table 2. Favorable conditions for successive annual fires can be expected around mid-June for the average year. Most burning was started in the early afternoon with prevailing temperature around 92 degrees and relative humidity averaging 42 percent. Wind velocity near the ground usually was light--1 to 3 miles per hour. Days with no wind were avoided to minimize danger of heat rising straight up and scorching crowns. A steady wind was desired for better control of the fire. Because of a generally light 1-year rough, practically all burning was done with headfires.

1/ Chaiken, L. E. Annual summer fires kill hardwood root stocks. Southeastern Forest Expt. Sta. Research Note 19. October 1952.

Table 1.--Cumulative mortality of understory hardwoods resulting from successive prescribed summer fires 1/

Species	Trees	1 year after first fire	1 year after second fire	1 year after third fire
	Number	Percent dead 2/	Percent dead	Percent dead
ANNUAL FIRES				
Sweetgum	117	9	21	33
Blackgum	89	9	18	18
Oak	46	0	9	18
Myrtle	41	5	35	49
BIENNIAL FIRES				
Sweetgum	121	3	5	--
Blackgum	90	2	3	--
Oak	34	3	6	--
Myrtle	41	6	11	--

1/ Burning done on $\frac{1}{4}$-acre plots each with five 1/100-acre observation plots containing up to five staked trees of each species per lot.
2/ Stem dead, no sprouts present.

Table 2.--Range of conditions encountered at the time selected for prescribed summer fires on the Santee Experimental Forest

Date of fire 1/	Burning began	Max. air temp.	Minimum relative humidity	Wind	Wind velocity 2/	Fuel moisture	Days since $\frac{1}{2}$-in. or more of rain
	Hour	Degree F.	Percent		M.p.h.	Percent	Number
6-19-47	1:00 pm	94	24	Var.	1 - 3	-	5
6-17-48	1:00 pm	84	46	E	1 - 3	-	9
7-11-49	12:45 pm	90	47	E	1 - 3	-	15
6-14-50	2:00 pm	87	46	SW	1 - 3	$5\frac{1}{2}$	6
6-28-51	1:00 pm	99	43	Var.	1 - 3	-	5
6-10-52	1:00 pm	95	45	W	1 - 3	5	29
7- 1-53	12:30 pm	96	39	SW	1 - 3	$4\frac{1}{2}$	2
6-15-54	1:45 pm	90	38	NE	4 - 7	3	3

1/ Burning usually scheduled for the first days after June 1 when conditions favor burning.
2/ At ground in forest cover.

Periodic winter burning prior to harvest will generally keep the hardwoods small even though not reduced in number. Annual summer burning could well begin several years in advance of harvest for the dual purpose of preparing the seedbed and reducing the hardwood population. This has been done on a 30-acre pilot plant at the Santee Experimental Forest with success at least equal to that on small plots.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 72 January 1955

PRELIMINARY TEST OF DIRECT SEEDING OF LONGLEAF PINE IN THE SOUTH CAROLINA SANDHILLS

There have been numerous attempts to reestablish longleaf pine in the Sandhills of South Carolina, where past history reveals that it once grew well. Most of these attempts were by planting seedlings, and for the most part they have been unsuccessful. For this reason, direct seeding trials have recently been started. Although initial tests of direct seeding longleaf pine are admittedly not very promising, this method of regeneration may have its place in the gradual reforesting of the Sandhills. There are large areas of cleared land, cut-over longleaf stands, scrub oak, and abandoned farmland which present possibilities for direct seeding. Because of the heterogeneous nature of Sandhill soils and topography, each site must be evaluated individually. Can a portion of these 1,300,000 acres of so-called "deserts in the rain" be successfully regenerated to longleaf pine by direct seeding methods? This question can be answered only by further research on these lands characterized by deep sands, high air and soil temperatures, low fertility and low water-holding capacity. Yet, these sites have nearly 50 inches of rainfall in any normal year.

Of the few attempts to establish longleaf pine by direct seeding in the Sandhill region, only one or two have shown any real success. Nevertheless, efforts will continue as a means of isolating the factors which are responsible for heavy seed and seedling losses.

During the 1952-53 planting season, twelve $\frac{1}{4}$-acre experimental plots were established on old-field sites near Aiken, S. C. 1/ The soils were typical Norfolk and Ruston sands. On each plot, enough local longleaf seed was sown to assure at least 15 sound seeds per seed spot. A total of 60,000 seed was sown, one-half of which was protected from rodents and birds by conical 3-mesh screens, and the remainder was unprotected. The plot layout provided a means of observing the effects of birds and rodents, season of sowing, soil type, cover, and mulching on germination and early establishment of longleaf pine. The extent of seed losses on these seeded plots from January to May is shown in table 1. Only 6 percent of the winter sowing and 14 percent of the unprotected spring seeding escaped the depredations of birds or rodents. Birds did no apparent damage to the protected spots, but some rodents refused to be deterred even though the screens were pinned down. Either by burrowing beneath the screens or by the simple process of tipping them over, they were able to rob the protected spots of almost one-third of the winter sowing and one-half of the spring seeding.

Regardless of season of sowing there was considerable damage on unprotected spots. The winter sowing (January) was after the main fall migration of birds. Likewise, the spring sowing was somewhat before the spring flight of migratory birds. Even so, there were enough stragglers or permanent residents to cause

1/ In cooperation with the Project Forester, Savannah River Project of the Atomic Energy Commission.

Table 1.--Longleaf pine seed loss to birds and rodents

Agent	Protected spots: Winter-seeded	Protected spots: Spring-seeded	Unprotected spots: Winter-seeded	Unprotected spots: Spring-seeded
	Percent	Percent	Percent	Percent
Rodents	31	48	78	60
Birds	0	0	16	26
Total 1/	31	48	94	86

1/ Based upon an expected 60 percent germination of 60,000 total sown seed.

some damage at both sowings. These losses could probably be tolerated if it were not for the high losses to rodents at the same time.

Critical soil moisture and temperature conditions which coincided with extremely low rainfall in May put the various seeding treatments to a severe test. Although this study did not include a fall sowing, the results indicate that early sowing develops larger and hardier stock which is better able to survive the climatic extremes of the first growing season. In 726 protected and undamaged spots totalling 18,150 sown seeds, it was found that 20 percent of the winter-sown but only 3 percent of the spring-sown seed had produced established seedlings by the end of the growing season. Thus, if satisfactory rodent control measures could be obtained, subsequent survival of longleaf pine direct-seeded in winter may be sufficient to justify the investment (fig. 1).

A comparison of other site factors, although less conclusive, indicated that better survival may be expected on sandy loams than on sands, and on old field sites than on scrub oak areas. Mulching the seedspots with sawdust did not appreciably help germination or survival. Seedlings in planting trials have indicated a similar response in the Sandhills.

This test has shown us some of the major factors to consider in any direct seeding attempt in this part of the Sandhills. What is needed most is a practical and economical method of protecting seed prior to germination. Though many foresters are reluctant to admit it, we need to know more about bird and rodent behavior--when are populations highest, are birds color blind, and what sites attract birds and rodents most.

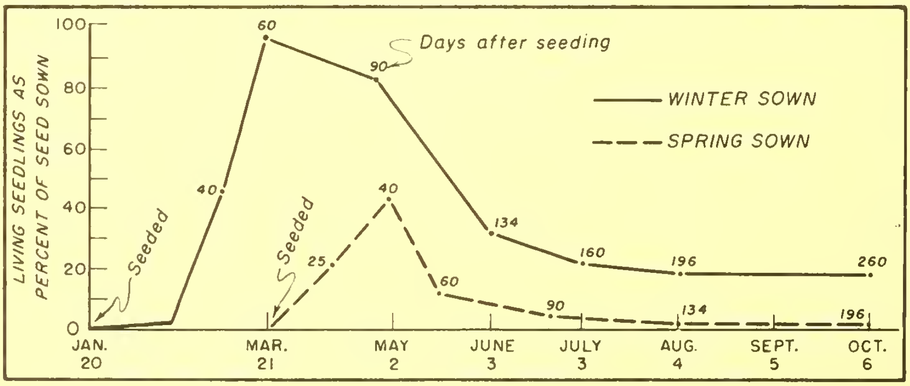

Figure 1.--Longleaf pine germination and establishment on protected seedspots, Sandhills, 1953 (based on expected germination of 60 percent of 18,150 seed on 726 spots).

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 73 January 1955

LOBLOLLY PINE GROWTH AS AFFECTED BY REMOVAL OF UNDERSTORY HARDWOODS AND SHRUBS

Does removal of an understory of hardwoods and shrubs in an even-aged sawtimber-size stand of loblolly pine produce a real increase in the growth of the pine? Forest managers need this information to help them decide what should be done with the understory.

An opportunity to determine the early reaction of a pine overstory to several understory treatments developed from a hardwood control study initiated in 1946. 1/ Three of the treatments in this study resulted in the elimination or annual removal of the understory in a pine stand. The treatments were (1) annual summer burning, (2) annual winter burning, and (3) annual summer foliage spray with chemicals following an initial burn. Each treatment, as well as a control treatment where nothing was done to the understory, consisted of three replicated $\frac{1}{4}$-acre plots as part of a randomized block design.

An essential condition of the stand in which the plots were located was its uniformity of site, density, and understory conditions. It was predominantly loblolly pine of 40 to 50 years on a site with an index of 85. Stand density averaged 90 square feet of basal area per acre in an even-aged stand with practically no pine trees below 6 inches in diameter. An understory tally taken on the control plots was considered to be representative of original conditions under all treatments (table 1).

Hardwood species were mainly red gum and black gum, water, willow, post and southern red oaks; shrubs were mainly myrtle, vaccinium, gallberry, and pepperbush.

The summer foliage-spray treatment eliminated the understory in a few years. Although annual fires killed back practically all of the aerial portions each year, there was a certain amount of resprouting each spring. As reported by Chaiken in Research Note No. 19, after five consecutive annual winter fires no diminution was observed in sprouting vigor of the understory hardwoods; on the other hand, three or four consecutive summer fires not only killed many root stocks but also reduced the size and vigor of sprouts.

1/ By L. E. Chaiken at the Santee Experimental Forest near Charleston, S. C.

Table 1.--Estimated number of understory stems per acre before treatment
(In number of stems)

Understory	Under 4½ feet tall	D.b.h. class (inches) 0	1	2	3	4	5	6	7	Total
Hardwoods	4167	1567	183	33	50	50	33	--	17	6100
Shrubs	3967	317	50	--	--	--	--	--	--	4334
Total	8134	1884	233	33	50	50	33	--	17	10434

In 1951, or 5 years after plot establishment, increment borings were taken from a representative sample of pine trees in each plot. Radial growth in inches during the previous 5 years was determined from trees 7 to 17 inches in diameter. Pine growth on the control plots, where understory hardwoods had been left undisturbed, was as good as that found on the areas where the understory had been eliminated or removed annually (table 2).

Table 2.--Overstory pine growth as affected by understory hardwood removal

Understory treatment	Overstory pine: Average d.b.h.	Average radial growth (5 years)	Basis
	Inches	Inches	Number of Trees
Control	12.7	0.36	69
Annual foliage spray	12.7	0.37	61
Annual summer fire	12.6	0.35	73
Annual winter fire	12.3	0.38	68

One might conjecture that a reduction in pine growth because of annual burning was equally offset by a growth increase due to annual elimination of the understory competition. However, complete removal of the understory by chemical means did not produce an increase in the pine growth rate. It follows that annual burning for 5 years did not reduce pine growth in these stands.

There were no major drought years giving rise to critical moisture conditions during the 5-year growth period observed. Before conclusive comparisons of overstory growth as affected by understory removal are made, a longer time interval should elapse, including years of low rainfall.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 74 January 1955

CLIPPING NEEDLES ADVERSELY AFFECTS SURVIVAL OF SOUTH FLORIDA SLASH PINE

Low survival of planted trees is often attributed to excessive water loss from the tops before the roots become established in the soil. On this assumption, many foresters have attempted to improve the rate of survival by clipping off some of the foliage just before planting. Past trials of foliage clipping have given variable results with different species of pines. This note reports negative results of a needle-clipping study [1/] in South Florida slash pine (Pinus elliottii var. densa).

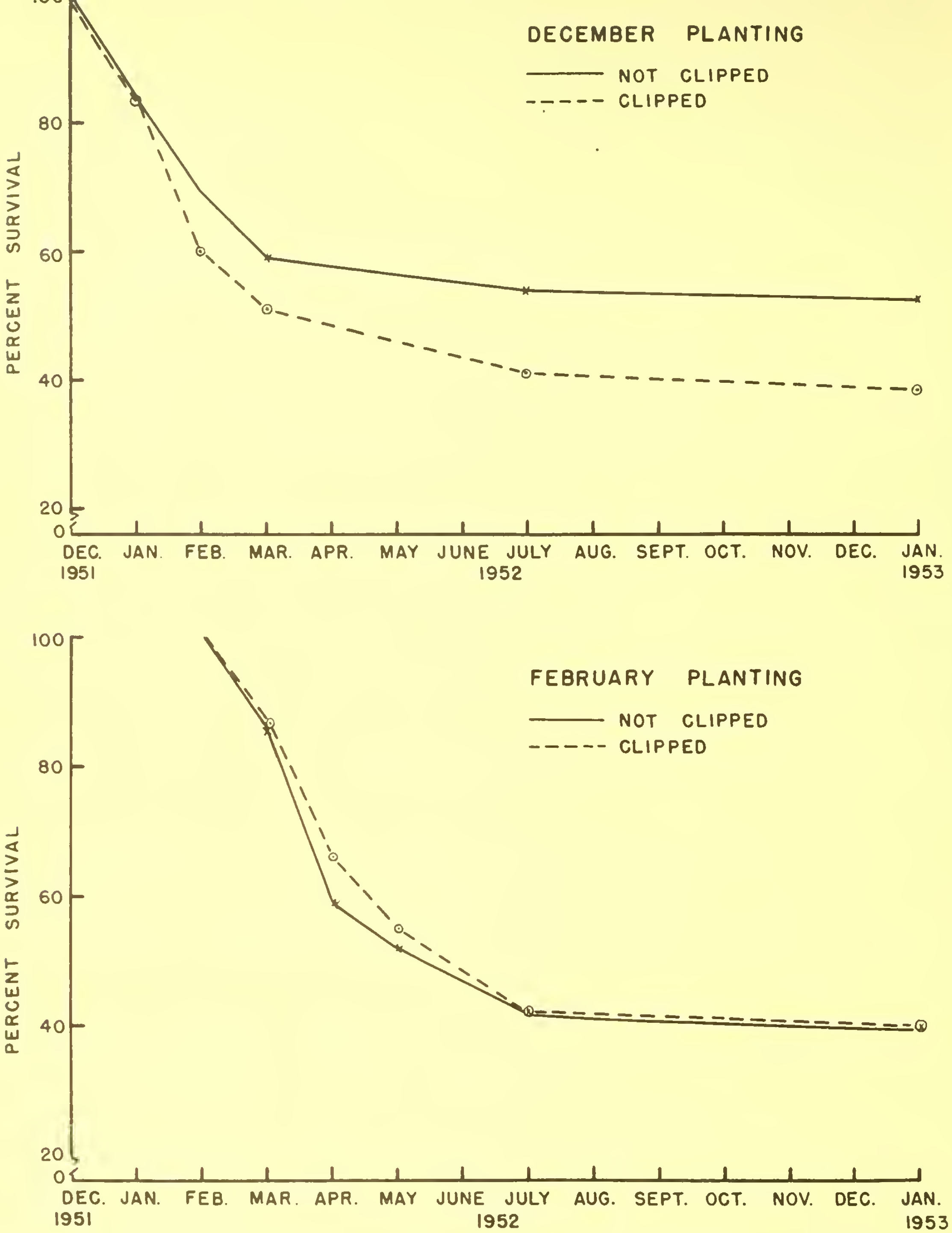
In the present study, one of several aimed at finding ways of improving survival of plantations in South Florida, the needles of 1-year-old nursery-grown seedlings of South Florida slash pine were clipped to about half their original length just prior to planting. One group of 450 seedlings was clipped and planted in December, and a similar group was clipped and planted in February near LaBelle, Florida. Survival data recorded periodically during the remainder of the calendar year are shown on the diagram.

Survival of the December-planted seedlings was significantly poorer than that of unclipped seedlings. No differences were noted in the February planting. Since needle clipping of South Florida slash pine did not result in significantly better survival in any instance, it is not a recommended nursery practice for this species.

These results appeared related to dormancy and needle functions. In December, the needles of this slash pine were still green and apparently performing necessary functions of photosynthesis and respiration. Clipping the needles apparently upset these normal functions and resulted in the death of some seedlings which counteracted any possible benefit derived for a few. In February, many needles of the treated nursery stock were either brown or turning brown at the tips. Clipping at this time had no apparent effect in either reducing transpiration or in upsetting other normal functions.

The trend in survival illustrated by the graphs is fairly normal for South Florida. Dry weather is usually experienced from November through April with progressively poorer soil moisture conditions toward the end of the period. This is the period of highest seedling mortality.

1/ A cooperative study of the Atlantic Land and Improvement Company, the Collier Enterprises, the Florida Board of Forestry, and the Forest Service, USDA.



Survival of clipped and unclipped South Florida slash pine seedlings planted in December and February.

Treatments and techniques being tested in other studies are aimed at overcoming the high initial mortality during this period by means of better planting stock, better methods of handling and planting, and by special treatments that will assure early root growth and subsequent establishment of the seedling.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 75 January 1955

BURNING AND GRAZING AFFECT PHYSICAL PROPERTIES OF COASTAL PLAIN FOREST SOILS

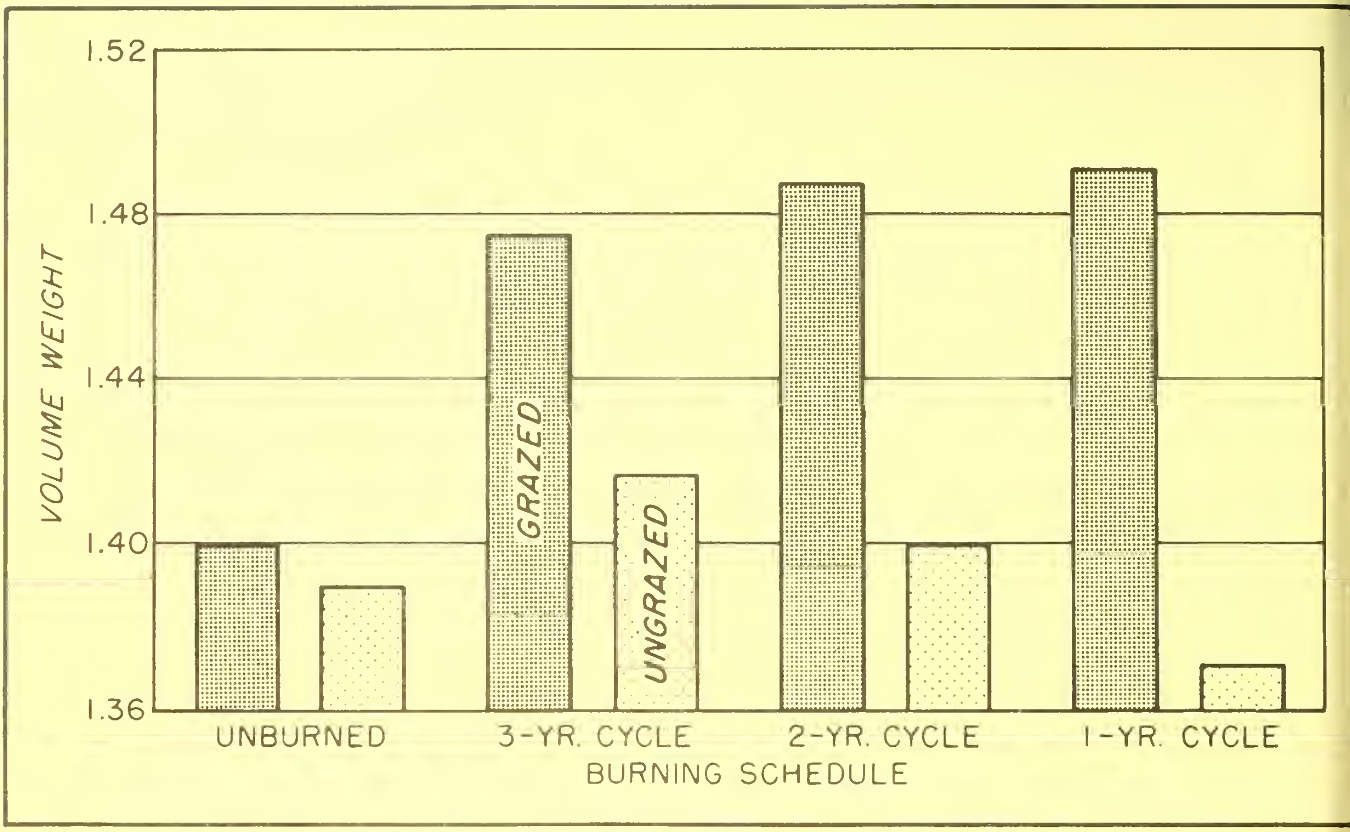
Trampling by cattle on burned forest areas, managed for both forage and timber production, altered the volume weight and water absorption properties of Lynchburg loamy fine sand and Plummer sand soils in recent studies [1/] conducted cooperatively by the Forest Service and the Georgia Coastal Plain Experiment Station. Surface texture of these soils is approximately 80 percent sand, 11 percent silt and less than 1 percent clay. Organic matter is normally about 3 percent. On similar unburned areas, litter accumulation diminished the effects of trampling and grazing.

Eight 50-acre units were stocked with six steers each and grazed annually from mid-March through January. Four burning frequencies were employed: whole unit annually, alternate halves annually, alternate thirds annually, and no burning. Several exclosures were set up in each unit to provide protection from grazing. Seven years after treatments were initiated, soil samples were procured from within and outside the exclosures and compared to determine the effects of grazing and trampling with and without burning. Forty-eight samples were collected for each condition of grazing and burning.

Trampling and grazing on the burned areas caused soil compaction within the 3-inch layer of topsoil, as reflected by the significant increase in volume weight from an average of 1.40 to 1.48. Observed differences in volume weight due to trampling and grazing were in direct proportion to the frequency of burning.

As shown by the figure, there was very little soil compaction on the unburned ranges, although all units were stocked with the same number of cattle for the same period. Evidently, the pine-needle and herbaceous litter effectively protected the soil from the compacting force of the animals' hoofs, and also lessened trampling effects by reducing runoff and preventing "sealing" of the soil surface. Removal of litter by burning permitted this force to be concentrated on smaller unit areas, and thus increased the compaction of the soil. Another factor may have been that cattle, given free choice of burned and unburned ranges, concentrated their grazing time on the burned range, where forage was more nutritious and palatable.

1/ Effects of burning and grazing on chemical properties of Coastal Plain forest soils are described in Research Note 56, July 1954.



Differences in soil volume weight of surface 3-inch soil layer between grazed and ungrazed areas.

Compaction of these upland soils by grazing and trampling caused a reduction in the infiltration rate of water into the soil. The average time required to saturate 3-inch core soil samples under a constant head of water was 7.75 minutes. This was considerably longer than the 5.43 minutes needed to saturate soil cores from ungrazed ranges. This effect of grazing was of greatest magnitude on burned ranges.

Percolation rate, based on timed flow of a measured quantity of water through saturated 3-inch soil cores, was rapid for the ungrazed, unburned range. The rate was somewhat slower on the grazed, unburned range and still slower on the burned, ungrazed range. The slowest percolation rate was observed in cores from ranges both burned and grazed, but even here percolation continued at a moderately rapid rate.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 76 Revised October 1955

A CONTROL FOR THE BLACK TURPENTINE BEETLE IN SOUTH GEORGIA AND NORTH FLORIDA

The black turpentine beetle, Dendroctonus terebrans, has caused heavy losses of slash and longleaf pines in the South during the past 5 years. Unless control measures are undertaken, losses will probably continue as long as the present drought cycle continues. The beetle has been especially active in naval stores areas during the past 2 years.

Black turpentine beetles can be controlled easily during the early stages because infestation nearly always starts with a few scattered attacks on the lower 18 inches of the tree trunk. Spraying the bark at this time kills the beetles and prevents other attacks on the sprayed tree for about 1 year.

THE BEETLE ATTACK

The attacks are characterized by masses of pitch which appear on the bark surface. Though this pitch may sometimes be fluid and run down the bark, it is usually quite solid, reddish colored, and sticks out from the bark.

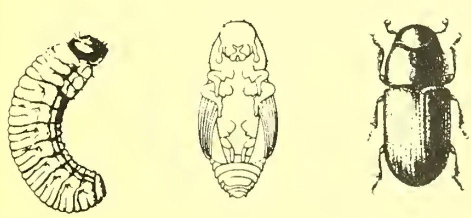
When the beetle is first active in a stand, it is confined to a small number of trees, but by the end of the season the beetle may be in 10 to 15 percent of the trees. During any period, the attacks in an area are largely concentrated on those trees which have been attacked in previous months. The beetle remains active in a stand for 2 to 3 years. Trees recently injured by fires, logging, and winds are particularly susceptible to beetle attacks, as are turpentined trees, especially those with virgin faces installed with a broad axe. Intensively turpentined trees growing in dense stands are also more liable to attack. Beetle attacks are usually concentrated on a small section of a timbered area; slash pine in the ponds and draws has been preferred in the past. However, the attack will probably be lightly scattered over most of the stand. The beetle also attacks fresh-cut stumps and will breed up in them.

THE TREATMENT

The primary objective of this treatment is to reduce the beetle population. Therefore, all attacked trees must be sprayed--even those with red needles--to obtain the best results. The following six steps are required in applying control measures.

1. Spot all attacked trees.--One effective method is to give the chipper and dipper a supply of narrow strips of white cloth each 36 inches long. When an attacked tree is found, a strip is tied around the tree at eye level or higher. These trees can be easily located after they have been reported in a general area.

BLACK TURPENTINE BEETLE



LARVA PUPA ADULT

2. Get the correct insecticide.--This is a 1-percent solution of the gamma isomer of BHC (benzene hexachloride) in No. 2 fuel oil. The BHC is most conveniently purchased as a liquid oil concentrate containing 1 pound of gamma isomer per gallon. To make a 1-percent solution, add 1 gallon of the concentrate to 14 gallons of diesel oil. If crystals form in the chemical, they must be redissolved in the concentrate before it is diluted in the oil.

3. Slough off the loose bark and debris at the base of the tree.--The main objective here is to push away from the tree the bark, moss, and debris which collects about the base of the pines--especially slash pine in the ponds and draws. It is not important to slough higher than the waist; nor is it necessary to cut deeply into the tight bark.

4. Apply the spray solution correctly.--This is most easily done with a common garden air-pressure spray with the nozzle adjusted to produce a cone or fan-shaped spray of fine droplets. A misty, fog-like spray or a spray of large drops is not desirable. A medium air pressure is advisable to force the spray into the crevices of the bark. Maintaining adequate pressure will facilitate the work.

The spray is applied to the basal 18 inches of the tree, or higher if there are attacks, until it runs freely down the bark. One gallon of the spray solution will adequately cover the basal 18 inches of seven 12-inch trees. While spraying, hold the nozzle within 4 inches of the bark, and walk slowly around the tree. Spray as high as the highest attack. An isolated attack a foot or more above the zone of attack may be spot sprayed without spraying the entire tree to that height. A second pass should be made around the tree directing the spray at the basal 2 to 3 inches of the tree. Do not spray during or after a rain when the bark is wet.

5. Omit the next two streaks on faced tree.--This is recommended so that the chipped trees may have a better opportunity to recover from effects of the beetle attacks and the spray. If possible, trees with numerous attacks should not be chipped for the rest of the season.

6. Continue these operations.--As long as the beetle is active in the area, trees should be checked and sprayed in order to keep the beetle population low. This is quite easy in naval stores timber, where the important job of spotting attacked trees can be carried on in the normal course of chipping and dipping.

The procedure outlined above enables an owner to take effective measures against the black turpentine beetle at any time--even before cutting is desirable or feasible. If he spots and sprays with care, he will reduce the beetle population and thus greatly lessen the intensity of future attacks.

An alternative method is to cut and remove the infested trees and spray the stumps with the 1-percent BHC oil solution. Although some residual trees may continue to be attacked, the method will work fairly well and is recommended where the tree-spray method cannot be used.

The treatments described in this paper are used only for the black turpentine beetle, since its attacks are made at the base of the tree. A different approach must be used if the stand is attacked by Ips engraver beetles or southern pine beetles. These insects may attack the full length of the tree, usually making numerous small pitch tubes on the bark surface along much of the trunk of the tree; consequently a basal spray will not control them.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 77 April 1955

GROWTH OF CROWDED 45-YEAR-OLD SLASH PINE AFTER RELEASE

A common problem in silviculture is to estimate whether short-crowned trees in a previously overcrowded stand will respond well enough to release to justify retention as growing stock. The answer, of course, varies with the species, age, and other characteristics of the particular trees. One study on the George Walton Experimental Forest in Dooly County in south-central Georgia indicates that 45-year-old slash pines with crowns averaging only 20 to 25 percent of tree height were unable to grow satisfactorily in the ensuing 5 years after release.

In the winter of 1949-50, the initial improvement cut was started on the experimental forest. Included in the area to be logged was a dense stand of slash pine approximately 45 years of age, growing on an old-field area of Lakeland loamy sand with a site index of 76. Short, thin crowns and yellowing of the bark indicated overcrowding. The initial impulse was to clear cut the area and plant. After consideration, however, it was decided to try a heavy release cutting and measure the effect on the residuals. All timber worked out for turpentine was cut (8.3 cords per acre). The remaining stand of round trees was reduced from 21.8 to 15.9 cords, and from 84.9 to 53.3 square feet of basal area in trees 5 inches and larger. The salvage and release cutting together harvested about half the original stand, including all the largest trees, and left the area with perhaps two-thirds of desirable stocking. The reserved trees, no longer crowded, were apparently free to grow.

After cutting, 99 randomly selected trees were tagged, and d.b.h., total height, crown ratio, and position in the stand canopy were recorded. Five years later, remeasurements were made. The following table presents the mean annual diameter and height growth made by survivors in each of the three identified crown classes.

Crown class after cutting	Number of trees	Average d.b.h. 1/	Average crown ratio 2/	Mean annual growth	
				Diameter	Height
		Inches	Percent	Inches	Feet
Dominant and codominant	24	8.7	25	0.12	0.5
Intermediate	29	6.7	22	0.06	0.3
Suppressed	32	4.2	17	0.001	0.1

1/ At beginning of study.
2/ Relation of green crown to total height at beginning of study.

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One intermediate and 13 suppressed trees died during the 5-year period. No dominants were lost. Nine suppressed trees and four intermediates had negative growth rates because they had grown little if any, while shedding considerable bark. Only two trees--both 11-inch dominants--grew as much as 1 inch in diameter during the 5 years. Crown ratios were less than 70 percent of the length required for a desirable rate of growth, and height growth was about half of normal.

Having somewhat smaller live crown ratios than the dominant trees, the intermediate ones grew only 50 percent as much in diameter and 60 percent as much in height. Sample measurements showed the average dominant to have a 62 percent greater crown width than the average intermediate. This suggests that the leaf surface of the dominant was at least twice that of the intermediate.

Mean annual diameter growth for the dominants and intermediates combined--the only trees of commercial value--was 0.09 inch, and the volume growth averaged 0.43 cord per acre annually, or only 2.7 percent. These rates of growth in diameter and volume were only about one-third normal. Though more than ample growing space had been provided, these slash pines failed to respond properly in the first 5 years. How well they can overcome this handicap in the next 5-year period remains to be seen. Crowns should never be permitted to become so short on potential timber trees.

In contrast, young plantations on similar soils are averaging $\frac{1}{2}$ inch per year in diameter growth and 1 to $1\frac{1}{2}$ cords per acre per year in volume growth. Thus, during the 5-year period, at least 3 cords per acre, and possibly 5, were sacrificed by not clear cutting and planting.

Unless the reserved trees step up their recovery in the next 5 years, it is clear that 45-year-old, short-crowned and partly suppressed slash pines are unsuitable growing stock. If no better trees are available, it may be best to clear cut and plant.

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RESEARCH NOTES

SOUTHEASTERN FOREST EXPERIMENT STATION

Asheville, North Carolina

Number 78 April 1955

THE RELATION OF GROWTH TO SITE AND RESIDUAL DENSITY IN LOBLOLLY PINE PULPWOOD STANDS

When a stand of loblolly pine reaches the point where a commercial pulpwood cutting is feasible, questions may arise regarding cutting intensity and expected growth on the residual stand. Cutting will often range from a moderate thinning that does little more than anticipate mortality and improve spacing to a heavy cut leaving scattered dominants with the hope that they will reseed the area. A knowledge of what future growth might be expected under varying conditions of site, age, and residual stand density would assist in determining the cutting intensity. Growth data from a series of 43 fifth-acre plots in young, even-aged loblolly pine stands have provided some information.

These plots were established in 1939 with a primary objective of exploring the effect of various methods of cutting on growth, mortality, and regeneration.[1/] They were located in the Piedmont and Coastal Plain areas of Virginia and the Carolinas. The data represent site index classes 70 and 80 in stands 25 to 35 years of age. Stand densities were reduced by cutting to residual basal areas ranging from 3 to 80 square feet per acre. In all cases the best trees in the overstory were left and the cut was from below, starting with trees 5.0 inches d.b.h. Residual basal areas of 3 to 12 square feet represented seed-tree cuts leaving 5 to 15 seed trees; 20 to 35 square feet represented a shelterwood cut leaving 40 to 50 trees; basal areas over 50 square feet resulted from moderate or heavy thinnings leaving 100 to 175 of the best trees per acre.

Nine years after cutting, all plots were remeasured and the ingrowth, mortality, and residual stand growth calculated. Mortality in the merchantable residual stand was negligible, inasmuch as the thinnings from below had removed the most susceptible trees. Ingrowth in these stands averaged 0.10 cord per acre per year and contributed little to the total growth. The spindly, low-vigor trees under 5.0 inches d.b.h. (unmerchantable) formed only a small part of the residual stand and suffered a high mortality because of logging damage and poor vigor.

Periodic annual growth after cutting was found to have a highly significant relation to site and residual basal area. Age of stand did not affect growth in this study within the narrow range of ages sampled (25 to 35 years). A regression analysis provided an equation in which each of the independent variables was significant at the 1-percent level. The equation is:

$$Y = 0.033259(BA)(SI) - 0.019459(BA)^2 - 3.429160$$

where Y = periodic annual growth per acre in cubic feet inside bark, for the 9-year period.

BA = residual basal area per acre in square feet.

SI = site index based on average height of dominants and codominants at 50 years of age.

1/ McClay, T. A. Growth, mortality, and regeneration after cutting in loblolly pine pulpwood stands. Southeastern Forest Expt. Sta. Paper 28. 1953.

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The equation is shown graphically in figure 1 for site index classes 70 and 80 over a range of residual basal areas per acre. The plotted points are actual plot data of growth by residual densities and site-index classes.

The curves show a logical trend of increasing growth with increasing residual stand density up to a point where growth is maximized. These data indicate that this point of optimum growth is reached at about 60 square feet of basal area on sites with a 70 index and at about 70 square feet on sites with an 80 index. Whether or not the growth curve levels off or declines beyond this point cannot be determined conclusively because of the lack of data from high-density stands. There is some evidence, at least for site index 70, that growth will decline for residual densities greater than 60 square feet of basal area per acre.

Obtaining sufficient growth data to cover adequately a wide range of sites, ages, and residual densities is a very large undertaking. Progress toward this goal is being made in our territory through region-wide growing-space studies for several species. A 5-year record of growth on 153 loblolly pine plots is being completed this dormant season. These data, all of which are from stands of not less than 60 square feet of basal area per acre, should provide additional growth information for high-density stands. An analysis and report will be made in the near future.

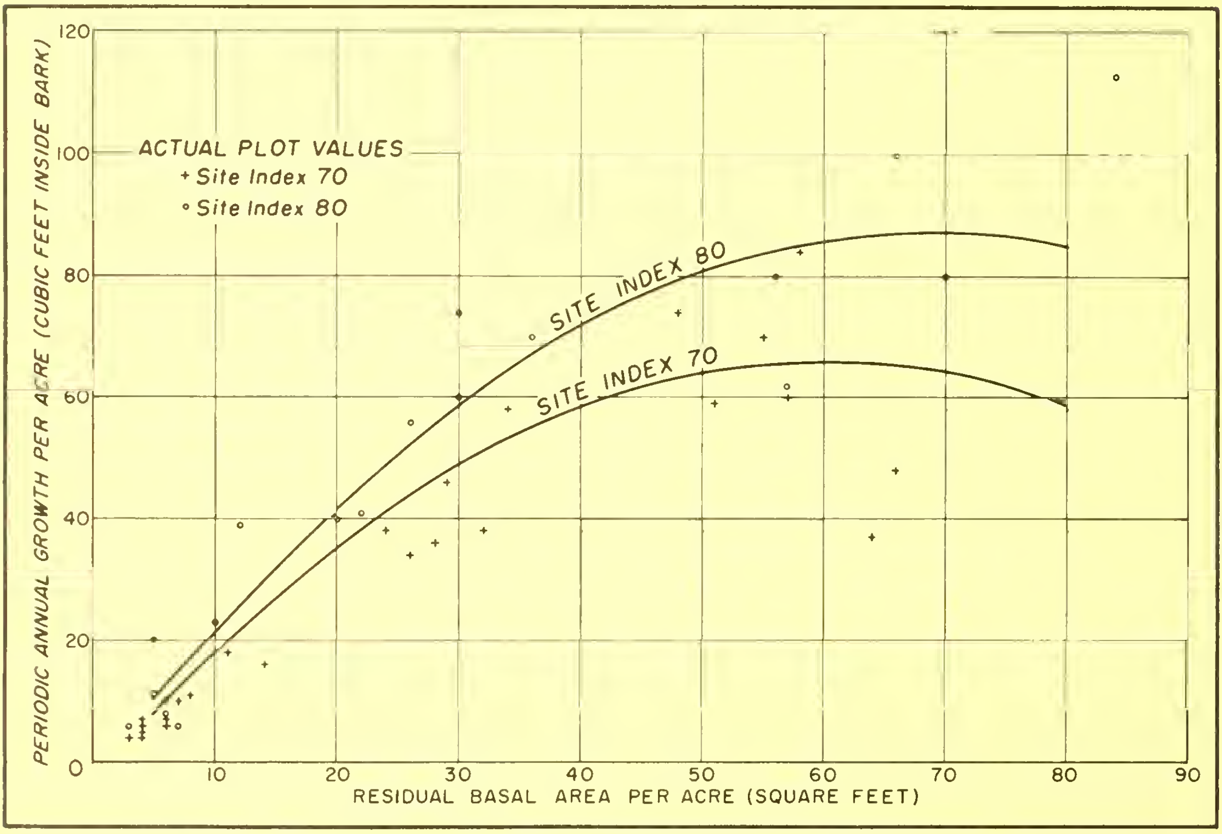

Figure 1. --The effect of site and residual density on periodic annual growth for a 9-year period after cutting in even-aged loblolly pine pulpwood stands.

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RESEARCH NOTES

SOUTHEASTERN FOREST EXPERIMENT STATION

Asheville, North Carolina

Number 79 April 1955

HOW TO ESTIMATE THE OUTPUT OF SLABS AT SMALL PINE SAWMILLS

Most of the current interest in utilizing chippable residues at small sawmills is being devoted to slabs. Because of their small size, edgings are thought to be too expensive to handle. Outlined below is a method for estimating with fair accuracy the output of slabs at small southern pine sawmills.

To estimate the rate of slab output at a mill, a tally (like the example below) should be kept for an 8-hour, or longer, period of the logs sawed by 1-inch diameters and of the total numbers of slabs and edgings produced. The numbers of logs, slabs, and edgings are totaled. The number of logs in each diameter class is then multiplied by the reciprocal of the diameter and the products are added. The sum is then divided by the total number of logs to obtain the weighted average reciprocal. Finally, the total number of slabs is divided by the total number of edgings. In the example given, the average reciprocal was found to be 0.10, the ratio of slabs to edgings 0.5

Diameter inside bark at small end	Number of logs	$\frac{1}{\text{Diameter}}$	Number of logs times $\frac{1}{\text{Diameter}}$	Number of slabs	Number of edgings
5	1	.20	.20	50	50
6	4	.17	.68	50	50
7	9	.14	1.26	50	50
8	14	.12	1.68	50	50
9	14	.11	1.54	50	50
10	13	.10	1.30	50	50
11	10	.09	.90	50	50
12	8	.08	.64	46	50
13	7	.08	.56		50
14	8	.07	.56		50
15	5	.07	.35		50
16	3	.06	.18		21
Total	96		9.85	396	721

Average reciprocal $= \frac{9.85}{96} = .10$ $\frac{\text{Total slabs}}{\text{Total edgings}} = \frac{396}{721} = .5$

Looking in the following slab-output table under the values nearest to those calculated, an operator can read the output of slabs in cubic feet of solid, bark-free wood per thousand board feet of lumber produced. In our example, the output is 25 cubic feet per thousand.

Average reciprocal	Number of slabs ÷ number of edgings								
	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
	Cubic feet per thousand board feet								
.17	49	53	56	60	64	67	71	75	78
.14	39	43	47	50	54	58	61	65	69
.12	32	36	39	43	47	50	54	58	61
.11	26	30	34	37	41	45	48	52	56
.10	22	25	29	33	36	40	44	47	51
.09	18	22	25	29	33	36	40	44	47
.08	14	17	21	24	28	32	35	40	43
.07	9	13	16	20	24	27	31	35	38

A. S. Todd, Jr.
Walter C. Anderson

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 80 April 1955

17-YEAR TRENDS OF TIMBER VOLUME IN THE NORTHERN COASTAL PLAIN OF NORTH CAROLINA

Back in 1937, the first complete inventory of timber volume in the Northern Coastal Plain of North Carolina was made by the Forest Survey. A reinventory of the forests in this 23-county area was finished in March of this year and the results have just been compiled. Timber volumes found during each survey are shown in the tables below along with changes resulting from the combined effects of cutting, mortality, and growth during the period.

Table 1.--Comparison of sawtimber volume, 1937 to 1955

Species group	1937	1955	Change
	Million bd.ft.	Million bd.ft.	Percent
Pines	9,064	9,142	+ 0.9
Hardwoods	5,777	6,218	+ 7.6
Cypress and cedar	1,228	934	-23.9
All species	16,069	16,294	+ 1.4

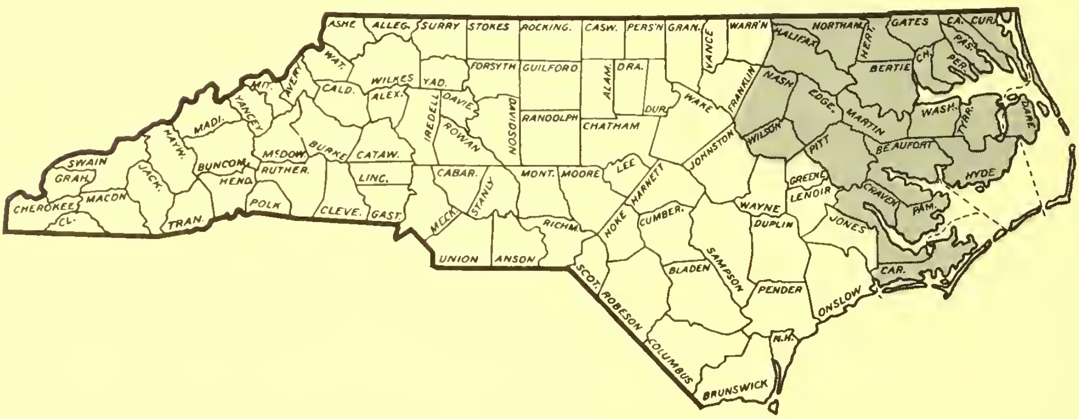
Table 2.--Comparison of volume in all trees 5.0 inches d.b.h. and larger, 1937 to 1955

Species group	Growing stock			Cull trees		
	1937	1955	Change	1937	1955	Change
	Million cu.ft.	Million cu.ft.	Percent	Million cu.ft.	Million cu.ft.	Percent
Pines	2,247	2,324	+ 3.4	97	85	- 12.4
Hardwoods	1,741	2,079	+19.4	456	702	+ 53.9
Cypress and cedar	287	224	-22.0	13	27	+107.7
All species	4,275	4,627	+ 8.2	566	814	+ 43.8

The 1937 survey volumes have been recomputed to allow for differences in standards between the two surveys and to provide a uniform basis for comparison. Thus, they will not agree with volumes previously published.

Yellow pine sawtimber volume increased slightly in spite of the fact that cutting of this preferred species group has been heavy. Pine growing stock, which includes both pole and sawtimber trees, increased 3 percent, indicating better stocking of trees in the smaller size classes. Cypress and cedar were also cut heavily, but these species, in contrast to pine, failed to restock and grow rapidly. A strong upward trend is evident in the volume of hardwoods, and at the present time they have surpassed the softwoods in total volume.

J. F. McCormack
Division of Forest Economics



LOCATION OF AREA IN N. C.

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 81 April 1955

IPS BEETLES ARE KILLING PINES: WHAT SHALL WE DO ABOUT IT?

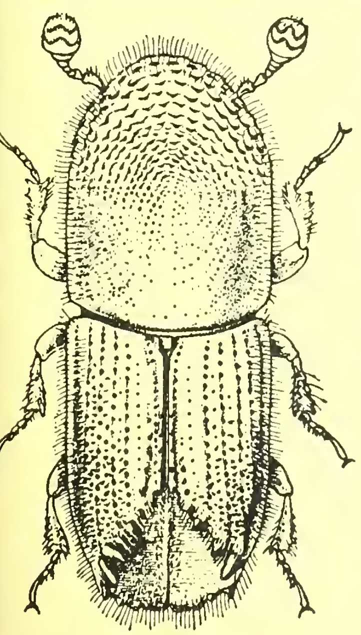
During the very dry years of 1954 and 1955, Ips engraver beetles have stepped up their numbers and made heavy attacks on pine in the Southeastern States. The flare-up is truly epidemic in some places. Central North Carolina, South Carolina and southern Georgia have severe outbreaks.

An aerial survey in January of southern Georgia, one of the hardest hit areas, showed 48,000,000 board feet or 65,000 cords of standing timber killed by insects. This figure does not include the large volume of timber killed and salvaged since June 1954, when the killing was first noticed. Much of the 1954 kill remained unsalvaged and was a complete loss to the lumber, paper, and naval stores industries.

HOW AND WHY DO THEY KILL TREES?

The Ips beetles are tiny, blackish, hard-shelled insects about 1/8 to 1/4 inch long. They are usually very active in the summer and fall, and during warm spells in the winter. They fly to and attack a tree--sometimes in the crown, sometimes in the trunk, sometimes from bottom to top--and bore through the bark. Hundreds of beetles attack at the same time. Wherever they bore, pitch runs out the hole and hardens, forming a "pitch tube." When the beetle reaches the wood, it bores a tunnel between the bark and the wood, up and down the tree. As it bores, it lays eggs spaced about 1/16 inch apart along each side of the tunnel. These eggs hatch into cream-colored worms which bore their own tunnels out from the beetle's tunnel. After a few weeks, these larvae stop feeding, rest, turn into beetles and leave the tree to look for other trees to start the cycle again. A cycle takes only about 6 weeks and there may be 4 to 6 of them during the year. If things are right for the beetle, every tree attacked and killed breeds up enough beetles to attack at least five more trees.

What makes conditions right for the beetle? Temperature, moisture, and many other factors. But mainly it is weakness or an unhealthy state in trees. It is the weak tree that becomes a target for insects. The more bugs, the more food they need; healthier trees are then attacked, until after awhile even the strongest trees are hit. Normally, when the weather is good, beetles will attack only weak limbs, a fire damaged tree, a lightning-struck tree, or one whose roots or trunk have been badly damaged in some mechanical way. They will attack tops during a cutting operation, and as long as there are plenty of tops for them to breed in they are quite happy. By the end of the season, the beetles in such a location are getting numerous. Then winter comes along bringing insect and disease enemies that cut the Ips population way down. But, during the last few years everything has been right for Ips, and dry weather has been especially good for it. Trees have generally become weakened by drought. Now, anything that comes along to weaken trees invites beetle attack--fire, windstorms, logging operations. Then too, a lot of forestry is going on "as usual." There's a lot of cutting which provides tops for beetles to get started in; there's naval stores which hurts the tree just enough to make it susceptible to attack. Let's remember this -- during normal weather most of these things don't favor the beetle, but during dry weather they do. Therefore, as long as dry weather lasts we've got to carry on woods operations a little differently in order to hold down the number of beetles and keep trees as healthy as possible. That means a little more work than usual, and a little more expense.



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HOW DO WE FIGHT THIS BEETLE?

The most important thing to remember in dealing with Ips is that you must get rid of the timber in which the beetle is breeding or may breed. Here is a list of things to do and not to do if you want to reduce tree killing in your woods. 1/

1. Cut down immediately the trees that have beetles in them. Usually this means trees with fading crowns and trunks with fresh pitch tubes; a few "shot holes" in the bark. Get this wood to a mill or peel or burn it; destroy the tops too. If you can't do these things, you may have to spray with chemicals (we'll talk about this later).
2. Remove trees containing the bugs first; old bug trees may be salvaged later.
3. In a cutting operation, treat the tops to keep the bugs out by:
   a. Burning them, or
   b. Spraying them with chemicals, or
   c. Pulling them into the open and lopping them into small pieces so they will dry out.
4. Lightning-struck trees, or trees badly damaged by heavy equipment should be handled like bug trees.
5. Fire damaged trees should be examined carefully; check the inner bark. If it has browned, salvage the trees immediately to keep the bugs out.
6. Reduce naval stores in an area "hot" with bugs.
7. Don't store large quantities of pulpwood in the woods very long. If it must be stored, spray with chemical.
8. Spraying with the chemical BHC (benzene hexachloride) in a light petroleum oil is a very effective way of killing beetles when the jobs suggested above can't be done. You will want to know this about spraying:
   a. BHC kills the bugs under the bark.
   b. When sprayed on felled green trees, logs, tops, and pulpwood, it kills the beetles which try to bore in. It will keep them out for about 3 months. It will slow down degrade of the timber.
   c. It can be applied with a simple 2- or 3-gallon garden pressure sprayer.
   d. Apply it as a medium fine spray until the bark begins to drip. A mist spray is not desirable. Do not spray after rain when bark is still wet.
   e. BHC is easy to mix. Ask the manufacturer for a BHC concentrate containing one pound of gamma per gallon of solution. Tell him what you want to do with it. When you get the chemical, add 1 gallon to 55 gallons of light fuel oil, stir well and the solution is ready to use. Follow the manufacturer's directions carefully.
   f. The BHC spray, ready to use, costs less than 20 cents a gallon. A gallon will spray a 16-foot log 24 inches in diameter; 5 gallons will spray a cord of pulpwood.
   g. Here is a list of suppliers of BHC:

      Ashcraft-Wilkinson Company, Atlanta 3, Georgia
      FASCO, P. O. Box 658, Jacksonville 1, Florida
      Southern Agricultural Insecticides, Inc., Hendersonville, N. C.
      Taylor Chemical Co., Aberdeen, N. C.
      Triangle Chemical Company, Macon, Georgia
      Chapman Chemical Company, Memphis 3, Tennessee

This list is not complete; no discrimination is intended or implied against concerns not listed.

WHAT ELSE?

You can't do this bug job alone. If your neighbors have bug infested woods, you must all work together to clean up the woods. The beetles can fly and they don't stop at property lines.

How long will this serious bug activity keep going? We don't know. As long as dry weather continues, all woodland owners must pitch in to do everything they can to keep down the beetle and reduce timber losses.

1/ Control measures for black turpentine and southern pine beetles are somewhat different. Details are given in other publications.

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Division of Insect Research

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 82 July 1955

PLANTING IN FURROWS AIDS INITIAL SURVIVAL OF LONGLEAF IN SANDHILLS

Many landowners in the Sandhill region of the Carolinas and Georgia are confronted with the problem of converting their scrub oak lands to a more valuable crop of trees. These sites, now suitable mainly for production of forest crops, were originally in longleaf pine. Through a combination of indiscriminate cutting, fire, cultivation, and subsequent land abandonment, much of this area has reverted to worthless species of scrub oak. On the basis of past history, longleaf pine, with its ability to root deeply on dry sites, should be the preferred species to plant. However, farmers and landowners have not been too successful in re-establishing longleaf pine either through natural replacement or by planting.

There are numerous reasons for low survival of planted longleaf pine. Improper planting technique and poor stock contribute to some of the failure. But much is due to combinations of critically dry periods, high temperatures, and low water-holding capacities of the deep, sandy soils. Under these conditions, the established scrub oaks utilize the available soil moisture to a point where pine cannot become established. Obviously, some form of pre-planting site preparation is needed to establish longleaf on these areas.

Initial tests now being conducted by the Santee Research Center in cooperation with the South Carolina Commission of Forestry and the Project Forester, Savannah River Project of the Atomic Energy Commission, are aimed at finding effective and economical means of reducing scrub oak competition to improve soil moisture relationships and subsequent pine survival. One of these tests compares: (1) complete eradication of the oaks by deep plowing and disking; (2) single furrows plowed 8 inches deep and spaced 6 feet apart; (3) part of the scrub oak removed by cutting stems and poisoning stumps within a radius of 2 feet from the planted seedlings; and (4) no treatment of the planting site. Each site preparation treatment was replicated three times on 1/5-acre plots. All site preparation was done in late November. After a soil stabilizing period of 1 month, 250 Grade 1 longleaf seedlings were hand-planted on each plot at a 6x6-foot spacing. All seedlings had been grown 1 year in the nursery and their foliage clipped to 5 inches in length before planting.

Soil moisture measurements were obtained at 10-day intervals at two depths under each site preparation treatment throughout the growing season. The gravimetric method of sampling was used and the results interpreted in terms of moisture available to the planted pine. First-year results at the Manchester State Forest definitely show that the degree or amount of scrub oak removal is directly correlated with amount of available soil moisture (fig. 1). Soil moisture was better on all treated plots than on the check plot during the growing season. On the average, it was best on the area where the oak was completely eradicated. However, during much of the growing season there was little difference between the eradicated and furrowed plots. Toward the end of the growing season, soil moisture on all treated plots was about the same.

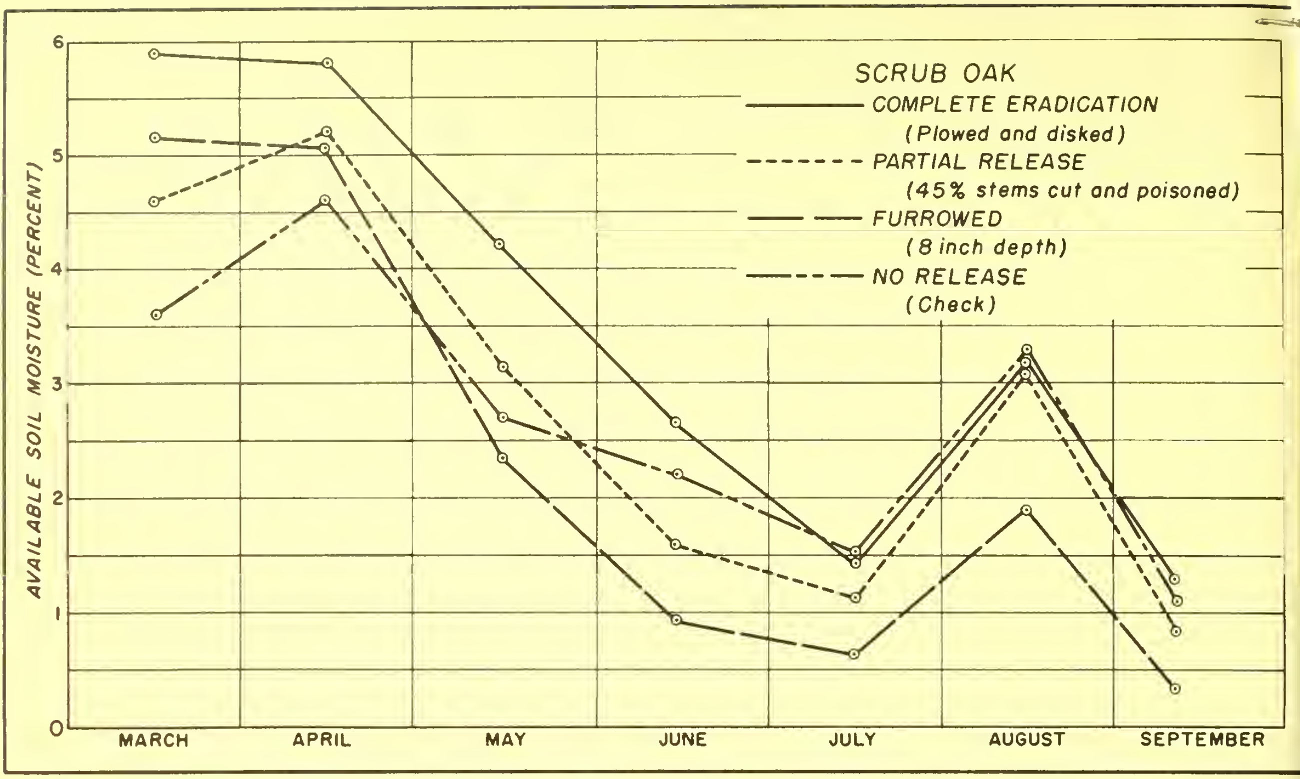

Figure 1.--Effect of scrub oak site preparation on available soil moisture, South Carolina Sandhills, 1954 growing season.

From the foregoing one might conclude that complete eradication of scrub oak results in the best survival of planted longleaf pine. Apparently this is not so. A count taken at the end of the growing season is shown in the following tabulation and indicates that trees planted in single furrows have the best chance for survival.

Site treatment	First-year survival (Percent)
Furrowed (8-inch depth)	71
No release (check)	57
Complete eradication (plowed and disked)	48
Released (45 percent stems cut and stumps poisoned)	45

Percent survival represents the average of three 1/5-acre plots, 250 seedlings per plot. The reasons why furrows gave best success are not obvious at this stage of our investigations. Extremes in soil temperature were less--but not markedly so--in the furrows than elsewhere. There was better soil stability before and after planting in the furrows than in the plowed and disked areas. Trees planted in the furrows also had better protection from the wind. Factors such as these seemingly set up a micro-environment quite suitable to planted longleaf seedlings.

Additional studies are under way which further explore furrowing and other means of site preparation in scrub oak areas of the Sandhills.

R. D. Shipman
Santee Research Center

FOREST SERVICE, U. S. DEPARTMENT OF AGRICULTURE
SOUTHEASTERN FOREST EXPERIMENT STATION
Box 2570, Asheville, North Carolina

August 4, 19

ERRATA

In figure 1, Research Note 82, "Planting in Furrows Aids Initial Survival of Longleaf in Sandhills," in the last two items of legend at to right of graph, transpose the symbols for the curves so that they read

—— - - —— FURROWED
(8 inch depth)

—— —— NO RELEASE
(Check)

Southeastern Forest Experiment Station
Asheville, North Carolina

ERRATUM

In Station Paper 83, "Ten Years of Experimental Farm Woodland Management in the Southern Appalachians," issued September 1957, the second paragraph, page 10, first sentence under Summary should read, "This 10-year summary shows that the woodlands contain less basal area, board-foot volume, and cordwood than they did in the beginning some 10 years ago."

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 83 July 1955

GRASS PRODUCTION UNDER DENSE LONGLEAF-SLASH PINE CANOPIES

Management of longleaf-slash pine forests often involves the integrated production of gum, wood, and forage. This in turn calls for a knowledge of the relation of stand density and other management factors to the yield of each product. It is well known that forage production tends to decrease with increasing stand density. Rate and degree are, however, not so well known. Studies that give some information on the stages of forage decline have recently been completed in the "wiregrass" longleaf-slash pine forests of Georgia. These studies were carried on in cooperation with the Agricultural Research Service and the University of Georgia, Coastal Plain Experiment Station.

Data were collected from 326 plots on upland portions of forest lands at the Alapaha Experimental Range during 1952-1954. Main grass species consisted of pineland threeawn, Curtiss dropseed, Florida dropseed, toothachegrass, Panicums, and creeping, slender, and broomsedge bluestems. Weight of grass was determined at the end of the growing season from annual clippings on 9.6 square-foot plots. These plots were protected from grazing by wire cages randomly placed throughout forest ranges where "rough" had been continually removed for several years by burning and grazing.

Tree canopy was ascertained on 0.02-acre plots (grass plots were in the center) by visually estimating the percent of ground covered by shadow with the sun directly overhead. Additional data were collected in 1954 so as to correlate tree basal area per acre with overhead canopy. Measurements were confined primarily to young stands where trees averaged 7 inches d.b.h., but ranged from 3 to 14 inches.

Normal grass production of 1000 pounds per acre (oven dry) on open forest ranges declined consistently as overhead tree canopy increased from 5 to 35 percent (tree basal area 92 square feet) but tended to level off at approximately 300 pounds per acre under the more dense canopies (fig. 1). The tendency for herbaceous vegetation to stabilize at higher tree densities has been noted in other studies in longleaf-slash pine forests and for bluestems forage in longleaf forests of Alabama.

This relationship between grasses and trees is of practical significance in evaluating range lands because grass production is generally considered the best criterion for estimating the grazing potential of forest range. Since changes in timber stands are accompanied by changes in herbage production, calculations and adjustments for grazing have to be made accordingly. During a portion of the timber rotation, grass production and grazing capacity may be greatly reduced, but when litter is removed periodically, grass may still be available in quantities worth grazing, even under well-stocked timber stands.

U. S. Department of Agriculture - Forest Service

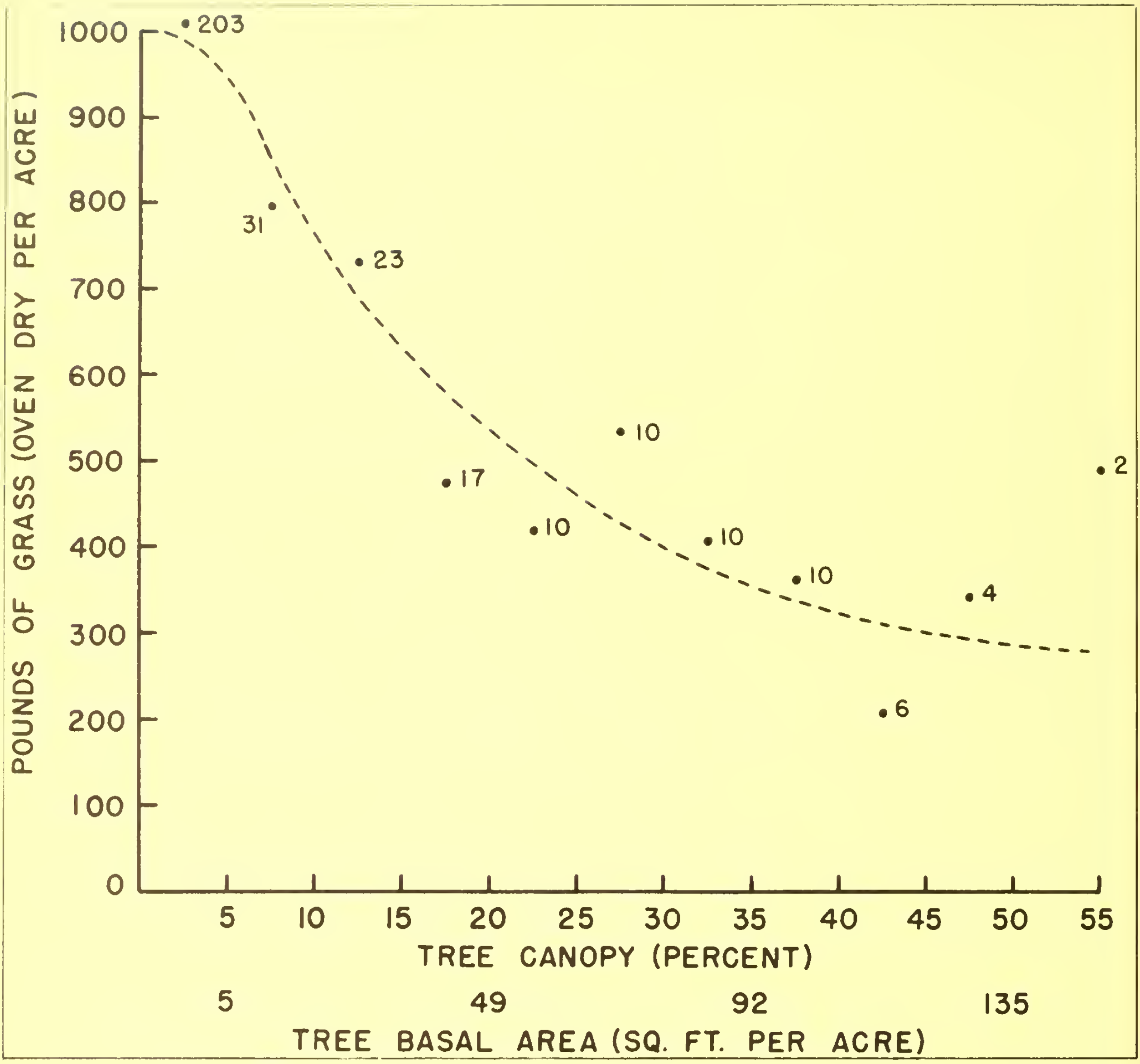

Figure 1.--Although grass production decreases as tree canopy increases, some grass still grows under heavy stands. As shown, curve levels out at about 300 pounds of grass per year under a 35- to 50-percent overstory.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 84 July 1955

BETTER SWEETGUM CONTROL WITH 2, 4, 5-T

In the South Carolina flatwoods, gum and oak are principal competitors of loblolly pine. A common method of releasing loblolly pine when overtopped by these hardwoods involves the use of 2, 4, 5-T applied in frills. The usual mixture is 2 parts 2, 4, 5-T (4lbs. acid equivalent per gallon) to 100 parts of water. Most susceptible are the white oaks, followed by the red oaks. However, sweetgum dies slowly, sometimes requiring 2 or more years. This often discourages the use of an otherwise economical and safe chemical mixture where sweetgum is prevalent. Fortunately, a recent test at the Santee Experimental Forest shows that an effective and quick kill of sweetgum is now possible. This requires adding an inexpensive wetting agent to the usual combination of water and 2, 4, 5-T, or using oil instead of water as a diluent. In either case, season of application is important.

A total of 360 trees ranging from 6 to 13 inches d.b.h. was included in the experiment. Each month for a year, 30 of the trees were frilled by means of overlapping ax cuts made at convenient chopping height. Poured into the frills of 10 trees each were the following chemical mixtures:

1. 2 parts 2, 4, 5-T: 100 parts water ($0.21 per gallon)
2. 2 parts 2, 4, 5-T: 1 part wetting agent: 100 parts water ($0.24 per gallon)
3. 2 parts 2, 4, 5-T: 100 parts kerosene oil ($0.36 per gallon)

A wetting agent known as "Irgaclorol N. F." was used, but any one of a number of wetting agents might serve as well. Although kerosene was used for the oil mixture, No. 2 fuel or Diesel oil may be substituted. Interim observations were made every 3 months. Figure 1 shows results (percent dead with no sprouts) 12 months after treatment.

Excellent results were obtained from the oil and 2, 4, 5-T mixture. Treatments made during the 5 months from March to July resulted in a mortality of 65 to 100 percent within one year. The quickest kill resulted from the May application, all trees dying within 5 months. October and November treatments also were quite successful.

Season of application also had an important bearing on the effect of the water, wetting agent, and 2, 4, 5-T mixture. Most of the trees treated in May, June, or July were dead within a year. In contrast, rather poor results were obtained from the applications made at other times. In fact there was little to choose between these results and those from the usual water and 2, 4, 5-T mixture.

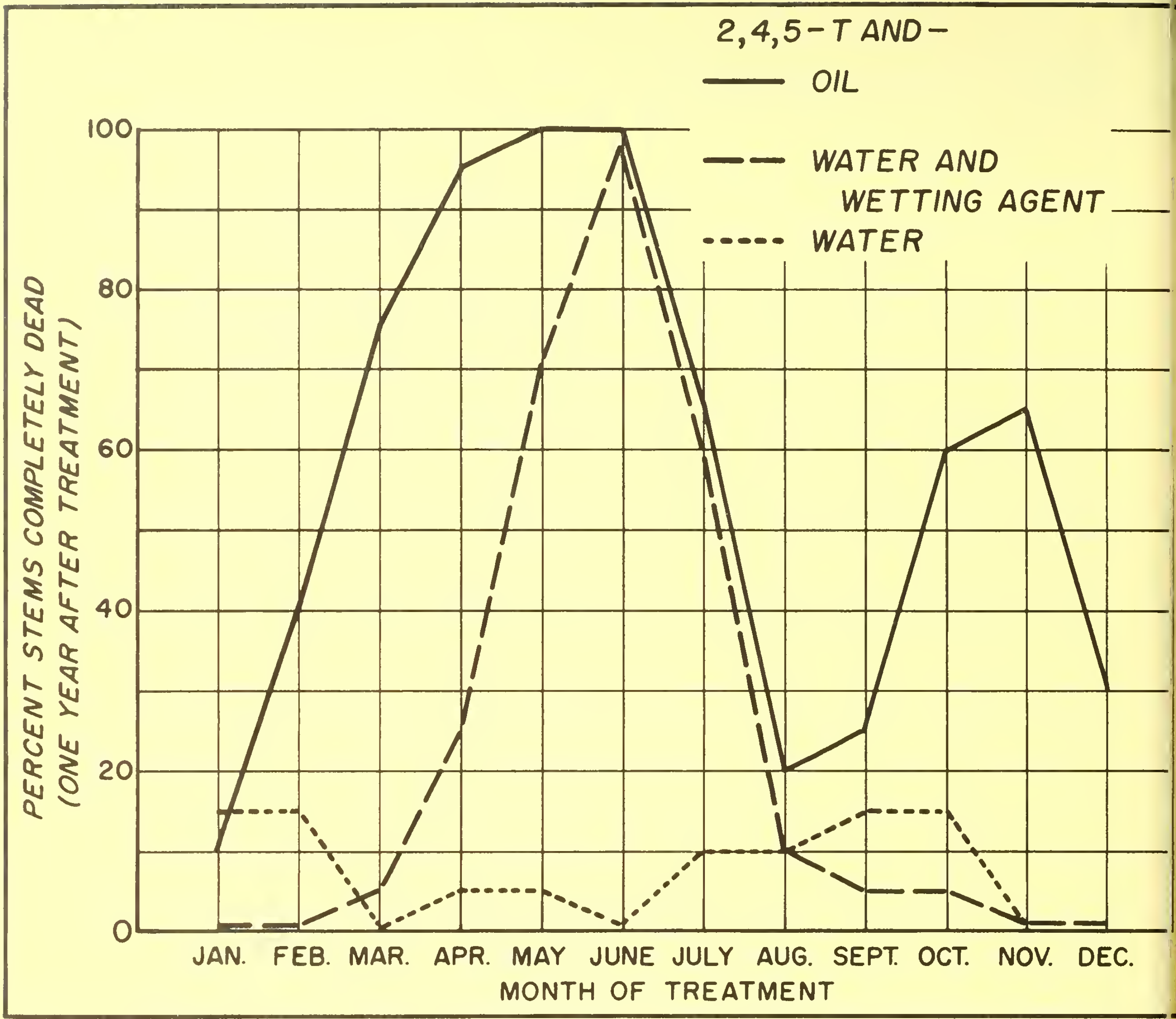

Figure 1.--Sweetgum kill using three mixtures of 2, 4, 5-T applied in frills at monthly intervals.

All mixtures were rated on the number of trees judged to be completely dead. Some of these "dead" trees may sprout during the ensuing growing season. On the other hand, the effective release of overtopped pine is better than the figures show, as many of the trees rated as "living" are almost dead. This study will be continued for another growing season, after which a more complete evaluation may be possible.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 85 July 1955

MORE HARDWOOD PULPWOOD CUT IN SOUTH IN 1954

In 1954 the production of hardwood pulpwood from Southern forests was 2,128,900 cords, 11 percent more than in 1953. Pine production declined 0.3 percent. Chestnut used for pulp amounted to only 32,800 cords. Total pulpwood production was 16,269,600 cords, equivalent to 60 percent of the total receipts of domestic pulpwood at all pulp mills in the United States.

In addition to the pulpwood cut from standing timber, 126,000 cords of residues from other forest products plants were used. Of this total, 80,000 cords were pulp chips made from coarse sawmill waste, and 46,000 cords were chips made from veneer cores, pole and piling ends, and cull crossties.

Pulpwood production in the Southern States, 1954

State	1954 Production				Change from 1953	
	Pine	Hardwood	Chestnut	Total	Pine	Hardwood
	Cords	Cords	Cords	Cords	Percent	Percent
Florida	1,661,200	400	--	1,661,600	- 0.6	-89.2
Georgia	2,879,900	172,500	5,100	3,057,500	+ 4.8	+38.4
South Carolina	1,160,500	170,400	--	1,300,900	- 8.9	- 1.4
North Carolina	1,228,900	278,500	--	1,507,400	- 2.7	+13.0
Virginia	1,033,600	224,800	--	1,258,400	0.0	- 3.4
Southeast	7,964,100	846,600	5,100	8,815,800	- 0.3	+ 8.5
Alabama	1,764,900	67,000	--	1,831,900	+ 2.2	+72.2
Arkansas	725,600	100,700	--	826,300	+ 7.8	- 6.6
Louisiana	1,265,200	239,000	--	1,504,200	+ 7.3	+21.6
Mississippi	1,217,300	746,500	--	1,963,800	- 4.4	+14.9
Oklahoma	33,000	--	--	33,000	-19.5	--
Tennessee	134,200	78,400	27,700	240,300	+27.4	-16.5
Texas	1,003,600	50,700	--	1,054,300	-13.4	- 1.4
Lower South	6,143,800	1,282,300	27,700	7,453,800	- 0.2	+12.7
Total South	14,107,900	2,128,900	32,800	16,269,600	- 0.3	+11.0
Percent	86.7	13.1	0.2	100.0	-	-

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U. S. Department of Agriculture - Forest Service

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 86 October 1955

SLASH PINE CROWN WIDTH DIFFERENCES APPEAR AT EARLY AGE IN 1-PARENT PROGENY TESTS

Recent measurements of seedlings in 1-parent progeny tests of slash pine at the Ida Cason Callaway Foundation[1/] near Chipley, Georgia, have revealed distinct differences in crown width between different lots of seedlings. This early manifestation of crown form places new emphasis on the importance of branching characteristics in selection of superior phenotypes.

The progeny were outplanted in 1952 in a randomized block design with 20 to 100 trees per plot. They have now attained average heights of 5 to 7 feet. The mother trees, excepting controls, were selected from a 15-year-old plantation and may be grouped according to general crown characteristics as slender and wide-crowned trees. All selected trees were among the fastest-growing trees in the stand in height and in diameter at breast height.

Measurements of crown width of the progeny were taken at one-third and two-thirds the height of the seedlings at the end of the third growing season after outplanting. Maximum crown diameter at each height was measured to the nearest 1/10 foot. The outplanting consists of two blocks, but no block differences were encountered, so results were pooled for this tabulation.

The following table gives the average crown width in feet and the ratio of the crown width to total height of the seedling, to provide a basis for comparing seedling lots of different average heights.

These data show that crown width of seedlings is influenced greatly by the mother. Because the seed were all open pollinated, no measure of the male influence can be given. It is of interest to note the nearly cylindrical crown form of the progeny of C-50 as compared with the broadly conical form for those of C-4 or C-10 and the controls.

When the progeny of C-50 are used as a basis for comparison, the crown widths of the offspring of C-4 at one-third height are 50 percent wider; those of C-10, 46 percent wider; and the control seed 37 percent wider. There was practically no difference in form of the control seed group or control seedlings when the difference in height is considered. The randomly collected seed as represented by the controls probably came from trees of better form than C-4 and C-10, but not so well formed as the other mother trees used here. Crown width varied somewhat within a progeny group. A more uniform group of well-formed trees could undoubtedly be obtained by controlled breeding.

1/ The Ida Cason Calloway Foundation Tree Improvement Project is conducted in cooperation with the Southeastern Forest Experiment Station.

Average maximum crown width at one-third and two-thirds tree height for 3-year-old slash pine of different maternal parents

Type of parent or origin of stock	Total trees	Average tree height	Average crown width: 1/3 height	Average crown width: 2/3 height	Width/height ratio x 100: 1/3 height	Width/height ratio x 100: 2/3 height
	Number	Feet	Feet	Feet	Percent	Percent
Slender-crowned						
C-50	145	6.22	2.4	2.0	39	32
C-37	149	5.88	2.6	2.1	44	35
C-54	34	6.80	2.9	2.4	43	36
C-56	47	6.68	2.9	2.2	43	34
C-63	40	6.62	2.6	2.1	44	32
Broad-crowned						
C-4	44	6.54	3.6	2.6	55	39
C-10	179	6.40	3.5	2.5	55	39
Control seed 1/	75	6.18	3.3	2.4	53	39
Control seedlings 2/	65	5.40	2.8	2.2	52	40

1/ Seed obtained from commercial source and seedlings grown in the Foundation nursery.

2/ Seedlings obtained from a commercial source.

When the individual measurements of crown width are plotted over height, there is a strong correlation between the one-third height measurement and total height in all lots except C-50. Here, again, the narrow-crown form of C-50 is emphasized as a near constant width, regardless of seedling height over the range observed. The angle of branch with the trunk was about the same for all progeny groups.

The results of these early measurements lend emphasis to the consideration of crown form and branching habits whenever selection work is done--a consideration not only for the geneticist and researcher but for the practicing forester in selecting his "leave" trees and seed trees.

Later observations of the progeny groups will show the extent to which these juvenile traits are maintained. In a few years, additional data on inheritance of crown width will be available from control-bred progeny from these same parent trees.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 87 October 1955

HOW MUCH WOOD IN A CORD OF PINE SLABS?

The volume of bark-free wood in a cord varies both by species and diameter of the logs from which the slabs came. An approximate figure for all southern pines is 50 cubic feet per cord. Converting factors by species and diameter of log can be read from the table below.

Volume of bark-free wood in a cord of pine slabs, by log diameter and species
(In cubic feet)

Average log scaling diameter (Inches)	Species		
	Longleaf and shortleaf	Loblolly	Slash
6	60	58	57
8	57	54	51
10	55	50	47
12	51	46	43
14	48	43	39
16	46	39	36
18	43	36	32
20	40	32	29

Measurement of 18 sample piles of southern pine slabwood indicates that a standard cord of slabs (128 cubic feet) contains, on the average, 79 cubic feet of solid wood and bark.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 88 October 1955

INHERITANCE OF RESISTANCE TO LITTLELEAF IN SHORTLEAF PINE

A recently completed test of 1-parent progeny from selected shortleaf pines indicates a definite inheritance of resistance to littleleaf. This is the first such trial to be carried out under the program of selection and breeding aimed at future control of this serious Piedmont forest tree disease. Previous to this, there were indications of such inheritance of resistance during studies of the causal factors, particularly during inoculation work with Phytophthora cinnamomi.

Although seedlings of shortleaf pine are considered to be immune to littleleaf, it is possible by intensifying the causal factors to produce clearly recognizable symptoms, particularly in the root system. Necrosis, lack of fibrous roots, and mycorrhizae are criteria in measuring relative resistance to littleleaf.

Open-pollinated progeny from six trees selected for apparent resistance to littleleaf and overall "superiority," and from four moderately diseased littleleaf shortleaf pines, ranging in age from 35 to 83 years, were used in these tests. After growing 1 year in the nursery bed, the seedlings were transplanted in March into a specially prepared tank-type bed containing a heavy clay soil from a littleleaf site. This soil had been inoculated 2 months previously with cooked wheat permeated with mycelium of P. cinnamomi.

Shortly after the resumption of new growth, the soil was flooded twice weekly until the end of the growing season. During October the seedling root systems were washed out of this heavy medium and data recorded.

The results of this study are briefly summarized in table 1. A high proportion of progeny from all "resistant" parents, with the exception of Z-17, exhibited resistance to factors responsible for littleleaf. The highest degree of resistance, 80 percent, was demonstrated by Z-15. The poor response of Z-17 is probably the result of an error in selection.

Three of the littleleaf parents produced a low proportion of resistant progeny; LLd gave the lowest percentage, or 15 percent. The fourth tree of this group, LLa, showed a rather high resistance to the disease. Apparently this tree was not littleleaf diseased; its condition was merely a reflection of a typically poor site. Such discrepancies were to be expected, since trees in only mild stages of littleleaf were chosen in order that sufficient viable seed could be obtained for testing.

More extensive tests will be made during 1955-1956, employing both open- and control-pollinated progeny from selected trees. Eventually, suitable strains will be screened for incorporation into seed orchards.

Table 1.--Results of littleleaf resistance test using open-pollinated progeny from apparently resistant and from diseased shortleaf pines.

"Resistant" parent trees		Littleleaf parent trees	
Designation	Seedlings resistant	Designation	Seedlings resistant
	Percent [1]		Percent [1]
Z-7	65	LLa	70
Z-13	45	LLb	25
Z-14	75	LLd	15
Z-15	80	LLe	20
Z-16	50		
Z-17	15		

1/ Each percentage is based upon 20 seedlings tested.

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Agriculture-Asheville

ERRATA

In Research Note 89, "A Winter Key to the Hickories of Georgia," issued October 1955, please insert not between husk and covered in the second line from the bottom of the first page. The line should read:

DD Husk not covered with yellow scales, fruit distinctly 4-ridged.

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 89 October 1955

A WINTER KEY TO THE HICKORIES OF GEORGIA

Identification-wise, the hickories (Carya spp.) are one of the poorest known genera of commercial trees in Georgia. Part of the expanded interest in the utilization, management, and control of Georgia hardwoods has rubbed off on this species group, and the ability to identify individual hickory species is becoming increasingly important.

Two issues complicate the winter identification of hickories. Foresters whose dendrological training is prior to 1953 will find the present nomenclature confusing. The latest check list[1] corrected the genus name to conform with the International Code. It also provided field workers a fighting chance in hickory identification by lumping species so that only 14 of the 37 listed in the 1927 check list are now recognized as species or major varieties. In addition, few keys are available for the hickories based on winter characteristics recognizable on adult trees with clear butt logs--the usual condition encountered by foresters in the field.

The key below attempts to utilize characteristics that can be observed on or near large trees. It is dependent primarily upon three major criteria: characteristics of the stalk supporting the leaflets (rachis), tightness of the bark, and the nature of the fruit husk.

- A. Bark shaggy.
  - B. Rachises remain on branches for several years.
    - SHELLBARK HICKORY (C. laciniosa (Michx. f.) Loud.)
  - BB. Rachises fall off each autumn.
    - SHAGBACK HICKORY (C. ovata (Mill.) K. Koch)
- AA. Bark tight or only slightly loose.
  - B. Rachis smooth or only slightly hairy. Fruit not ridged, husk thin.
    - C. Fruit less than 1 inch in length.
      - PIGNUT HICKORY (C. glabra (Mill.) Sweet)
    - CC. Fruit longer than 1 inch in length.
      - COAST PIGNUT HICKORY (C. glabra var. megacarpa (Sarg.) Sarg.)
  - BB. Rachis hairy.
    - C. Fruit husk with wings, bud with valvate scales.
      - D. Husk 4-winged from base to apex.
        - E. Seed sweet.
          - PECAN (C. illinoensis (Wangenh.) K. Koch)
        - EE. Seed bitter.
          - WATER HICKORY (C. aquatica (Michx. f.) Nutt.)
      - DD. Husk 4-winged above the middle. Seed bitter.
        - BITTERNUT HICKORY (C. cordiformis (Wangenh.) K. Koch)
    - CC. Husk without wings, buds with imbricate scales.
      - D. Husk covered with yellow scales, fruit only slightly ridged.
        - SAND HICKORY (C. pallida (Ashe) Engl. & Graebn.)
      - DD. Husk covered with yellow scales, fruit distinctly 4-ridged.
        - MOCKERNUT HICKORY (C. tomentosa Nutt.)

1/ Little, Elbert L., Jr. Check list of native and naturalized trees of the United States. Ag. Handbook No. 41. 472 pp. 1953.

Several other important winter characteristics can be used to supplement the key. Shellbark hickory can be distinguished from shagbark by its large terminal buds close to an inch in length and its orange twigs as compared with terminal buds ½ inch in length and the gray-brown twigs of shagbark. Bark plates of shellbark are relatively straight and do not tend to curl outward as on shagbark. The twigs of shagbark are especially stout and rugged when compared with the slim twigs of pignut. Water hickory is characterized by a small rather inconspicuous terminal bud; bitternut has a long, sulphur-yellow terminal bud.

The latest check list does not recognize red hickory (C. ovalis (Wangenh.) Sarg.) as being distinct from pignut hickory and for that reason, it has not been included in the key. However, it can usually be recognized by the slightly scaly ridges of the bark and the readily dehiscent husk of the fruit compared with the tight bark and tardily dehiscent husk of pignut.

Table 1 indicates the most common occurrence of the various species by physiographic province and topographic location. It can also be used in conjunction with the key for identification.

Table 1.--Most common occurrence of hickory species in Georgia

Species	Mountain		Piedmont		Coastal Plain	
	Bottoms	Upland	Bottoms	Upland	Bottoms	Upland
Shagbark	x	--	x	--	--	--
Bitternut	x	--	x	--	--	--
Mockernut	--	x	--	x	--	x
Shellbark	--	--	1/ x	--	--	--
Sand	--	--	2/ x	--	--	--
Pignut	--	--	--	x	--	--
Coast Pignut	--	--	--	--	--	x
Pecan 3/	--	--	--	x	--	x
Water	--	--	--	--	x	--

1/ Primarily in eastern Piedmont.
2/ Principally on sandy soils.
3/ Not native to Georgia but planted extensively.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 90 March 1956

POND PINE REGENERATION ON GRAZED SWITCH CANE RANGES

Natural reproduction of pond pine (Pinus serotina Michx.) within established pond pine and switch cane (Arundinaria sp.) stands is generally sparse in the absence of fire or disturbance. An opportunity to observe the effect on pine reproduction exerted by grazing cattle in this vegetation type was afforded by the range management studies on the Frying Pan Experimental Range in Tyrrell County, North Carolina. These studies were conducted by the U. S. Forest Service in cooperation with the North Carolina State College, the North Carolina Department of Agriculture, and West Virginia Pulp and Paper Company, owner of the land.

One hundred and ninety-two observational plots, each 1/200-acre in size, were distributed over the range. Half of these plots were grazed at recommended stocking rates by cattle accustomed to the cane range, and the remainder of the plots were fenced to exclude cattle. Some plots were in pond pine stands, others were in switch cane without an overstory of trees, but all plots were within seeding distance of a pond pine seed source. A scattering of pond pine reproduction was present on the area, presumably as a consequence of a fire which occurred in 1943. This reproduction (trees up to 12 feet tall) was counted and recorded upon establishment of the plots in early 1950. Annual observations of growth, mortality, and new seedling establishment were made through two complete growing seasons.

Seed trees were present but we have no measure of the actual quantity of seed shed. Only one newly germinated pine seedling was found during the period. Over this 2-year period, grazing did not promote new seedling establishment. The data indicate that grazing exerted a slight effect on young pine height growth and a decided effect on mortality (table 1).

The difference in height growth between grazed and protected seedlings was not statistically significant, but the measurement of height was misleading because, in the case of grazing damage, a terminal or near terminal sprout often developed on a nipped-off leader and contributed to the total height. The difference in mortality between grazed and protected seedlings was significant. Of further interest is the fact that the mortality on the protected plots was confined to small seedlings which were hopelessly overtopped and crowded out by competing vegetation, while the mortality on the grazed plots occurred in all height classes.

The high rate of mortality on the grazed plots prompted a survey to determine the nature and extent of grazing damage on pond pine. A series of 64 permanent 1/10-acre plots distributed on the Frying Pan Range was used for the survey. A total of 295 pond pine seedlings up to 8 feet tall were observed on the 17 plots upon which young pine occurred.

Table 1.--Growth and mortality of grazed and protected pond pine

Condition		Grazed	Fenced
Total 1/200-acre plots - - - - - - -	number	96	96
Plots containing pond pine up to 12 feet tall - - - - - - - - - - - -	number	18	24
Total pine up to 12 feet tall - - -	number	72	97
Average height of young pine in 1950 - - - - - - - - - - - - -	inches	61	51
Average annual height growth 1950 - 1952 - - - - - - - - - - -	inches	9	10
Mortality 1950 - 1952 - - - - - - - -	percent	24	3
Average 1950 height of trees that died 1950 - 1952 - - - - - - -	inches	56	6

Grazing damage to pond pine was generally confined to foliage below 8 feet in height. Infrequently trees above 8 feet were "ridden down" and browsed but trees 6 and 7 feet tall were commonly grazed completely. The terminal bud was grazed in about one-third of the trees, more often in the lower height classes, and one-fourth of the trees had the main stem broken (table 2).

Table 2.--Grazing damage to young pond pine

Height class (feet)	Total seedlings	Seedlings with terminal bud browsed		Seedlings with main stem broken	
	Number	Number	Percent	Number	Percent
0 - 2	22	12	54	--	--
2 - 5	74	36	49	--	--
5 - 8	199	46	23	--	--
Total	295	94	31	75	25

Because pond pine sprouts profusely, heavily damaged branches may be replaced the following growing season. However, new growth is taken more readily by cattle and its repeated removal results in permanent injury.

Observations indicate that cattle graze pine when the supply of more nutritious and palatable feed is limited. On the Frying Pan Experimental Range the vegetation is confined to a relatively few species; cattle tend to graze pine foliage particularly in the winter, apparently in an effort to satisfy their diet requirements. A wider selection of forage or supplemental feeding would probably reduce the grazing damage to pine reproduction.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 91 July 1956

18 MILLION CORDS OF PULPWOOD PRODUCED IN SOUTHERN STATES DURING 1955

Pulpwood production in the South continued its upward trend with a surge of new production in 1955. The total volume cut in 12 southern states amounted to 18,014,600 cords, a gain of 10.7 percent over 1954 and a new peak in the historical records of the wood-pulp industry in this Region. Production changes by species group over 1954 were gains of 9.8 percent in pine and 17.5 percent in hardwoods, while use of chestnut declined 20.4 percent.

Pulpwood production in Southern States, 1955

State	1955 production				Change from 1954	
	Pine	Hardwood	Chestnut	Total	Pine	Hardwood
	Cords	Cords	Cords	Cords	Percent	Percent
Florida	1,826,900	1,600	--	1,828,500	+10.0	+300.0
Georgia	3,568,800	187,600	3,200	3,759,600	+23.9	+8.8
South Carolina	1,268,700	244,600	--	1,513,300	+9.3	+43.5
North Carolina	1,273,400	296,600	4,000	1,574,000	+3.6	+6.5
Virginia	1,138,100	264,700	3,500	1,406,300	+10.1	+17.8
Southeast	9,075,900	995,100	10,700	10,081,700	+14.0	+17.6
Alabama	1,860,100	68,700	--	1,928,800	+5.4	+2.5
Arkansas	782,700	94,300	--	877,000	+7.9	-6.4
Louisiana	1,366,600	283,500	--	1,650,100	+8.0	+18.6
Mississippi	1,028,400	880,100	--	1,908,500	-15.5	+17.9
Oklahoma	33,700	4,400	--	38,100	+2.1	+100.0
Tennessee	220,800	90,400	15,400	326,600	+64.7	+15.2
Texas	1,119,500	84,300	--	1,203,800	+11.5	+66.3
Lower South	6,411,800	1,505,700	15,400	7,932,900	+4.4	+17.4
Total South	15,487,700	2,500,800	26,100	18,014,600	+9.8	+17.5
Percent	86.0	13.9	0.1	100.0	--	--

Use of wood residues for pulp in 1955 was also up sharply. Materials obtained from other wood-using industries totaled 374,100 cords, almost three times the volume reported the previous year. Of this amount 258,900 cords, or nearly 70 percent, were pulp chips made from slabs and other coarse sawmill waste. The remaining 115,200 cords were veneer cores, cull crossties, and ends trimmed from pine poles and piling. The residues used are not included in production from standing timber shown in the table above.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 92 July 1956

HOW TO CONVERT TOWER ANEMOMETER WIND VELOCITIES TO WIND VELOCITIES USED ON THE 8-100-0 METER

Hundreds of open-type fire danger stations located in the eastern and southern United States measure condition of vegetation, rainfall, fuel moisture, and wind velocity. These measurements are integrated by the 8-100-0 meter into a build-up index and burning index. Such records have been found very useful in the highly technical job of fire control. But if reliance is to be placed on the records, measurements of all factors used in the meter must be accurately made. In previous instructions for operating fire danger stations in the Southeast, a table was given for converting tower wind velocities to the 20-foot standard used with the 8-100-0 meter. After some months of use, it has been found that the table gives wind velocities that are too low. We recommend that all danger stations currently using the table on page 5 of Southeastern Forest Experiment Station Paper No. 52 use instead the table given here.

Conversion of wind velocity measured at fire towers (40-60 feet above the tree canopy) to the open station standard (20 feet above the ground)

Tower velocity	Open station velocity	Tower velocity	Open station velocity
- - - - - - -	Miles per hour	- - - - - - -	
0.5-1.0	1	25.5-26.0	19
1.5-2.0	1	26.5-27.0	20
2.5-3.0	2	27.5-28.0	20
3.5-4.0	3	28.5-29.0	21
4.5-5.0	4	29.5-30.0	22
5.5-6.0	4	30.5-31.0	23
6.5-7.0	5	31.5-32.0	23
7.5-8.0	6	32.5-33.0	24
8.5-9.0	7	33.5-34.0	25
9.5-10.0	7	34.5-35.0	26
10.5-11.0	8	35.5-36.0	26
11.5-12.0	9	36.5-37.0	27
12.5-13.0	9	37.5-38.0	28
13.5-14.0	10	38.5-39.0	29
14.5-15.0	11	39.5-40.0	30
15.5-16.0	12	40.5-41.0	31
16.5-17.0	12	41.5-42.0	31
17.5-18.0	13	42.5-43.0	32
18.5-19.0	14	43.5-44.0	33
19.5-20.0	15	44.5-45.0	34
20.5-21.0	15	45.5-46.0	34
21.5-22.0	16	46.5-47.0	35
22.5-23.0	17	47.5-48.0	36
23.5-24.0	18	48.5-49.0	37
24.5-25.0	18	49.5-50.0	37

The new table is based on 700 wind measurements taken at four widely separated standard danger stations--two in the longleaf-slash pine region and one each in Coastal North Carolina and Maryland.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 93 July 1956

A SITE-PREDICTION TEST IN SLASH PINE PLANTATIONS IN THE MIDDLE COASTAL PLAIN OF GEORGIA

With the recent tremendous surge of pine tree planting in Georgia has come a parallel interest in methods of predicting growth in plantations. It is recognized that existing site index and yield tables for natural stands cannot be applied in these plantings.

Barnes and Ralston[1/] found that site quality for slash pine plantations in Florida can be accurately determined by the measurement of two physical soil properties--depth to mottling and depth to a fine-textured horizon. In their work, site quality is used to indicate height of dominant trees at 25 years in order to avoid confusion with the standard 50-year site index method in use for natural stands. Depth to mottling is described as a "measure of the nonsaturated growing space available to tree roots above the ground water table," and depth to a fine textured horizon is described as the "depth to a layer in the soil which has a high capacity for holding water against gravitational drainage."

Recently the Georgia Forestry Commission, the University of Georgia, and the Southeastern Forest Experiment Station jointly conducted a pilot study testing the applicability of the Barnes and Ralston method of determining site quality in slash pine plantations in the middle coastal plain of Georgia. Data were gathered on 82 plots representing 43 plantations in four counties. A regression analysis of these data showed that depth to mottling and depth to a fine-textured horizon were closely correlated; hence only the former was employed in this test. The study showed that site quality, as estimated from depth to mottling according to the basic equation by Barnes and Ralston, agreed closely with the observed site quality on most of the Georgia soils sampled. However, for a few soils which had a shallow depth to mottling the equation underestimates height considerably. Deviations of the estimated heights from the observed are shown in figure 1.

On these shallow soils, with depth to mottling less than 10 inches, the average deviation is about 22 feet. However, only 5 observations were taken on these soils, a fact which suggests that the very shallow soils comprise only a minor portion of the planted total.

On the deeper soils, in which depth to mottling was 15 inches or more, the average deviation of the calculated height from the observed is only 1.4 feet, the difference being positive or an underestimate. This is well within the calculated standard error of 11 percent for the Florida study.

Diameter growth in Georgia appears to be consistently better than that in Florida, although the difference is not great. Observed diameters at various ages and by number of surviving trees per acre are compared with diameters for Florida plantations for the 70-foot site quality class in figure 2. The Florida diameters were obtained by extrapolation from table 13 of Barnes' Report No. 3.[2/] Diameters in the Georgia plantations are 5 to 8 percent larger than those in the Florida plantations for the same site class for any given age and number of trees per acre. There is no simple explanation for the better diameter growth in Georgia, although it may be due to a wider initial spacing in the Georgia plantations.

The 70-foot site-quality class was chosen for the comparison of diameters because 66 percent of the Georgia plots fell within this class. Of the other plots, 23 percent were in the 60-foot class, 8 percent in the 80-foot class, and 3 percent in the 50-foot class. A total of 89 percent of the plots fell within the 60- and 70-foot classes (56 to 75 feet at 25 years).[3/] This indicates that site variation is not great in plantations in this section of Georgia.

Although the Georgia study was exploratory in nature and limited as to area sampled, it does suggest that the Barnes-Ralston method of site quality determination and their site quality curves can be used with a good degree of assurance on many of the middle coastal plain soils in Georgia. However, until more comprehensive sampling is carried out, the data must be used with caution on the soils having a shallow depth to mottling. Fortunately, these soils appear to be only a minor portion of the whole. In applying tables of average diameter, the study further indicates that the Barnes-Ralston diameter values should be adjusted upward by about 7 percent.

The results of this pilot study have prompted a more comprehensive investigation in the growth of slash pine plantations, which will cover the entire area of the middle coastal plain of Georgia and will include a minimum of 200 additional plots. Until this larger and more complete study is carried out, the present pilot study provides a means for estimating the growth of slash pine plantations on different soils in this area.

1/ Barnes, Robert L., and Ralston, Charles W. Soil factors influencing the growth of slash pine plantations in northeast Florida. University of Florida School of Forestry, Research Report No. 1, 11 pp. 1952.

2/ Barnes, Robert L. Growth and yield of slash pine plantations in Florida. University of Florida, School of Forestry, Research Report No. 3, 23 pp. 1955.

3/ For purposes of comparison, Barnes and Ralston determined by extrapolation that "site index (50-year basis) is roughly equivalent to site quality (25-year basis) plus 20 feet."

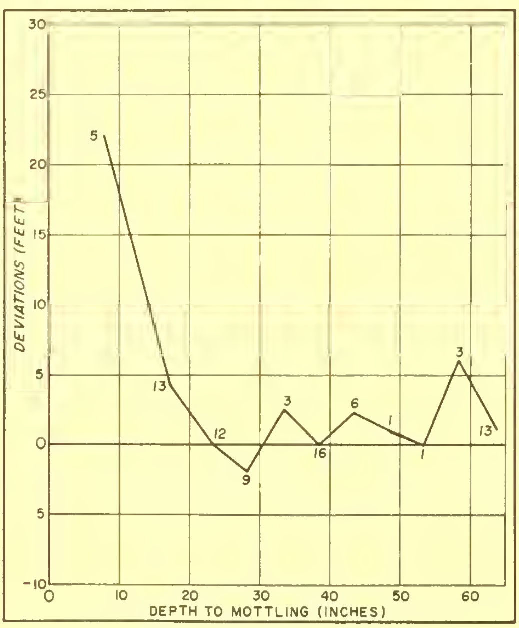

Figure 1.--Deviation of the calculated site quality (using the Barnes and Ralston method) from the observed site quality by depth of soil to mottling, middle coastal plain of Georgia.

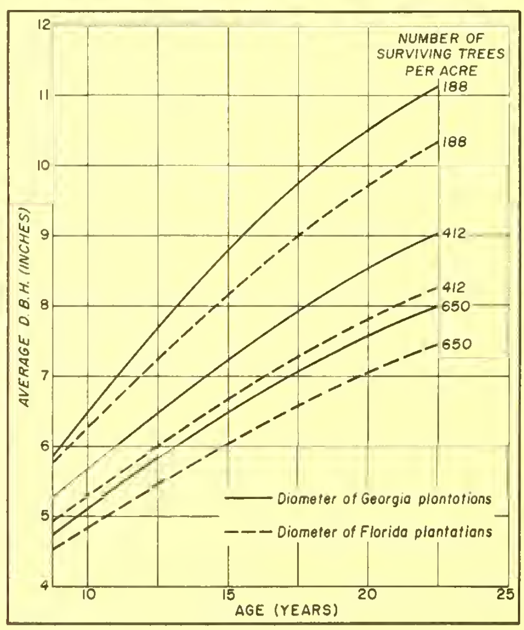

Figure 2.--A comparison of average diameter of Georgia plantations with average diameter of Florida plantations for slash pine on site quality 70 feet at 25 years.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 94 October 1956

GEOGRAPHIC VARIATION IN CLIMATE IN THE LOBLOLLY PINE REGION

A species as widespread as loblolly pine is apt to include a wide diversity in climate within its range. These climatic differences may in turn have very important consequences in genetic variation and in the silviculture, management, and regeneration of the species. A knowledge of the climatic variation may help to explain why the species reacts differently to the same treatment in different places.

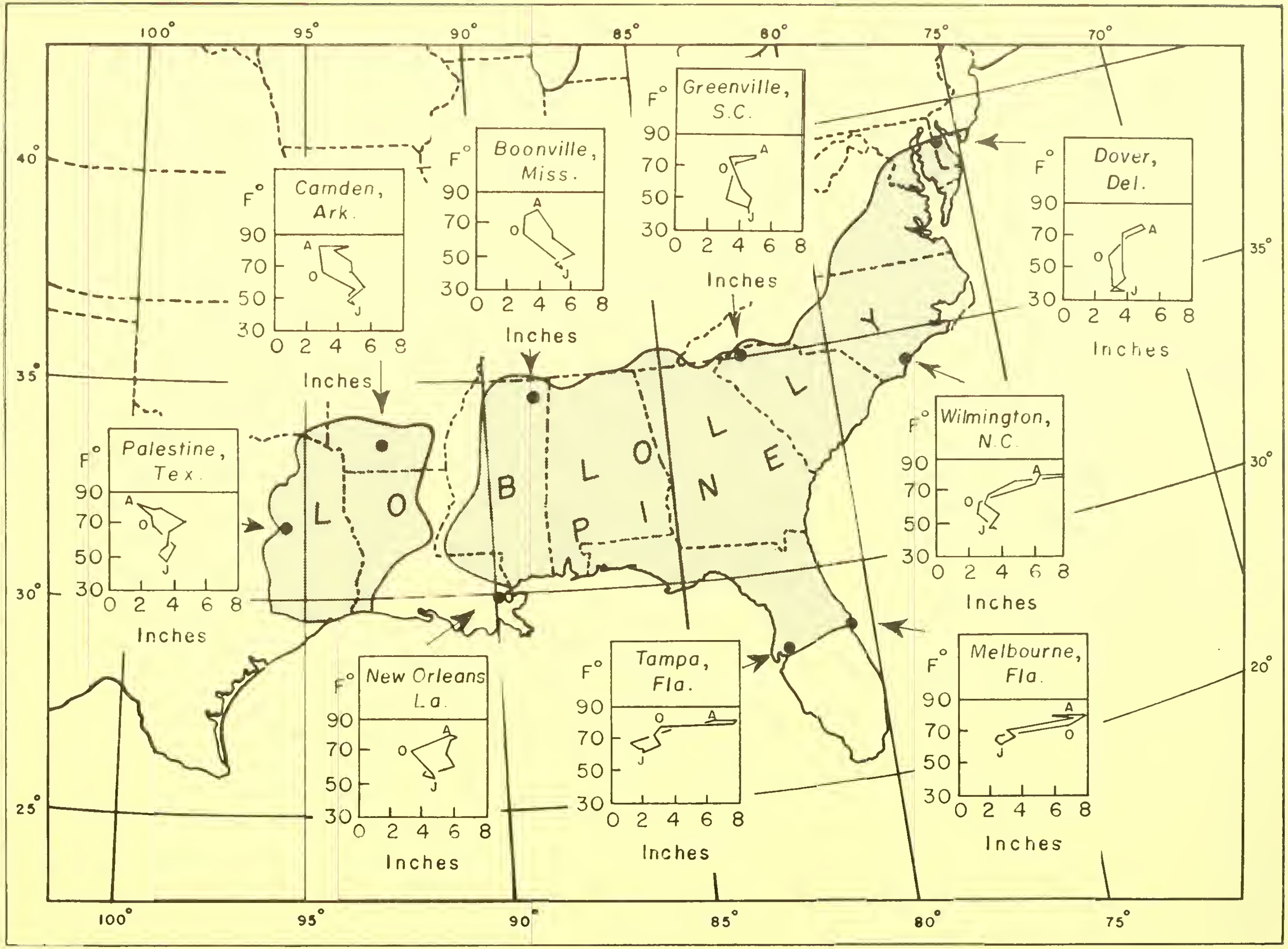
The range in climatic types exhibited throughout the loblolly pine region is illustrated on the reverse side of this sheet. The climographs used to portray the climatic patterns consist of mean monthly temperature plotted over mean monthly rainfall for each month and a line connecting the months in sequence. The letters, J, A, and O identify the months of January, August, and October in each graph. The climographs were constructed from "normals" for the southern pine region, published recently by Hocker. 1/ The data for each graph cover 25 or more years between 1921 and 1950.

An inspection of the climographs shows the characteristic subtropical climatic pattern in central Florida, and a typical east coast climatic pattern in Delaware, changing gradually to a midcontinental type in Arkansas and Texas. Outstanding differences revealed by the climographs are the low summer rainfall in the western inland portion of the loblolly pine belt compared with the extremely high summer rainfall in the southeastern portion, and a distinct difference in winter temperature in going from north to south. Summer temperature is more or less uniform throughout most of the range of the species, and winter rainfall is ample except in central Florida.

On the basis of the climatic differences one would expect more difficulty getting natural reproduction of loblolly pine in the western part of the region because of the low growing-season precipitation. On the other hand, in the Tampa vicinity there is a deficit in winter rainfall which may result in the failure of winter plantings unless they coincide with a particular rainy period. The data may also help to explain the origin of other phenomena such as racial differences in structure or function or both.

1/ Hocker, Harold W., Jr. Climatological summaries for selected stations in and near the southern pine region, 1921-1950. Southeast. Forest Expt. Sta. Paper 56, 12 pp., illus. Aug. 1955.

W. G. Wahlenberg and Carl E. Ostrom



Range in climatic types throughout the loblolly pine region.

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 95 October 1956

HEAT TOLERANCE OF SLASH AND SAND PINE SEEDLINGS

Heat-treating seedlings by immersing the roots in hot water (116° F.-125° F.) has been shown to destroy nematodes on certain plant species with no deleterious effect on the plants. Since, in the future, it may be desirable to treat nematode-infested pine seedlings in this manner prior to outplanting, a preliminary study was designed to determine the heat tolerance of slash and sand pine seedlings. The results of this study are presented here.

One-year-old seedlings were treated in groups of 50 by placing them in a wire basket and immersing the root systems in a constant-temperature water bath for time intervals of 17 and 25 minutes at temperatures ranging from 116° F. to 130° F. This treatment produced no visible changes on the roots. One set of controls was immersed in water at 70° F. and another set received no immersion treatment.

All seedlings were outplanted in the nursery, spaced 2x2 feet, and were watered when necessary. Four months after outplanting, a survival count was taken. Survival of both species at 116° F. for both immersion periods compared favorably with survival of the controls, as shown in the following table. At 120° F., however, slash pine survival, although slightly reduced, was considerably higher than that of sand pine. Temperatures of 125° F. and 130° F. resulted in almost complete mortality of both species.

Survival of heat-treated slash and sand pine seedlings

Temperature (Degrees F.)	Treatment time	Survival	
		Sand pine	Slash pine
	Minutes	Percent	Percent
Not treated 1/	--	61	54
70° F. 1/	25	61	75
116° F.	17	50	56
116° F.	25	64	58
120	17	12	40
120	25	2	32
125	17	0	0
125	25	0	2
130	17	0	0
130	25	0	0

1/ 100 seedlings; all other treatments on 50 seedlings each.

From the results obtained, it appears that the heat tolerance of slash and sand pine seedlings is high enough to warrant further studies on the destruction of nematodes by this method.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 96 October 1956

PALES WEEVIL CONTROL WITH INSECTICIDES: FIRST YEAR RESULTS

Until recently, the regeneration of most burned and cutover pine land in the South was left to natural reseeding. This process required 5 to 10 years or more, and frequently the restocking was only partial.

Now that stumpage values have increased and wood-using industries with an investment totaling millions wish to safeguard raw-material supplies, many timberlands are being planted immediately after fires or cutting. However, the pales weevil is doing serious damage to seedlings in these plantations.

Because insect damage is most severe during the first year following cutting or a fire, some planting is being postponed until a summer season has passed. This waiting period reduces pales weevil damage. But the delay brings in its train loss of growth for one year, increased planting costs, and greater difficulty in controlling hardwood competition. For such reasons, studies were installed in 1954 to determine whether seedlings planted soon after the harvest cut could be protected from weevil attack.

Pales weevils are attracted to cutover, burned, blow-down, or bark-beetle-killed stands. Here the insects feed on young pine seedlings on dull dark days and at night, and hide in the litter during the day. Eggs are laid in pine stumps or in the roots of dying trees. The grubs developing from these eggs feed in the inner bark of stumps, whereas in the roots where the bark is thin they deeply engrave the sapwood. Several months are required for the larvae to complete their feeding, change to pupae, and emerge as adults. When young seedlings are growing in the types of areas mentioned, adult beetles feed on the tender bark, girdling and killing the plant. On hardwood and old-field sites the weevil is rarely a problem, since it is attracted only to coniferous areas.

Replicated, randomized blocks of white pine trees were planted at Bent Creek, North Carolina, in March 1955, on land which had been cleared of pine the previous fall. The young trees were treated by spraying, dipping, and the application of granular insecticide around the base of the seedlings. In this preliminary study, all treatments significantly reduced the kill as compared with check plots. Since the data in the two replicated blocks for each chemical were similar, the results have been combined in the table shown on the following page.

Benzene hexachloride and dieldrin applied as a spray and dieldrin applied as a dip were toxic to the seedlings at the concentration used. Benzene hexachloride was not tested as a dip because of its known toxicity to pine rootlets.

The sprays were applied to the seedlings following planting. An average of 3 ounces of insecticide was applied to each seedling and the soil in a 3-inch radius surrounding it. The spray material was toxic to the weevils both while they were feeding and while they were hiding in the soil. While this method of application was most effective, it was also the most costly, since application of the spray material required a separate operation from that of the planting. On small planting areas where valuable trees are to be protected, where wildling seedlings are to be protected on cutover lands, or where weevils appear unexpectedly, this method of application has considerable value.

Treatment	Total treated	Natural and insecticidal mortality	Survival following natural and insecticidal mortality	Killed by pales weevil feeding	Control due to treatment
	Number of seedlings				Percent
Emulsion spray					
2% Aldrin	76	5	71	1	99
2% BHC	78	24	54	3	95
2% Heptachlor	77	8	69	4	94
5% Chlordane	84	5	79	5	94
5% DDT	75	10	65	8	88
2% Dieldrin	88	24	64	12	81
Emulsion dip					
2% Dieldrin	89	20	69	10	85
2% Aldrin	89	3	86	18	79
2% Heptachlor	83	3	80	17	79
Granular					
5% Heptachlor	67	4	63	9	86
Check (no treatment)	89	3	86	58	--

Application of 1/8 cup of granular 5 percent insecticide (formulated on vermiculite) to the soil surface surrounding the seedlings was intermediate in cost and control between spray and dip treatments. This material can be applied at the time of planting by the planting crew; however, because of the greater quantity of material needed over that of the dip procedure, this method of application is intermediate in cost. The granular insecticide is toxic to the weevils only while they are hiding in the soil and not while they are feeding; it appears to have excellent possibilities when used in combination with the dip treatment.

Dipping the seedlings prior to planting offers good protection for the least expenditure of money, since only a small quantity of insecticide is required. Treatment of the dipped seedlings was accomplished by immersing the tops of the seedlings down to the rootlets in insecticide prior to planting. Gloves with a rubberized or plastic coating should be worn by all persons handling the insecticide or treated trees. Since the treated stock is handled in the normal manner, costs in addition to the dipping treatment are not required. Where weevil populations are low, survival will probably be better than that shown in the table. When weevil populations are high, some seedlings may be girdled and killed before the weevils receive a lethal dose of insecticide. The dip material is theoretically toxic to the weevils only while they are feeding. However, some of the insecticide from the stem and foliage apparently washes from the tree and also kills beetles in the soil.

Further studies are planned next year in which aldrin and heptachlor will be retested in 10 localities throughout the Southeast on other species of pine, with various planting procedures.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 97 October 1956

GOOD SEED PRODUCTION FROM A YOUNG STAND OF LOBLOLLY PINE

In 1946, four permanent seed traps were established in a 35-year-old stand of old-field loblolly pine at the headquarters of the Santee Experimental Forest, in Berkeley County, S. C. A 10-year record of seeds caught in these traps now provides good local information regarding the seasonal and yearly periodicity of seed production from a young stand on a good site. This information should be useful to forest managers aiming for natural regeneration of loblolly pine grown on short rotations in the South Carolina Coastal Plain.

Condition of the study area is assumed to be similar to that of a managed stand. The intermediate cuttings made may be compared to a series of moderately heavy thinnings under management. The first cut was made in 1937, the second and heaviest in early 1946, and the last in 1954.

Consistently good seed production was obtained during the period of measurement. Estimated seedfall dropped below 200,000 viable seeds per acre only once (1950), when 56,000 seeds were produced. An outstanding feature was the enormous crop in 1955, estimated at over 1 million sound seeds per acre. This crop was double that of 1948, the next best year (fig. 1). The good crop in 1948 may have been a response to the thinning made early in 1946, but no seedfall data are available from uncut stands to check this point.

Viability followed the general pattern of production, being lowest in the poorest seed year and highest in the best. However, average viability was high, amounting to 66 percent for the 10 years.

In two of the observation years, the fall of sound seed began as early as the last week of September; ordinarily this occurred during the second week of October. On the average, about one-third of the seed was down by November 1, one-half by November 15, and three-fourths by December 1. For all practical purposes seedfall was over by early January (fig. 2).

Although this study was not as comprehensive as the one by Jemison and Korstian[1/] on the Duke Forest, some interesting comparisons are possible. They are as follows:

Item	Santee Experimental Forest	Duke Forest
1. Seed viability	34 to 75 percent	29 to 57 percent
2. Beginning of seedfall	October 10	October 20
3. Peak of seed production	Late October- early November	Early November
4. Production by January 1	88 percent	84 percent

1/ Jemison, G. M., and Korstian, C. F. Loblolly pine seed production and dispersal. Jour. Forestry 42: 734-741.

Some significance of geographic location is apparent in the foregoing. At the Santee, almost 250 miles south of the Duke Forest, the progress of the annual seedfall is at least 10 days ahead. Location may also have a bearing on differences in seed viability and possibly in over-all seed production between the areas; both are items which should be kept in mind for future study.

From a local standpoint, the Santee seed study indicates that young stands under management are capable of producing abundant seed crops. Furthermore, in a harvest cutting anticipating natural regeneration, any necessary seedbed preparation should be completed by about November 1 and cutting delayed until about January 1 for the best utilization of a seed crop.

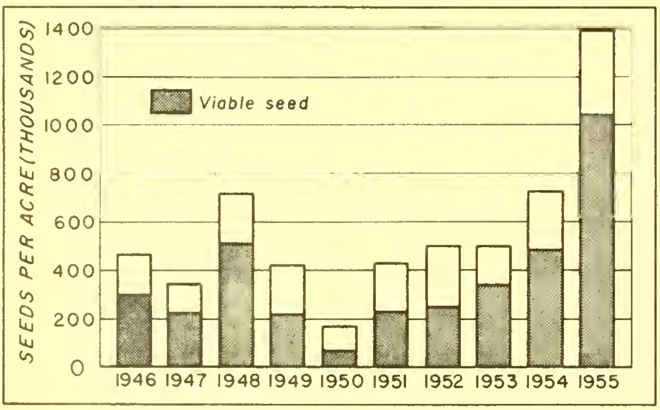

Figure 1.--Ten-year record of loblolly pine seedfall in a 35- to 45-year-old stand, Santee Experimental Forest.

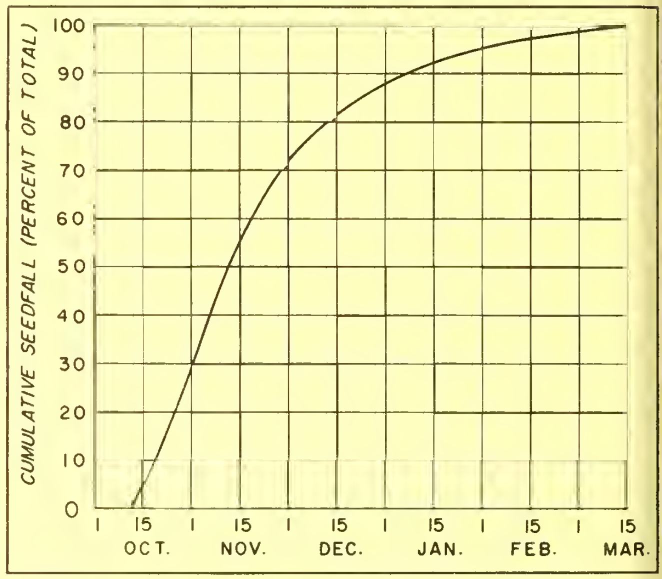

Figure 2.--Average rate of loblolly pine seedfall as determined from 10-year record in a small sawtimber stand, Santee Experimental Forest.

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Santee Research Center

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 98 October 1956

FURROW OLD FIELDS TO PLANT LONGLEAF IN THE SANDHILLS

Planting in furrows can substantially improve first-year survival of longleaf pine on Sandhills old fields where there is a well-established "rough." This was demonstrated by an experimental planting near Aiken, South Carolina, which resulted in 92 percent survival for trees in furrows, compared to only 59 percent in the untreated area. Seedling vigor on furrowed areas was outstanding, and pointed to early height growth. More soil moisture during the critical part of the growing season appeared to be the main reason for better survival in the furrows.

Most tree planting in the Sandhills of the Carolinas and Georgia is in old fields. In the future, an increasing acreage of land occupied by scrub oak will be planted, but old fields will continue to be an important part of the reforestation job. Foresters are aware of the serious competition for soil moisture and nutrients from scrub oak and are prepared to eliminate all or part of the oak before planting time. Few realize that similar competition may occur in old fields from the typical cover of grass and weeds. Consequently, the conventional technique is to plant without any mechanical site preparation. This may help explain past poor survival of longleaf pine, which has led to a lack of enthusiasm for the species on the part of Sandhills planters.

It has been demonstrated in an earlier test that furrowing in scrub oak areas materially improved the initial survival of longleaf in the Sandhills.1/ Accordingly, the Santee Research Center began a study in 1954 2/ on the Savannah River Project near Aiken, S. C. to measure the effects of furrowing on early survival of longleaf in old fields. Four $\frac{1}{4}$-acre plots were furrowed with a tractor-drawn Sieco (disk) plow which made a single furrow about 8 inches deep and 24 inches wide, and four plots were left unfurrowed as checks. In each treatment 1200 (1-0) longleaf pine seedlings were planted at a spacing of 4 x 6 feet. The age of the "rough" on this field and others being planted at the Savannah River Project is 7 to 8 years.

At 10-day intervals from June 14 to September 10, random soil samples were taken at three depths (3, 6, and 9 inches) on each plot. On furrowed plots, samples were taken from the base of the furrow. Soil moisture determinations were made by oven-drying, and a laboratory analysis established the wilting coefficient for the soil.

1/ Shipman, R. D. Planting in furrows aids initial survival of longleaf in Sandhills. Southeast. Forest Expt. Sta. Research Note 82. 1955.

2/ In cooperation with the School of Forestry, N. C. State College, and the Savannah River Project, Atomic Energy Commission.

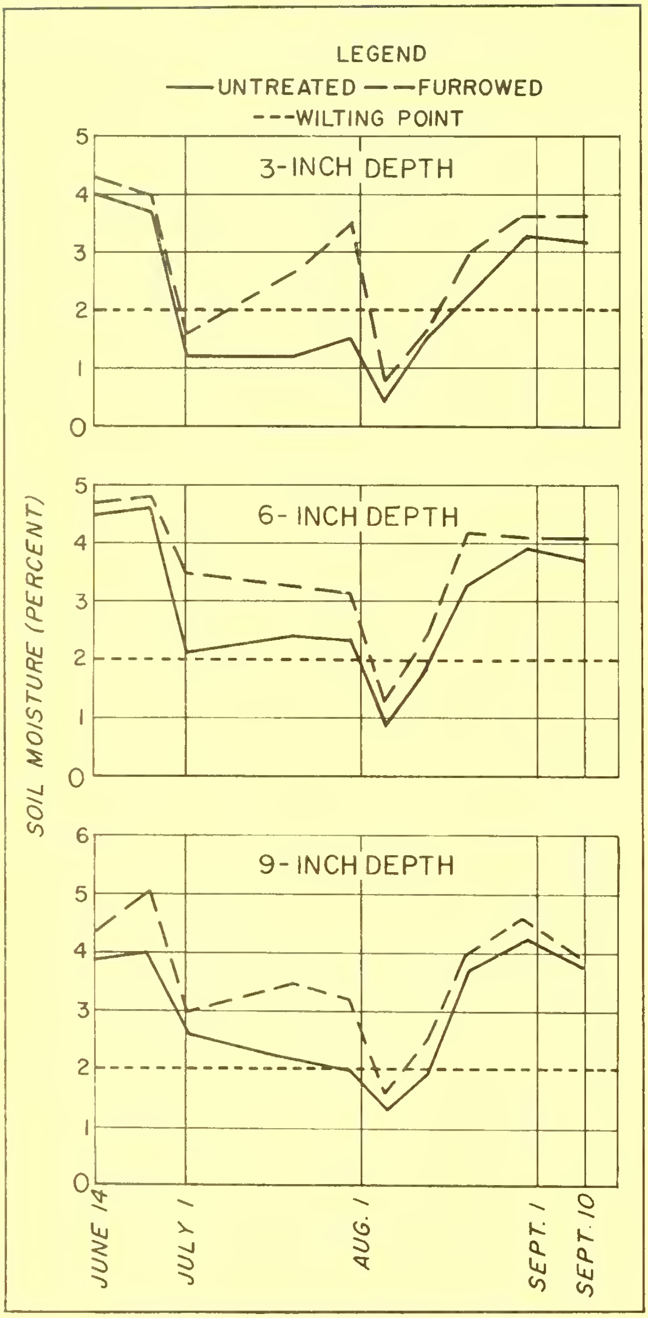

Figure 1.--Seasonal trend of soil moisture at three depths on furrowed and unfurrowed old fields.

Figure 1 shows that consistently better soil moisture conditions resulted from furrowing. At shallow levels the soil moisture on untreated plots dropped below the wilting point for a period of 46 days between July 1 and August 15. In contrast, soil moisture in the furrows dropped below the wilting point twice, but for a total period of only 20 days. Moisture content remained below the wilting point for longer periods in the untreated plots at the deeper levels (6 inches and 9 inches) also, but the difference was not so marked as at the shallow levels. For the entire period of measurement, soil moisture in the furrows remained above that in the unfurrowed plots.

As a result of this test and comparable investigations in the scrub oak type, approximately $8\frac{1}{2}$ million seedlings were machine-planted in furrows on some 10,600 acres of old fields by the Atomic Energy Commission during 1955-56 as part of the large-scale planting program on the Savannah River Project. Interim observations indicate a marked superiority in survival, compared with several hundred acres of plantations on unfurrowed fields.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 99 October 1956

TRENDS IN THE PRICE OF SOUTHEASTERN PULPWOOD

Pulpwood consumption in the Southeast has considerably more than doubled in the past ten years. Last year, it totaled 10 million cords. During the same period, the average price of pine pulpwood rose from $10.10 to $15.50 per cord, and hardwood from $9.70 to $13.45. These prices and others in the table below are based on reports from 14 representative paper mills that consume 65 percent of all the pulpwood currently produced in the five states of Florida, Georgia, North and South Carolina, and Virginia.

Three price series are shown in the table--one for wood f.o.b. railroad cars, one for wood trucked directly to mills, and one for all wood. The rail and truck wood series show trends more clearly than the all-wood series, since the latter reflects not only changes in price but changes in the proportions of rail, truck, and barge wood purchased. On the other hand, the all-wood prices are the ones applicable to total regional volumes of production or consumption.

As an indication of the size of the pulpwood business, nearly 145 million dollars worth of pulpwood was produced last year, on a basis of all-wood prices. In the entire South, the figure was probably 255 million.

AVERAGE PRICE OF ROUGH PULPWOOD IN THE SOUTHEAST, BY YEAR 1/

Year	Pine			Hardwoods		
	Rail wood 2/	Truck wood 3/	All wood 4/	Rail wood 2/	Truck wood 3/	All wood 4/
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
1938	3.55	3.85	3.60	--	--	--
1939	3.75	4.40	3.90	--	--	--
1940	4.00	4.60	4.15	--	--	--
1941	4.50	5.00	4.60	--	--	--
1942	5.90	6.65	6.00	--	--	--
1943	7.15	8.00	7.25	--	--	--
1944	8.15	8.70	8.20	--	--	--
1945	8.35	9.15	8.45	8.10	8.55	8.10
1946	9.90	10.75	10.10	9.50	10.55	9.70
1947	10.80	11.70	10.95	9.70	10.55	9.80
1948	11.65	12.30	11.70	11.00	11.25	11.05
1949	10.85	11.80	11.00	10.75	11.25	10.80
1950	11.85	12.55	11.90	10.70	11.50	11.00
1951	13.65	14.70	13.85	12.40	13.15	12.75
1952	13.70	14.70	13.90	12.40	13.15	12.80
1953	13.70	14.70	13.90	12.35	13.15	12.75
1954	13.75	14.75	13.95	12.30	13.15	12.75
1955	14.15	15.05	14.35	12.50	13.45	13.05
Sept. 1, 1956	15.25	16.60	15.50	12.65	13.95	13.45

1/ Per cord of 128 cubic feet of 5-foot wood with bark. Includes dealers' allowances in cases where they are paid.

2/ F.o.b. railroad car.

3/ Delivered to pulp mill.

4/ Weighted average of all wood loaded on railroad cars, trucked to pulp mills, and delivered to barge landings.

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RESEARCH NOTES

SOUTHEASTERN FOREST EXPERIMENT STATION

Asheville, North Carolina

Number 100 October 1956

WEIGHT LOSS BY FUEL MOISTURE STICKS FROM WEATHERING

Systems of forest fire danger measurement in the East and South require the use of basswood indicator slats, commonly known as fuel moisture sticks, to approximate the moisture content of the upper layer of fuel. Sets of sticks are distributed twice a year to the field, where they are ordinarily exposed for a 6-month period. From the beginning it was known that sticks would lose weight progressively during exposure. Tests at the Bent Creek Experimental Forest, near Asheville, N. C., indicated that preweathering the sticks on racks until they had lost about 5 percent of their weight, and a correction of $\frac{1}{2}$ gram at the end of each of the first two 6-week periods, would compensate for weathering loss. Accordingly, a card indicating the necessary correction was included with each set.

Because of higher average precipitation and temperature, it appeared likely that weathering would be somewhat greater in the South than in the North. A number of sets that had been exposed for a 6-month period at state-operated danger stations in Georgia and Louisiana were therefore recalled and weight loss determined. Although there was considerable difference among sets, probably in part because of differences in exposure, the loss was clearly greater than we had allowed for. The correction was therefore somewhat arbitrarily increased from $\frac{1}{2}$ to 1 gram for each of the first two 6-week periods (or a total of 2 grams) for all sets distributed to fire control agencies south of North Carolina and Tennessee beginning in July 1955.

Establishment in 1955 of key fire danger stations in cooperation with Region 8 of the U. S. Forest Service and a number of southern state Forestry Commissions provided a better means for checking weathering loss. The stations were located in Bulloch and Pierce Counties in Georgia; Columbia, Madison, and Leon Counties in Florida; Greene and Hancock Counties in Mississippi; and St. Tammany Parish in Louisiana. A ninth station was established on the Conecuh Ranger District of the Alabama National Forests, and in 1956, a tenth in Tyler County, Texas.

At seven of these stations, two sets of sticks of equal weight were exposed within a few feet of each other. One set had direct sunlight, the other was shaded by one or six layers of screens, depending on the season. Sets were replaced each month. Average loss in weight for all sets for the period January through June 1956 was as follows:

Month	Kind of exposure		
	Unshaded	1 screen	6 screens
	Grams	Grams	Grams
January	0.94	0.77	--
February	.60	.59	--
March	.56	.40	--
April	.81	--	0.30
May	.43	--	.37
June	1.53	--	.37
Total	4.87	1.76	1.04

The combined weathering loss of sets under one and six layers of screen was 0.8 gram greater than the 2-gram correction. For a set that weighed 100 grams, this could mean nearly a 1-percent error in fuel moisture. Because fuel moisture is one of the variables included on the 8-100-0 meter, and also determines the Buildup Index, an error of this magnitude could conceivably raise the Burning Index as much as 15 or 20 units by the end of an extended dry period. But we know that sticks weather progressively less during months of exposure.

Since fresh sticks were exposed each month, the 2.8-gram loss represents the cumulation of six maximums of weathering. Loss from sets exposed for the full 6-month period can be assumed to be considerably less than this. Another point to be considered is that no one set of sticks can be expected to react to wetting and drying precisely as any other set. Fairly close tolerances are set during calibration[1/] but, even so, small differences can be expected among sets in field use.

On the basis of our present information, it seems reasonable to conclude that our method of preweathering and a correction of 2 grams for southern sets is, for all practical purposes, satisfactory. Other variables such as condition of lesser vegetation, wind velocity, time of screen change, and inaccuracies in taking and reading measurements, are much more likely to introduce error in determining fire danger with the 8-100-0 meter than stick-weathering loss.

Although weight loss of unshaded sticks considerably exceeded the 2-gram allowance, this also appears relatively unimportant in danger determination with the longleaf-slash pine meter. The meter was developed by the Southern Forest Experiment Station principally for flashy fuels and, therefore, gives less weight to fuel moisture than other variables. A change of a few points in fuel moisture means only a few points difference in Burning Index.

During the preweathering period we have found that weight loss is greatest during hot and wet weather. Some information was obtained on the effect of precipitation, without regard to temperature, by grouping weight losses of 74 sets according to monthly precipitation classes. Period of exposure extended from August 1955 through July 1956.

Monthly precipitation	Sets	Total loss	Average loss
Inches	Number	Grams	Grams
0 - 1.9	22	12.9	0.57
2.0 - 3.9	23	17.9	.78
4.0 - 5.9	15	12.8	.85
6.0 - 7.9	8	8.7	1.09
8.0 +	6	8.6	1.43

Because of unequal number of sets and the unknown effect of temperature and other factors, no great significance is attached to specific values in the table given here. However, it seems clear that the more rain, the more loss from weathering.

The following procedure can be used by careful observers to check stick weathering. A set of pilot sticks is kept in the weighing shelter except when periodically exposed for a day beside the regular set. After exposure, the moisture content of the pilot set is determined to the nearest tenth percent in the usual manner. The pilot set is then replaced on the balance by the regular set and the slider on the beam moved forwards or backwards until the pointer indicates exactly the same percent as that of the pilot set. The slider is left at this point on the beam for subsequent weighings of the regular set. Such checks can be made at any desired interval except, of course, during rainy periods.

1/ Nelson, Ralph M., Calibration of fuel moisture sticks used in the East and South. Fire Control Notes 16(1): 40-42. 1955.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 101 January 1957

FERTILIZER INCREASES GROWTH RATE OF SLASH PINE [1]

In 1946, a study was commenced near Lake City, Florida, to determine the effect of fertilizer on the growth and gum yield of slash pine (Pinus elliottii, Engelm.). A group of 40 trees ranging in diameter from 9 to 14 inches was selected in a 12-year-old open stand in an old field. Soil types were fine sands in the Leon and Rex series. Fertilizer was applied to 20 of these trees 3 times each year for 4 years in March, June, and August at a total annual rate of 500 pounds of nitrogen per acre, with varying amounts of phosphate, potassium, and minor elements. All trees were worked for naval stores during the 4-year period. Fertilization increased gum yields by 23 percent and this increase was fairly consistent for each of the 4 years. [2]

In 1953, the trees were felled, and a modified stem analysis was used to determine what effect the fertilizer applications had on tree growth. Volume growth of a 12-foot section of the trunk was measured for separate 4-year periods before and during fertilization on both fertilized and unfertilized trees.

For each treatment group, volume growth for the 4-year period during fertilizer application was analyzed by a multiple regression equation testing the relationship of volume growth to initial diameter, initial age, gum yield during a 4-week calibration period, and volume growth for the 4-year period prior to treatment. For each group, only prior volume growth significantly affected growth during treatment. But the fertilized trees, adjusted for prior growth, showed consistently higher growth than the untreated group. These relationships are shown graphically in the figure.

To get a quantitative value for the increase in growth attributable to fertilizer, a covariance analysis was used to establish separate adjusted mean growth figures for fertilized and unfertilized trees for the period during fertilization. The adjustment accounted for any growth differences that already existed between the two groups of trees prior to treatment. These adjusted mean growth figures showed that fertilizer increased tree growth by 36.6 percent.

1/ Grateful acknowledgement is made to T. C. Evans, Statistician, and Dr. C. S. Schopmeyer, Research Forester, for helpful suggestions in the analytical sections of this report.

2/ Snow, Albert G., Jr. Progress in the development of efficient turpentining methods. Southeastern Forest Expt. Sta. Paper 32. January 1954.

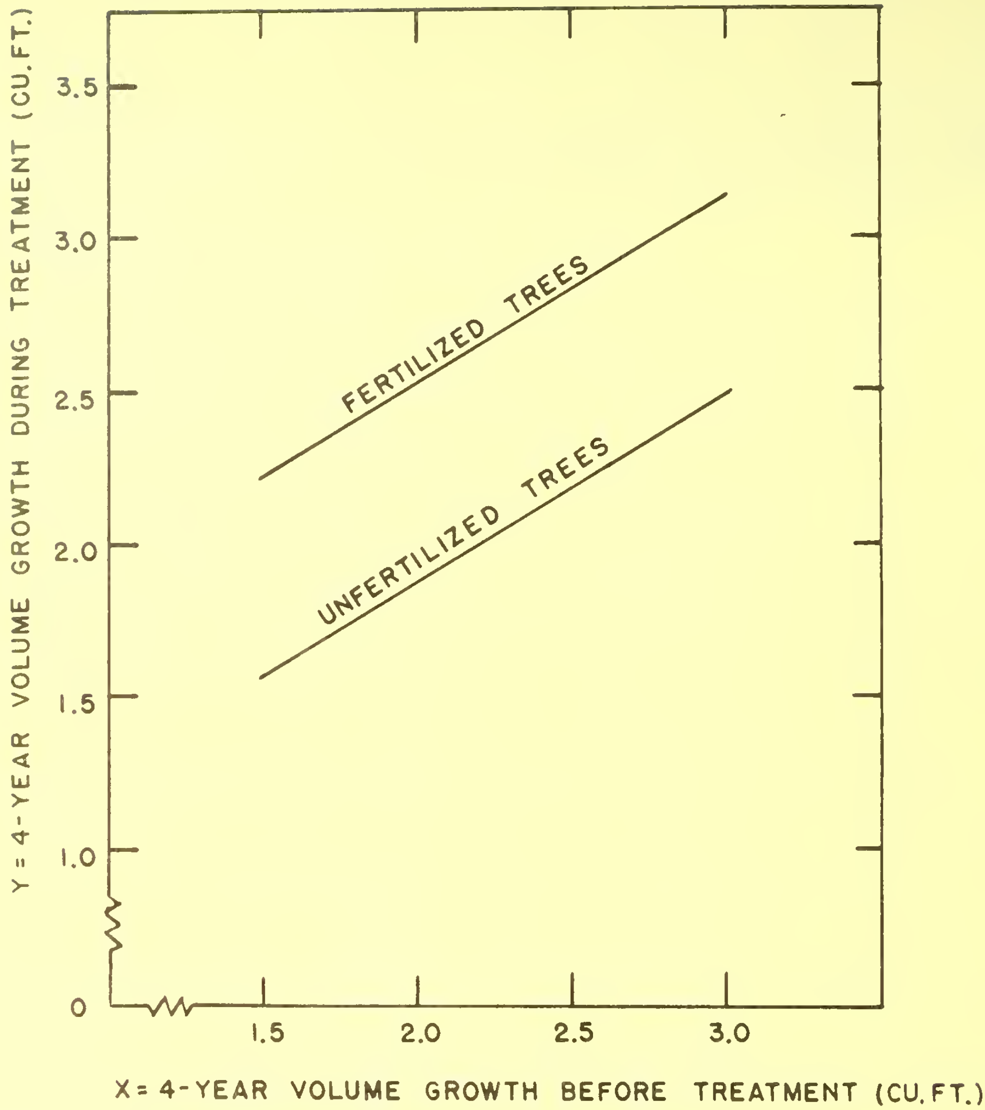

Figure 1.--Effect of fertilizer on growth as determined from the equations:
Y (fertilized trees) = 1.295 + 0.622X
Y (unfertilized trees) = 0.626 + 0.622X

This study was not designed to test the economic feasibility of fertilizing slash pine trees to increase growth rate. Consequently, the question of cost and return has not been answered. By showing that fertilizer can appreciably increase both growth and gum yield, however, this study points out the need for more refined tests of fertilizer effects designed to determine whether such treatment would be economically feasible under prescribed conditions and to determine the necessary chemical constituents, optimum rates of application, optimum age for treatment, and proper fertilizing schedules.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

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THE EXTENT OF MOIST SITES IN THE GEORGIA PIEDMONT AND THEIR FOREST ASSOCIATIONS

Recently, when intensive research in Piedmont hardwoods was commenced, a cooperative study by the University of Georgia School of Forestry and the Southeastern Forest Experiment Station was made of the extent of cove and bottomland sites suitable for hardwood production. Also, a related study was made of the tree associations commonly found on these classes of land. In this paper, the term association is used for local tree species groupings, some of which are not sufficiently widespread to be recognized as forest types.

Moist sites occupy 18 percent of the forest land in the Georgia Piedmonts. Cove forests, those confined to the valley slopes of the present erosion cycle, were intensively sampled from aerial photographs of nine representative counties. The percentage of forest area in coves ranged from 8.15 to 9.35 percent and averaged 9.05 percent. An analysis of Forest Survey data showed that an additional 9 percent of the forest land in the Piedmont proper was occupied by bottomland hardwood types. Sandhill counties, transitional between the Piedmont and Coastal Plain, had approximately 20 percent of their forested area in bottomland hardwoods.

A combination of field observations and analysis of Forest Survey data provided a basis for distinguishing some of the important forest associations shown in the following list. In the cove forests, it is estimated that the association of "mixed mesophytic"[1/] tree species occupied from 40 to 50 percent of the area. The sweetgum-yellow-poplar association, the least prevalent association in the coves and understory species, will probably cover a somewhat lesser acreage in future stands because relative intolerance of both major species leads to a natural succession by more tolerant mesophytic species. Two oak-hickory associations are intermediate in occurrence.

Associations found in the bottomlands of the Georgia Piedmont, except the boxelder association, are similar to the forest types recognized by Putnam[2/] and the Society of American Foresters.[3/] However, the secondary species differ somewhat from those found in the Delta and Coastal Plain bottoms, possibly because the Georgia Piedmont bottoms are at the extreme of the range for many of the species listed by Putnam.

The association with willow as the principal species occurred less frequently than any of the other associations found in the bottomlands. Riverfront and green ash associations were the most commonly observed. Bottomland oak (water, willow, overcup, cherrybark, and swamp chestnut oaks), boxelder, and sweetgum associations were intermediate in occurrence.

The species composition, excellent site conditions, and good growth rates on moist sites substantiate the opinion that these areas show the best possibilities for profitable hardwood management in the Georgia Piedmont.

1/ Authority for common names used in this paper is "Check list of native and naturalized trees of the United States," by Elbert L. Little, Jr., U. S. Dept. Agr. Handbook No. 41, 472 pp. 1953.

2/ Putnam, John A. Management of bottomland hardwoods. U. S. Forest Service, South. Forest Expt. Sta. Occas. Paper 116, 60 pp. 1951.

3/ Society of American Foresters. Forest cover types of North America (Exclusive of Mexico). Soc. Amer. Foresters, 67 pp. 1954.

FOREST ASSOCIATIONS ON MOIST SITES IN THE GEORGIA PIEDMONT

A. COVE ASSOCIATIONS.

1. White oak-black oak-hickory association. Principal species: white oak, black oak, and hickory. Secondary species: post oak, southern red oak, and blackgum. Occupies upper slopes and southern exposures. Produces trees of medium quality with fair growth. Local representative of Forest Cover Type 52.[3/]

2. Sweetgum-yellow-poplar association. Principal species: sweetgum and yellow-poplar. Secondary species: loblolly pine, northern red oak, black oak, red maple, beech, hickory, and basswood. Occupies moist lower slopes. A temporary association succeeding loblolly pine. Produces high quality factory lumber and veneer logs. Pure yellow-poplar stands are a common variation of this association. Represents Forest Cover Type 87.[3/]

3. Northern red oak-white oak-sweetgum-hickory association. Principal species: northern red oak, white oak, sweetgum, and hickory. Secondary species: black oak, blackgum, beech, and basswood. Usually confined to upper slopes of northern exposures. A high value association with medium to good growth. Variant of Forest Cover Type 52.[3/]

4. Mixed mesophytic association. Common associates: beech, white oak, northern red oak, black oak, swamp chestnut oak, southern red oak, basswood, yellow-poplar, red maple, hickory, sweetgum, blackgum, sourwood, dogwood, and loblolly pine. Principal species of this association vary with its location. Occurs on lower moist slopes with rich, deep soils. Most widely distributed association found in coves. Variant of Forest Cover Type 60.[3/]

B. BOTTOMLAND ASSOCIATIONS.

1. Riverfront association. Principal species: river birch, sycamore, sugarberry, and green ash. Secondary species: cottonwood, sweetgum, black willow, water oak, and boxelder. Limited to edges of creeks and rivers. Pure stands of sycamore, sugarberry, or cottonwood are common variants of this association. Local representative of Forest Cover Type 61.[3/]

2. Black willow association. Principal species: black willow. Secondary species: cottonwood, green ash, river birch, and sweetgum. Common on the poorest drained bottoms with standing water. Many stands are pure to predominantly black willow. Similar to Forest Cover Type 95.[3/]

3. Green ash association. Principal species: green ash. Secondary species: soft maples, black willow, sweetgum, and boxelder. Common on first-bottoms. Variant of Forest Cover Type 93.[3/]

4. Sweetgum association. Principal species: sweetgum. Secondary species: boxelder, willow oak, elm, green ash, water oak, and loblolly pine. Generally found on first-bottoms. Variant of Forest Cover Type 92.[3/]

5. Boxelder association. Principal species: boxelder. Secondary species: green ash, sycamore, sugarberry, sweetgum, and red maple. Found throughout the bottoms. Boxelder appears to be a secondary invader.

6. Bottomland oak association. Principal species: water oak, willow oak, overcup oak, cherrybark oak, and swamp chestnut oak. Secondary species: winged elm, sweetgum, and hickory. Occupies the better drained sites. Also occurs in predominant to pure stands of water oak or willow oak, or a mixture of the two. Local representative of Forest Cover Type 91.[3/]

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 103 June 1957

HONEYSUCKLE OR TREES?

Thousands of acres from Georgia to Maryland are infested with an evergreen vine known as Japanese honeysuckle (Lonicera Japonica Thunb.). In the lower Piedmont of Georgia, it occurs in varying densities on about 10 percent of the forest land.[1/] In the upper Coastal Plain and Piedmont of Maryland, it is found on 8 percent of the forest area.[2/] It is just as prevalent in the Piedmont of Virginia and North and South Carolina. The vine prefers fertile nitrogen-rich land, where it often builds up to waist-height, completely wrapping up shrubs, tree seedlings, and saplings, and preventing the re-establishment of trees. It spreads in geometric proportion to the perimeter of an established colony until nitrogen-poor sites are encountered, upon which it does not thrive. In a dense pine forest, needle-drape and shade keep it in check, but when the stand is opened sufficiently for regeneration the incipient honeysuckle soon covers the ground and keeps new stands from becoming established.

Honeysuckle provides good winter grazing for cattle, and for short periods the cattle will generally gain weight. As a game food honeysuckle rates high, especially for deer browse. Grazing helps to control it, but even severe and repeated grazing will not destroy it. The area available for deer browse in the Piedmont far exceeds the need. Honeysuckle seriously interferes with the growth of other browse species, and this is particularly unfortunate because nitrogen-poor sites produce little nutritious forage. Since honeysuckle is a serious hindrance to re-establishment of trees and shrubs on the better sites, control of this vine is essential, particularly where timber production is the primary objective.

Tests with various chemicals on the control of honeysuckle were started in the summer of 1951 and are being continued on the Hitchiti Experimental Forest, near Macon, Georgia. Thirteen different chemicals in varying concentrations and frequencies of application have been tried to date. All except one of the tested chemicals killed back aerial foliage with the initial applications, regardless of concentrations and mixtures used. But in all cases honeysuckle has resprouted; in fact, honeysuckle has resprouted after four applications of some chemicals.

1/ Nelson, Thomas C. Honeysuckle is a serious problem. Southeast. Forest Expt. Sta. Research Note 41. July 1953.

2/ Bond, A. R. Maryland's fifth column. Amer. Forests 62(10): 46-47, 88-90.

Two of the chemicals tested retarded the growth of honeysuckle considerably, reducing both the density of cover and the vigor of the new sprouts. And a second application of these chemicals practically eliminated all honeysuckle, so that a year later the few residual sprigs were of extremely poor vigor. The two promising treatments are given below:

1. Spray foliage with 4 gallons per acre of butoxy ethanol ester of 2, 4-D and 2, 4, 5-T, 2:1 ratio, 2 pounds acid equivalent per gallon of concentrate (ACP-977 or its equivalent) in 250 gallons of water, early in the summer. Repeat treatment later in the summer when sprouting recurs, using a lower volume of the same concentration.

2. Spray foliage with 10 pounds per acre of 50 percent 3-amino-1, 2, 4-triazole wettable powder (Weedazol or its equivalent) in 125 gallons of water early in the summer. Repeat treatment later in the summer or the following spring when the foliage commences to turn green again, using a lower volume of the same concentration.

Treatment 2 inhibits the formation of chlorophyll. The foliage first turns pink, then pales, and finally the leaves are shed. The plant dies progressively, beginning at the growing tips.

Both treatments are costly when figured on a per-acre basis. Chemical for treatment 1 sells at about $6.00 per gallon. Chemical for treatment 2 sells at about $2.25 per pound. It takes approximately 4 gallons of the former and 10 pounds of the latter per acre for the initial treatment of dense honeysuckle. The follow-up treatment requires about half as much.

The method to be used in application of chemicals can be determined best by the size of the area to be sprayed. On large areas of several acres, spraying is most efficiently done with a power sprayer equipped with hose and adjustable nozzle; a relatively coarse, cone-shaped spray provides good coverage of the honeysuckle foliage; on smaller areas, a low-pressure backpack pump can be most efficiently used.

Further tests are under way on lowering the costs of these treatments. In heavy honeysuckle areas, pretreatment with a heavy harrow and later spraying of the new sprouts will be tried. The effectiveness of follow-up disking some months after spraying will also be investigated. Control costs may be lowered with these combination treatments.

Small patches of honeysuckle can be controlled by mulching with a 2-inch layer of sawdust. Sawdust not only smothers the honeysuckle but also deprives it of nitrogen during the process of decomposition.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

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SLASH PINE PROGENY TESTS INDICATE GENETIC VARIATION IN RESISTANCE TO RUST [1/]

Southern fusiform rust caused by *Cronartium fusiforme* is one of the most serious diseases attacking slash pine. Each year, it kills many trees and the cankers make portions of the trunks unfit for lumber and other products. The nature of this disease is well known, but little in the way of practical control measures is available for planted or natural stands.

One approach to the problem of control is to select resistant strains of slash pine, if they exist, or to develop resistant strains through planned breeding. A first step in this approach is to determine whether disease-free trees in infected stands produce seedlings having more than average resistance to the rust. Early results of 1-parent progeny tests at the tree improvement project of the Ida Cason Callaway Foundation, near Chipley, Georgia, indicate that some degree of rust resistance is in fact passed on to the seedling progeny.

The tests at Chipley are part of a broad program aimed at developing superior strains of southern pines. The mother trees in a 15-year-old plantation of unknown seed source were selected in 1950 on the basis of their growth rate, trunk and crown form, and freedom from rust cankers. At that time, about 75 percent of the surviving trees in the plantation were cankered. This stand had more trees with rust infections than the average, although fast-growing, old-field plantations often have a high rate of infection.

The seedlings from the 1950 and 1951 seed crops were grown in the Foundation's nursery in 1951 and 1952, respectively. Seedlings were given standard spraying treatment to control rust in the seed beds, and infection was low.

Nothing is known of the culling practice for the control seedlings, which were purchased, but the usual practice is to cull diseased seedlings at the nursery. Seedling lots designated "control seed number 1 and 2" and "Southern Mississippi" were grown in the Foundation's nursery. Seed of control number 1 was purchased; seed of control lot number 2 and Southern Mississippi were supplied by the Southern Forest Experiment Station.

Seedlings were outplanted as 1-0 stock in the spring of 1952 and 1953. The 1952 planting was in plots varying from 20 to 100 trees, with 3 replications. The 1953 planting was in 25-tree plots with 4 replications and was

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1/ This study was conducted by the Southeastern Forest Experiment Station, USDA, in cooperation with the Ida Cason Callaway Foundation and the Georgia Forest Research Council.

adjacent to the 1952 planting. Stem and branch cankers were counted in the fall of 1955, when trees planted in 1952 averaged about 8 feet in height and those planted a year later averaged about 5 feet.

Progeny groups of certain maternal parents had only about half as many infected trees as others (table 1). Also, the average percent infection in progeny of 9 selected trees was 33 and 30 percent less in the 1952 and 1953 plantings, respectively, than in 4 lots of control seedlings from unknown parent trees.

Table 1.--Rust infection in slash pine progeny from open pollination of disease-free mother trees and unselected mother trees

Origin	Planted spring 1952				Planted spring 1953			
	Trees	Stem cankered	Branch cankered	Total trees with canker	Trees	Stem cankered	Branch cankered	Total trees with canker
	Number	Percent	Percent	Percent	Number	Percent	Percent	Percent
Seedling lot								
Control seed (1)	114	37	55	64	66	18	15	30
Control seedlings	104	28	58	64	42	29	33	48
Control seed (2)	30	53	70	77	85	36	28	51
Southern Mississippi	56	52	71	77	92	50	26	58
Average	--	42	64	70	--	33	26	47
Parent								
C-4	62	23	45	45	80	26	19	32
C-6	71	24	34	48	79	25	16	33
C-7	71	30	42	54	71	30	15	39
C-10	250	24	51	59	97	23	24	39
C-37	216	14	26	30	84	8	12	20
C-50	212	34	52	61	94	29	31	50
C-51	203	22	51	58	89	19	15	27
C-63	58	16	26	29	92	23	28	39
C-65	252	13	36	43	85	12	11	21
Average	--	22	40	47	--	22	19	33

Infections were low in both plantings of the progeny of a mother tree known as C-37; in fact, they were less than half that of the controls. Furthermore, the C-37 progeny are among the fastest growing in the plantations and the trees have characteristically short branches. Progeny of C-50 are also very fast growing and extremely slender crowned, but they have the highest infection of any select group. Control seed number 2 and Southern Mississippi lots planted in 1952 and 1953 represent single lots of seed, respectively. Part of each of the two lots of seed was planted in the nursery in 1951 and part in 1952. In the 1952 planting the percent of total trees with cankers was the same in both lots. In the 1953 planting there was only a 7 percent difference. However, for both seedling lots, there were fewer trees with stem cankers than branch cankers in the 1952 planting, while the reverse was true in the 1953 planting. It should be pointed out that in these groups as well as in the progeny of plus trees it was difficult to tell whether a large stem canker in a whorl of branches originated on the branches or on the stem. Stem cankers are the more damaging because they may deform the trunk, weaken it so that it breaks, or even kill the tree.

Although the results reported here are from few tests of short duration, they indicate there may be some inherent differences in susceptibility to rust among individual slash pine trees. More complete information will soon be available from periodic observations of these trees as they grow older and of trees in additional plantings made in 1954, 1955, and 1956 with seed from open and controlled pollinations.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 105 June 1957

SAWTIMBER PRICES ARE HIGHEST IN THE FALL

Timber growers who sell sawtimber in the autumn receive more than those who sell at other times of the year. This is the conclusion reached from a study of an 8-year record of prices received for marked stands in South Carolina.[1] After the effect of long-term price trends had been removed, the average October price was 21 percent higher than the annual average.

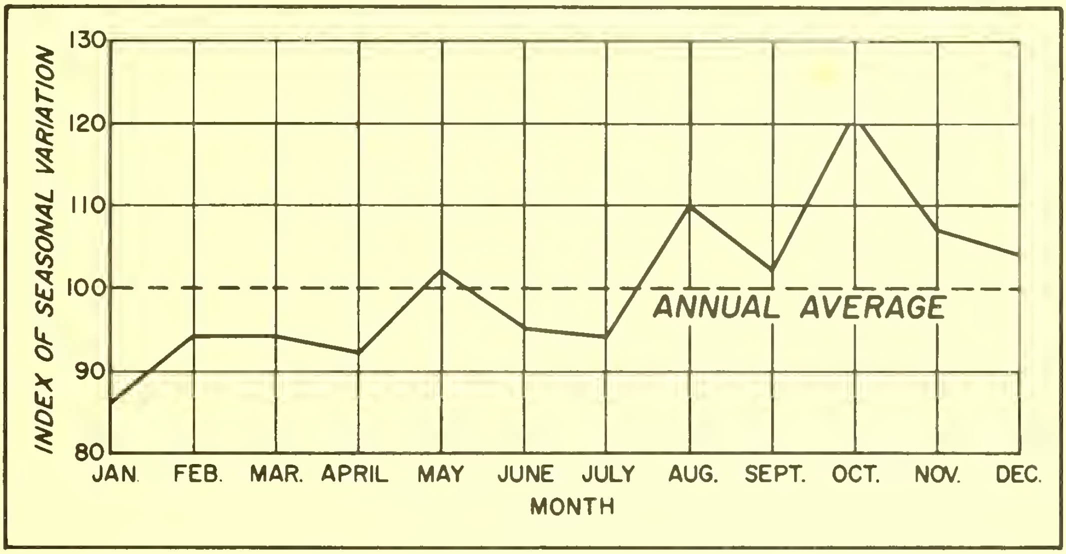

Figure 1.--The pattern of seasonal variation in sawtimber prices, South Carolina, 1948-1955

Why the fall price is highest is not entirely clear, although it seems reasonable to believe that the level of sawtimber prices rises or falls as competition for timber intensifies or lessens. The number of competing sawmill operators probably depends primarily on farming activity, rainfall, and the condition of the lumber market. Since many small sawmill operators also farm, sawmilling activity increases in the fall after crops have been harvested. This is normally the driest season of the year as well as an active period in the lumber market.

The seasonal price pattern for this 8-year period may not be a good guide for any particular year. For example, the October price was actually highest in only three of the eight years. Nevertheless, a timber grower who consistently sells his timber in the fall will apparently fare better than if he sold at any other one season or scattered his sales throughout the year.

1/ Price data collected and made available by the South Carolina State Commission of Forestry.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

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HOW LONG DOES IT TAKE TO GROW PINE PULPWOOD OR SAWTIMBER IN NORTH CAROLINA?

On each of 2,725 Forest Survey inventory plots scattered throughout North Carolina, age and total height of one pine tree were obtained to get an estimate of the site index. Site index was read from curves based on total height at age 50 years. D.b.h. to the nearest tenth of an inch was also measured on these trees.

Average d.b.h. plotted over age by site index revealed straight line relationships throughout the range of available data. Regression lines showing the relationship between d.b.h. and age by site index for loblolly pine and shortleaf pine were constructed based on these averages. For example, figure 1 shows that it takes 41 years to grow a 10-inch loblolly pine on site 60, and figure 2 shows that it takes a shortleaf pine 43 years to reach 10 inches on site 60. The number of sample trees of other pine species was too small to provide reliable estimates by both age and site index. For these species, estimated average d.b.h. by age is given only for the average site index (fig. 3).

The computed ages shown by the following graphs are not for average forest-grown trees, but for selected dominant and codominant trees which have been in a relatively free-growing position throughout their lives. Thus, these are ages that might be expected under near-optimum stocking conditions in natural stands--and perhaps under conditions which might be attained in well managed stands.

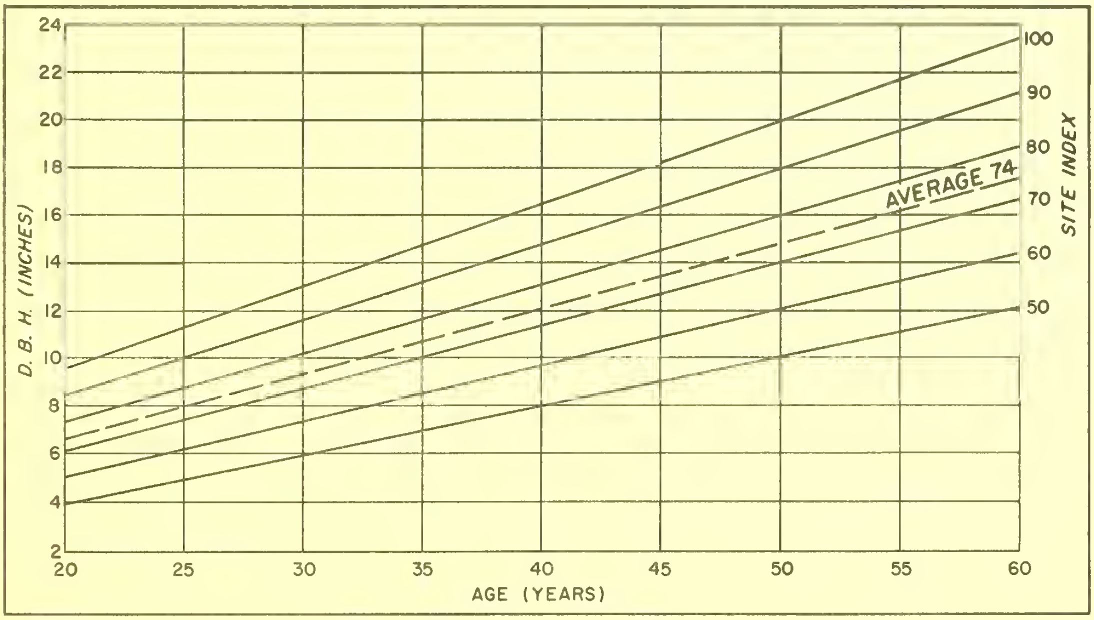

Figure 1.--Average d.b.h. of loblolly pine by age and site index.

U. S. Department of Agriculture - Forest Service

Figure 2.--Average d.b.h. of shortleaf pine by age and site index.

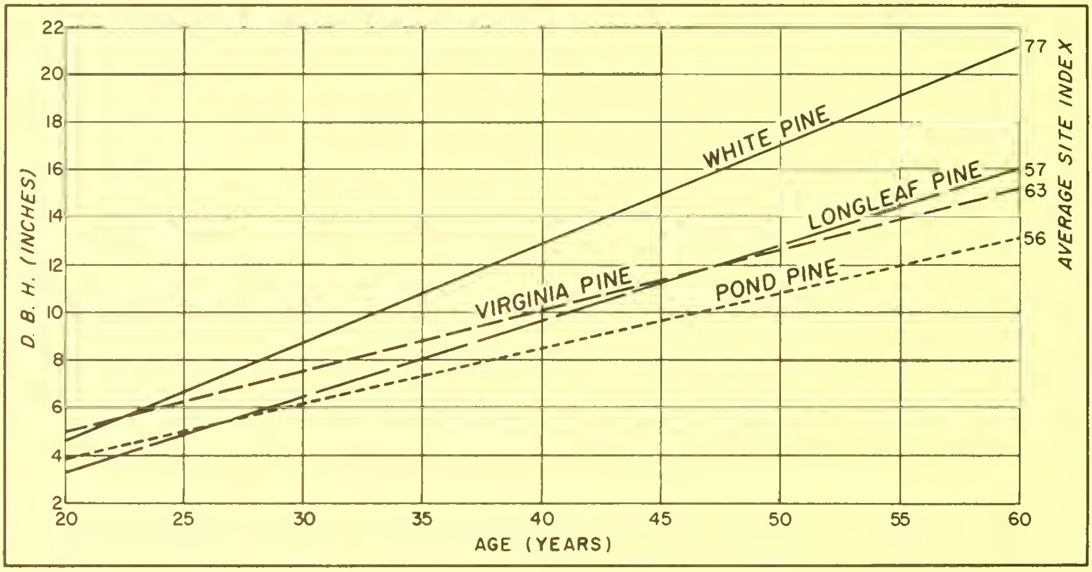

Figure 3.--Average d.b.h. of other pine species by age.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

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MOST CANKERED TREES ARE GOOD RISKS IN LOBLOLLY PINE SAWTIMBER STANDS

Loblolly pine sawtimber trees with as much as half of their bole circumferences damaged by *Cronartium fusiforme* rust cankers can be left at least 10 years in well-stocked stands with little risk of loss from wind breakage. From 1946 to 1957 not a single cankered tree was lost in a study area on the Santee Experimental Forest.

Loblolly pine stands in the Carolina Coastal Plain are often improperly thinned when all cankered trees are removed. Such thinnings may leave many unproductive openings in the stand, or leave slow growing, poorly formed trees in lieu of more vigorous cankered trees. To avoid these conditions, Wenger developed a rule-of-thumb as a guide for tree markers.[1/] The rule is that a cankered tree is safe to leave for at least 5 years if any sound callus can be seen extending past the canker along both edges when the marker faces that side of the tree.

To test Wenger's rule, 21 dominant and codominant loblolly pine with 10 to 50 percent of their stem circumferences cankered by the rust were left in a 40-year old, even-aged, loblolly pine stand on the Santee Experimental Forest. In 1946, when this study was initiated, the stand averaged 79 square feet of basal area per acre and 11.4 inches in d.b.h. Improvement cuts were made in the winter of 1946, leaving a residual stand averaging 64 square feet of basal area and 14.0 inches in d.b.h.

During the period 1946-1957, storm winds up to 60 miles per hour have buffeted the Experimental Forest. Nevertheless, all 21 test trees survived. In fact, the fusiform-rust-infected trees grew almost 2 inches in diameter and 9 feet in total height in 10 years--an increase in size comparable to that of sound trees on an adjacent 1-acre study plot (table 1).

Changes in width and length of the cankers on individual trees have varied over the past 10 years. Some trees are healing over their cankers; others are not. Averaged over all trees, the cankers decreased in length 0.7 inches while increasing in width 1.1 inches (table 2).

1/ Wenger, Karl F. The mechanical effect of fusiform rust cankers on stems of loblolly pine. Jour. Forestry 48(5): 331-333. 1950.

Table 1.--Diameter and total height changes of cankered loblolly pine compared with sound trees

Sample trees	Average d.b.h.		Average total height	
	Sept 1946	Feb. 1957	Sept. 1946	Feb. 1957
	Inches	Inches	Feet	Feet
Cankered	14.1	16.0	85	94
Sound	14.0	15.6	86	93

Table 2.--Average length and width of fusiform rust cankers on 21 loblolly pine in 1946 and 10 years later

Average length of cankers		Average width of cankers	
Sept. 1946	Feb. 1957	Sept. 1946	Feb. 1957
Inches	Inches	Inches	Inches
34.4	33.7	6.5	7.6

The survival and growth of the test trees in this study show that Wenger's rule-of-thumb is a practical guide. Very few cankered trees need to be cut in young stands for fear of mechanical breakage. A more important consideration is the possible effect of canker position and size on the soundness and quality of a tree. Location of large cankers in the first or second log of a tree may have an important bearing on its potential grade or yield. A decision to cut or leave such trees will depend on the judgment of the tree marker.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 108 September 1957

AN EFFECTIVE CONTROL FOR CULL HARDWOODS

The goal in cull hardwood control is a low-cost technique that completely kills all treated trees. In the search for such techniques the excellent control of cull sweetgum reported by Shipman [1] suggested the possibility of similar results with other species. Consequently, an experiment was set up at the Santee Experimental Forest. It showed only 69 of 997 chemically treated trees surviving after 14 months. Of about 20 species, only American holly showed substantial resistance to control (table 1).

Table 1.--Species kill resulting from a spring treatment with a 2,4,5-T and oil mixture applied in frills

Species	Trees treated	Dead trees: 6 to 10 inches d.b.h.	Dead trees: 12 inches and over d.b.h.
	Number	Percent	Percent
American beech (*Fagus grandifolia* Ehrh.)	159	91	73
American holly (*Ilex opaca* Ait.)	115	67	33
Sweetgum (*Liquidambar styraciflua* L.)	24	94	100
American hornbeam (*Carpinus caroliniana* Walt.)	228	99	100
White oaks (*Quercus* Sp.)	174	100	100
Hickories (*Carya* Sp.)	163	100	100
Winged elm (*Ulmus alata* Michx.)	57	100	100
Red oaks (*Quercus* Sp.)	24	100	100
White ash (*Fraxinus americana* L.)	20	100	100
Miscellaneous species	33	96	80

1/ Shipman, R. D. Better sweetgum control with 2,4,5-T. Southeastern Forest Experiment Station Research Note 84. 1955.

A mixture of 2, 4, 5-T and oil was applied in frills during the growing season. The mixture was 1 part 2, 4, 5-T (4 lbs.acid, propylene glycol butyl ether ester) to 20 parts of fuel oil. Application was in late May and early June in frill-girdles made at a convenient chopping height.

The trees treated were residual culls from a harvest cutting, ranging from 6 to 30 inches d.b.h. but averaging only 9 inches. All were located along a terrace of a typical coastal plain tributary stream in the swamp chestnut oak-cherry bark oak type. The prevalent white oaks were swamp chestnut oak and post oak. Bitternut hickory was the common hickory. The red oaks included cherry bark oak, Shumard oak, water oak, and willow oak. Miscellaneous species were yellow-poplar, red maple, and boxelder; of these only a few red maple survived.

Crown kill was rapid among the affected trees; on most, the foliage was completely brown well before the end of the first growing season. Summarized results are based on one survival count made in late July, 14 months after treatment. Any tree with live foliage, living stem tissue, or sprouts was classed as living. Even so, most of the few survivors were of poor vigor and will eventually die.

Besides a high level of control, the low cost gives this treatment a practical significance. The entire job was done with 37 man hours of labor, 1-1/4 gallons of a commercial concentrate of 2, 4, 5-T and 23-3/4 gallons of fuel oil--roughly equivalent to $50.00. This treated 13 acres with an average of 77 cull trees totaling 34 square feet of basal area per acre.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 109 September 1957

SPECTACULAR RISE IN SOUTHERN PULPWOOD PRODUCTION CONTINUES

In 1956 the 72 pulpmills drawing wood from southern states received a total of 20,345,000 cords, setting another record in the use of pulpwood for the seventh straight year. The new total was 1,956,000 cords, or 10.6 percent greater than 1955. This increase was shared by all of the southern states except Louisiana, where a slight decline occurred. The use of sawmill slabs, veneer cores, and other coarse plant residues for pulp also gained in importance and now exceeds 3 percent of current wood requirements.

Pulpwood production in southern states, 1956

State	Round pulpwood: Change from 1955	Round pulpwood: Pine	Round pulpwood: Hardwood	Round pulpwood: All species	Plant residues	Total all sources
	Percent	Thousand cords				
Florida	+6.7	1,950	1	1,951	9	1,960
Georgia	+2.4	3,665	185	3,850	39	3,889
South Carolina	+19.4	1,583	223	1,806	39	1,845
North Carolina	+17.0	1,512	330	1,842	80	1,922
Virginia	+15.9	1,273	357	1,630	26	1,656
Southeast	+9.9	9,983	1,096	11,079	193	11,272
Alabama	+9.0	2,001	102	2,103	84	2,187
Arkansas	+6.6	803	132	935	140	1,075
Louisiana	-4.6	1,289	285	1,574	74	1,648
Mississippi	+8.4	1,191	878	2,069	67	2,136
Oklahoma	+95.5	69	6	75	--	75
Tennessee	+20.1	245	147	392	7	399
Texas	+21.2	1,339	120	1,459	94	1,553
Lower South	+8.5	6,937	1,670	8,607	466	9,073
Total South	+9.3	16,920	2,766	19,686	659	20,345
Percent	--	83.2	13.6	96.8	3.2	100.0

In the five southeastern states, production amounted to 11,272,000 cords, 55 percent of the total. Georgia has far outdistanced the other states in pulpwood use and still leads with a production rate just under 4 million cords. Roundwood production in excess of 100,000 cords occurred in Baker County, Florida, Charlton and Clinch Counties, Georgia, and Fairfield and Georgetown Counties in South Carolina. Other leading areas are the states of Alabama, Mississippi, and Florida, and Union and Winn parishes in Louisiana.

What does the production of 20 million cords of wood mean in terms of physical volume? If all this wood were assembled at one place, the stack would cover nearly 15,000 acres with a layer of pulpwood 4 feet deep. It would weigh nearly 60 million tons; and to haul it all at one time would require 3 railroad freight trains stretching from Jacksonville, Florida, to Seattle, Washington.

The 1956 production statistics were compiled by the Southern and Southeastern Forest Experiment Stations in cooperation with the Southern Pulpwood Conservation Association. Copies of Forest Survey Release No. 80, which presents detailed state and county production figures, are available on request from either of the experiment stations.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 110 September 1957

ESTIMATING D.B.H. FROM STUMP DIAMETER IN SOUTHERN APPALACHIAN SPECIES

Forest conditions prior to logging are often reconstructed by measuring the trees in the residual stand and the stumps of cut trees. A curve or table for estimating diameters breast high from stump diameters is needed to estimate the volume of cut trees.

Curves were developed to estimate diameter breast high, outside bark, from both inside bark and outside bark diameters at stump height (6 inches above ground) for 9 species and species groups in the Southern Appalachians. Measurements were taken on yellow pine (shortleaf pine, pitch pine, and Virginia pine), mixed oaks (scarlet oak, northern red oak, blackjack oak, black oak, and southern red oak), white oak, chestnut oak, yellow-poplar, red maple, black locust, a miscellaneous group including all other native tree species, and shrubs (especially laurel and rhododendron). The measurements were well distributed over diameters ranging from 0.6 inch to over 33.0 inches.

A series of curves were developed by regression analysis showing the relation of diameter breast high to stump diameter. Composite curves were made whenever the analyses showed no significant differences between species or species groups (table 1).

For most purposes, stump diameters may be measured to the nearest inch and the corresponding diameter breast high read from table 1. If more precise estimates are needed, stump diameters may be measured to the nearest 0.1 inch and the diameter breast high estimated by interpolation from the table, or from curves constructed from the equations listed in the accompanying tabulation.

Curve number	Equation
1	D.b.h. = .922 stump diameter + .01
2	" = .970 " " + .11
3	" = .928 " " - .72
4	" = .868 " " - .69
5	" = .862 " " - .10
6	" = .850 " " - .96
7	" = .890 " " - .42

Table 1.--Diameter breast high estimated from stump diameter

Stump diameter (Inches)	When stump diameter is measured inside bark: Curve 1: Yellow-poplar, red maple, chestnut oak, miscellaneous species & shrubs	Curve 2: Black locust and Yellow pine	Curve 3: White oak	When stump diameter is measured outside bark: Curve 4: Yellow pine, chestnut oak, white oak, and miscellaneous species	Curve 5: Yellow-poplar and black locust	Curve 6: Mixed oaks	Curve 7: When stump diameter is measured inside bark for mixed oaks and outside bark for red maple and shrubs
	Diameter breast high outside bark in inches						
1	0.9	1.1	0.2	0.2	0.8	0	0.5
2	1.9	2.0	1.1	1.0	1.6	0.7	1.4
3	2.8	3.0	2.1	1.9	2.5	1.6	2.2
4	3.7	4.0	3.0	2.8	3.3	2.4	3.1
5	4.6	5.0	3.9	3.7	4.2	3.3	4.0
6	5.5	5.9	4.8	4.5	5.1	4.1	4.9
7	6.5	6.9	5.8	5.4	5.9	5.0	5.8
8	7.4	7.9	6.7	6.3	6.8	5.8	6.7
9	8.3	8.8	7.6	7.1	7.7	6.7	7.6
10	9.2	9.8	8.6	8.0	8.5	7.5	8.5
11	10.2	10.8	9.5	8.9	9.4	8.4	9.4
12	11.1	11.7	10.4	9.7	10.2	9.2	10.3
13	12.0	12.7	11.3	10.6	11.1	10.1	11.2
14	12.9	13.7	12.3	11.5	12.0	10.9	12.0
15	13.8	14.7	13.2	12.3	12.8	11.8	12.9
16	14.8	15.6	14.1	13.2	13.7	12.6	13.8
17	15.7	16.6	15.0	14.1	14.6	13.5	14.7
18	16.6	17.6	16.0	14.9	15.4	14.3	15.6
19	17.5	18.5	16.9	15.8	16.3	15.2	16.5
20	18.4	19.5	17.8	16.7	17.1	16.0	17.4
21	19.4	20.5	18.8	17.5	18.0	16.9	18.3
22	20.3	21.4	19.7	18.4	18.9	17.7	19.2
23	21.2	22.4	20.6	19.3	19.7	18.6	20.1
24	22.1	23.4	21.5	20.1	20.6	19.4	21.0
25	23.1	24.4	22.5	21.0	21.5	20.3	21.8
26	24.0	25.3	23.4	21.9	22.3	21.1	22.7
27	24.9	26.3	24.3	22.7	23.2	22.0	23.6
28	25.8	27.3	25.2	23.6	24.0	22.8	24.5
29	26.7	28.2	26.2	24.5	24.9	23.7	25.4
30	27.7	29.2	27.1	25.4	25.8	24.5	26.3

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

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A TEST OF THE APPLICATION OF EXISTING SITE-INDEX CURVES TO THE FLATWOODS SLASH PINE TYPE

The only published curves available for determining 50-year site indices for slash pines have been those issued by USDA in 1929.[1/] These curves were constructed for use throughout the range of slash pine and may not be fully applicable to the flatwoods slash pine type of northeast Florida and southeast Georgia. A test, therefore, was made to determine their applicability to this area.

Site-index values for slash pine are usually expressed by dominant tree heights at 50 years of age. Values obtained from dominant trees close to that age are generally reliable. The site-index values obtained from trees 40 to 60 years old can be used to check the values obtained from younger trees. To obtain these data, 36 plots were located within a 30-mile radius of Lake City, Florida, in natural stands containing dominant 40- to 60-year-old slash pines and younger trees in the 15- to 40-year age classes. Both age classes were on sites identical in topography, drainage, and soil type, but were separated enough to allow free growth of both age classes. Age and height measurements were taken on trees of both age classes, and their respective site-index values were obtained from Miscellaneous Publication 50.

An analysis similar to the one employed by Coile and Schumacher[2/] for loblolly and shortleaf pines was used to determine the correction factor for testing the existing site-index curves. The basic difference in the methods of analysis was a substitution of the site index of older trees as the standard for that of soil-site values. The regression used was of the following form:

$$\text{Log}\,\frac{y}{Y} = b_0 + b_1\left(\frac{1}{A}\right) + b_2 \log Y$$

where: $\frac{y}{Y}$ = correction factor to be applied to existing curves.

y = site index estimated from young trees.

Y = site index estimated from old trees.

$\frac{1}{A}$ = reciprocal of age of young trees.

Since the correction at age 50 is set at 0, the fitted equation to obtain the correction factor for the younger ages becomes:

$$\text{Log}\,\frac{y}{Y} = b_1\left(\frac{1}{A} - \frac{1}{50}\right)$$

When this correction factor is applied to the site-index curves in Miscellaneous Publication 50, new curves appear above the old ones (fig. 1). The differences between the two curves are small, but do indicate that some caution should be observed in determining site-index values for 15- to 30-year-old slash pines from the curves published in 1929; they may overestimate the site by 1 to 2 years.

1/ Volume yield, and stand tables for second-growth southern pines. U. S. Dept. Agr. Misc. Pub. 50, 202 pp., illus. 1929.

2/ Coile, T. A., and F. X. Schumacher. Site index of young stands of loblolly and shortleaf pines in the Piedmont Plateau region. Jour. Forestry 51: 432-435. 1953.

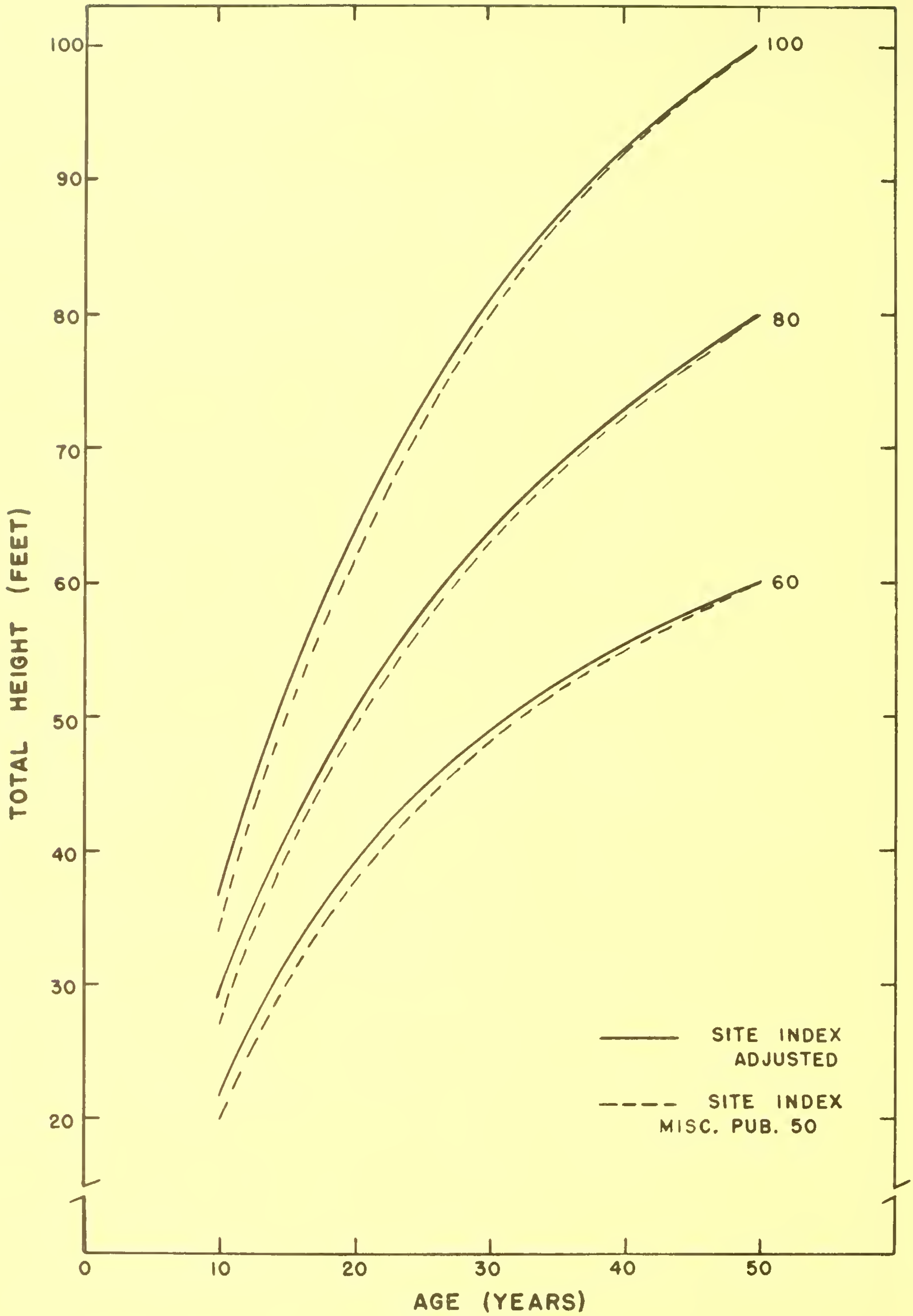

Figure 1.--Relation between adjusted curves and those shown in Miscellaneous Publication 50, for site index of slash pine.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 112 September 1957

ROOTING OF SHORTLEAF AND SLASH PINE NEEDLE BUNDLES

Methods of propagating pines and other forest trees vegetatively, especially by the rooting of cuttings, are constantly being sought as aids in tree improvement studies. In the course of this work, stem cuttings of many species of pine have been rooted with varying degrees of success. Another potentially useful method is the rooting of needle bundles whereby numerous like "progeny" may be produced from a single branch taken from a selected mature tree or from a young seedling hybrid. Successful rooting of needle bundles of eastern white pine,[1] Japanese red pine,[2] and red pine,[3] has already been reported. However, only those of Japanese red pine budded and produced top growth.[4] At Athens, Georgia, needle bundles of shortleaf pine were successfully air-layered, and a few developed shoots.[5]

Recently we have successfully rooted needle bundles of both shortleaf and slash pine.

The first study was made with needle bundles in different stages of development from $1\frac{1}{2}$-year-old shortleaf pine seedlings. Small wooden flats were used, containing a 50-50 mixture of coarse sand and ground peat moss, and a sheet of heavy blotter paper was placed over the surface. When they had been dipped in 0.8 percent indolebutyric acid in talc, the bases of the bundles were inserted to a depth of $\frac{1}{4}$ inch in holes pricked through the paper with the point of a sharpened pencil. The flats were covered with glass panes and kept under 24-hour fluorescent light in an airconditioned room. During the first month the needle bundles were watered with a suspension of Captan. Thereafter, water alone was used.

1/ Thiman, K. V., and A. L. Delisle. Notes on the rooting of some conifers from cuttings. Jour. Arnold Arbor. 23: 103-109. 1942.

2/ Toda, R. Rooting responses of leaf-bundle cuttings of pine. Bul. Tokyo University Forests 36: 41-48. 1948.

3/ Jeckalejs, H. J. The vegetative propagation of leaf-bundle cuttings of red pine, Pinus resinosa. Forestry Chronicle 32(1): 89-93. 1956

4/ Toda, R. The conversion of buds into roots in the leaf-bundle cuttings of pine. Bul. Tokyo University Forests 36: 49-53. 1948.

5/ Zak, Bratislav. Experimental air-layering of shortleaf and loblolly pine. Southeastern Forest Expt. Sta. Paper 69, 12 pp., illus. 1956.

Five months after planting, the needle bundles were removed and examined. Of 492 needle bundles, only 12 (2.4 percent) bore any roots. These roots varied in length from $\frac{1}{2}$ inch to 4 inches. Different treatments had been applied, but valid comparisons were impossible in view of the weak rooting response. In one individual series, however, characterized by needle bundles with 1-inch primary leaves attached at the base to $1\frac{1}{2}$-inch secondary needles, 18 percent rooted.

The second study dealt with slash pine. Fully developed needles from a 2-year-old rooted slash pine cutting originally taken from a 1-year-old seedling were rooted after 2 to 3 months in a 50-50 mixture of sand and peat moss. Three treatments were tested as follows: (1) needle bundles planted 2 inches deep; (2) needle bundles planted $\frac{1}{2}$ inch deep; and (3) needle bundles placed flat on the surface of the medium with the bases covered by moist paper toweling and aluminum foil.

This experiment with slash pine needle bundles was carried out during early summer in a shaded greenhouse where supplemental light was used to extend the photoperiod to 16 hours. No attempt was made to maintain high humidity above the rooting medium. Plain tap water was applied daily. All needle bundles were treated with 0.8 percent indolebutyric acid in talc. The results are given in the following tabulation. The greater success of treatments 1 and 3, as compared to treatment 2, is probably the result of better water absorption by needle bundles in these treatments.

Treatment	Planted (Number)	Rooted (Percent)
1	12	58
2	24	5
3	12	42

Of the rooted needle bundles of both species tested, only those of slash pine were retained and observed for shoot growth. One of these produced a shoot after 3 months. It is hoped that eventually this problem of top dormancy may be satisfactorily solved to allow use of this interesting method of vegetative propagation in forest research.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 113 September 1957

SEED PRODUCTION OF SHORTLEAF PINE IN THE PIEDMONT

To regenerate shortleaf pine successfully in the Piedmont by natural seeding, the forest manager must have information about the seed supply. Observations being made in eight stands in North Carolina, South Carolina, and Georgia show that shortleaf pine produces large amounts of seed of reasonably good quality in some years, and only negligible amounts in others.

The seed crop was small in 1954, the year observations were begun, and large in 1955 (table 1). In 1956 the crop was a failure, apparently because a heavy frost in March 1955 destroyed most of the flowers. Current observations indicate that the crop will be substantially larger in 1957 than in 1956.

Table 1.--Sound seed per acre produced by eight shortleaf pine stands in the Piedmont

Location of stands	1954	1955	1956
	- - - - Number - - - -		
Morganton, N. C.	46,000	185,600	2,000
Morganton, N. C.	48,000	181,600	5,200
Clemson, S. C.	7,200	228,400	1,200
Clemson, S. C.	1,200	63,200	400
Athens, Ga.	33,200	154,400	0
Athens, Ga.	20,000	103,600	0
Union, S. C.	3,200	31,600	1,200
Union, S. C.	500	22,600	0

Soundness of seed ranged from 44 to 66 percent and averaged 48 percent in 1954. In 1955 soundness ranged from 44 to 51 percent and averaged 48 percent. The light seedfall in 1956 did not permit a reliable estimate of soundness.

In each of the 3 years observed, the fall of seed began in the last week of October and reached a peak in November. In 1955, the best of the 3 years, 70 percent of the seed fell before December 1, and 90 percent before January 1 (fig. 1).

The data were obtained from 10 seed traps in two stands at each of the following locations: Morganton, N. C.; Clemson, S. C.; Athens, Ga.; and Union, S. C.[1] The stands vary in age from 40 to 78 years and the presence

[1] Duke Power Company cooperated at Morganton, and Clemson College at Clemson.

of old cones showed that all had previously produced seed. Basal area varies from 75 to 165 square feet per acre, and site index ranges from 48 to 76 feet. The data are as yet insufficient, however, to show the effects of geographic location, stand characteristics, and annual weather variations on seed production.

Observations will be continued indefinitely in an attempt to obtain sufficient data to show these effects.

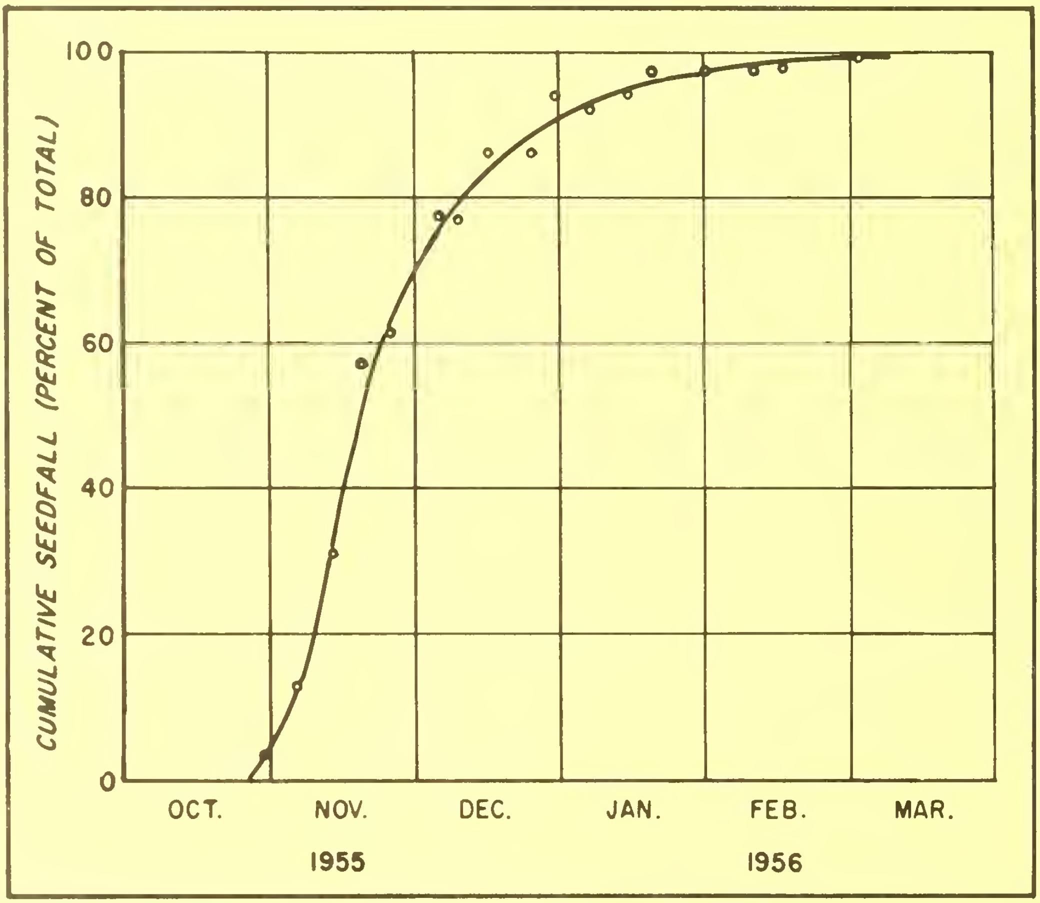

Figure 1.--Average rate of shortleaf pine seedfall for eight Piedmont stands.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 114 January 1958

SOME BASIC THERMAL PROCESSES CONTROLLING THE EFFECTS OF FIRE ON LIVING VEGETATION

Both prescribed fire and wildfire produce their effects on living vegetation by means of certain basic thermal processes. Knowledge of these processes can be used to obtain better results with prescribed fire and to anticipate some of the effects of wildfire.

One of the primary factors controlling the effects of fire is the lethal temperature. As a first approximation it is convenient to think of the lethal temperature as a single quantity, say 140° F., which represents the borderline between killing and non-killing temperatures.

The quantity of heat required to raise the temperature of living vegetation up to the lethal temperature is directly proportional to the difference between this temperature and the initial vegetation temperature. For example, twice as much heat will be required to raise the temperature of pine needles or buds up to a temperature of 140° F. on a cool day when the initial vegetation temperature is 50° F. as on a hot day when this initial temperature is 95. Hence fires of equal intensity are more damaging on hot days than on cool days. Stated in another way, living vegetation can tolerate a more intense fire on a cool day than on a hot day. These relationships can be worked out mathematically and in some instances plotted as simple curves. In figure 1, for instance, height of scorch for constant low-intensity fires with flames 12 to 18 inches long is shown as a function of initial vegetation temperature. The main curve A is based on a lethal temperature of 140° F. Curve B is based on a lethal temperature of 135°. The plotted points represent observed height of scorch for experimental fires. A significant feature of the curves in figure 1 is the rapid increase in height of scorch line when the initial vegetation temperature is 95° F. or more. For shaded locations, the initial vegetation temperature is approximately equal to the air temperature but is somewhat greater in sunny exposures.

Initial vegetation temperature also affects temperature differentials between various susceptible parts of a tree subjected to fire. Suppose that on a cold day when the temperature is 40° F. a fire heats the needles of a pine to 220°. The crown would thus be completely scorched or browned. However, the buds with their higher heat capacity might be heated to only 100° or 105° F. and would remain undamaged. On a hot day when the initial vegetation temperature is 95, the needles of a similar tree could be heated to the same temperature of 220 by a somewhat lower intensity fire. In this case the buds might reach a temperature of 145° F. because of their high initial temperature. Hence, two different fires, one of which was relatively cool on a hot day and the other relatively hot on a cool day, may result in equal amounts of crown scorch. But the former may do considerably more damage to the trees than the latter because it should produce greater injury to the heavier parts of the tree such as the buds and cambium tissue. Thus, crown scorch is not always a reliable indication of total damage.

It has long been observed that summer fires do considerably more damage than winter fires. This has on occasion been explained by assuming that summer fires are more intense than winter fires or that trees are more susceptible during the growing season than during the dormant winter season. Some seasonal effects are undoubtedly present, as are indicated by the effectiveness of repeated summer fires in reducing the vigor of hardwood sprouting, which is discussed by Chaiken,[1/] but the more direct and immediate effects can be mostly accounted for in terms of the basic thermal mechanisms.

Although approximate computations are simplified by assuming a constant lethal temperature of 140° F., the lethal temperature actually depends on duration of temperature. The time-temperature relation is shown by the curve in figure 2, plotted from the measurements of Nelson.[2/] His data were obtained by the water bath method on pine needles of four different species (pitch, longleaf, slash, and loblolly). Because there was not much difference between species, the curve in figure 2 represents the average for the four different pines.

A value of 140° F. is probably about right for headfires. However, the time-temperature curve based on Nelson's data indicates that a temperature of 132° to 135° F. would be more realistic for the slower spreading backfires because of the longer exposure time. A somewhat lower value for the lethal temper-

1/ Chaiken, L. E. Annual summer fires kill hardwood root stocks. Southeast. Forest Expt. Sta. Research Note 19. 1952.

2/ Nelson, Ralph M. Observations on heat tolerance of southern pines. Southeast. Forest Expt. Sta. Paper 14. 1952.

ature, such as 135^{o} F., has little effect on the height of scorch when the initial vegetation temperature is low, and has considerably more effect when the initial temperatures are high. This can be seen readily by comparing curve A (based on 140^{o} F.) and curve B (based on 135^{o} F.) in figure 1.

In a zone near the ground, fires spreading with the wind (headfires) are not necessarily hotter than fires spreading against the wind (backing fires). Figure 3 shows the temperature rise measured above headfires and backing fires in a predominantly grass fuel mixed with some pine needles. Measurements were made by thermometers with their bulbs insulated to reduce their sensitivity and to give about the same temperature response as fully developed longleaf buds. Headfires appear to be somewhat cooler than backing fires in a zone about 10 inches deep next to the ground. However, the depth of this zone, as well as the difference between the two types of fires, should in general depend on arrangement and quantity of fuel and the wind speed.

The higher temperatures measured near the ground for backing fires appear to be a result of most of the combustion taking place at the lower levels. This effect would probably be greatest in grass-type fuels in which a slow-spreading fire would burn the base of grass stems before burning their tops. Then the stems would tend to topple over and burn near the ground. In fast-spreading headfires, however, grass stems should burn in the reverse order, with much of the combustion occurring at higher levels.

The rate of spread of headfires, and hence their intensity several feet above the ground, is very sensitive to changes in wind speed. This is shown by the curve in figure 4, in which the rate of spread of both headfires and backing fires in feet per minute is plotted as a function of wind speed in miles per hour as measured about three feet above ground. The test fires were in rather light grass-pine needle fuels. Wind speeds are shown as negative for backing fires. Since measurement of rate of spread was not the main purpose of the test fires in the study on which these data were taken, there are only a few measurements for headfires. The position of the curve is, therefore, somewhat uncertain in the headfire region and is for this reason shown by a broken line. Owing to the increase in oxygen supply, backing fires spread faster into a strong wind than into a light wind, but their rate of spread is much less sensitive to changes in wind speed than is that of headfires. For most prescribed backing fires it would be difficult to get a rate of spread much in excess of three feet per minute--especially in denser stands where the wind speed is low.

Headfires should result in lower mortality in areas where most of the reproduction consists of longleaf in the grass stage. The same should also be true for young longleaf up to 5 or 6 feet tall, which is more likely to be killed by heat-girdling near the base of the main stem than by injury to the well-protected buds.

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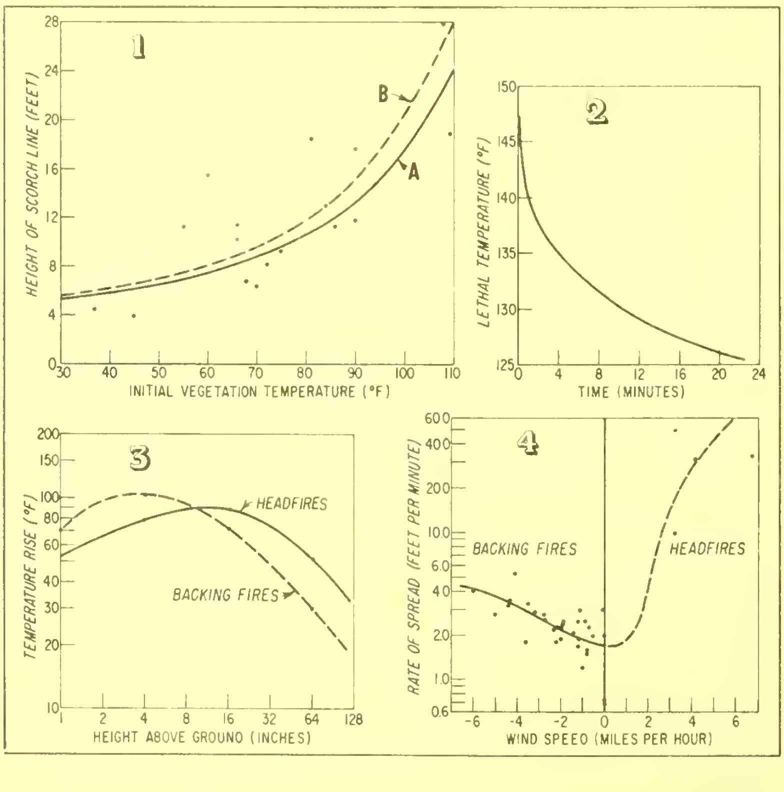

Figure 1.--Height of scorch line for low-intensity fires is shown as a function of the initial vegetation temperature. Curve A represents the theoretical or computed relationship between these two variables when the lethal temperature is taken to be 140^{o} F. and curve B the relationship if the lethal temperature is taken to be 135^{o} F.

Figure 2.--Lethal temperature is plotted as a function of time of exposure. This curve is the average for four different pine species (pitch, longleaf, slash, and loblolly) on which Nelson determined the time-lethal temperature relationship by the water bath method.

Figure 3.--The temperature rise at different heights over backing fires and headfires as measured by thermometers with insulated bulbs. Scales are logarithmic.

Figure 4.--Rate of spread for backing fires and headfires as a function of the wind speed measured about three feet above ground level. Rate of spread scale is logarithmic. Wind speeds for backing fires are shown as negative.

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 115 January 1958

DEFECT IN PIEDMONT HARDWOODS

The quality of Piedmont hardwoods has been steadily declining during past decades. The principal factors contributing to this trend have been fire, "high grade" selective logging, overgrazing, and a general lack of good management. In recent years, better fire control and changes in land utilization have brought a rapid increase in the number of young unmanaged stands, adding further to the total volume of poor quality hardwoods.

Detailed studies of cull in hardwoods have been made by pathologists, entomologists have described insect defects in timber, and utilization specialists have listed and evaluated types of defect that affect grade in hardwood logs and lumber. Little information, however, has been available regarding the types and prevalence of defect in the new and unmanaged stands in the Piedmont today. To gain such information, an extensive woods survey was started in 1955 as part of the hardwood research program of the Athens-Macon Research Center. This work was recently completed and is now being followed by a sawmill study designed to correlate internal defect with external evidence of defect.

During the woods survey, 1,000 trees including 40 different species were examined on 100 line plots randomly selected within the Piedmont of North and South Carolina and Georgia. All external signs of defect, such as insect holes, fire scars, cankers, and swollen knots, which might reduce the grade of lumber were recorded. Other data included measurement of tree diameter and vigor, and a description of each plot including topographical position. A preliminary review of results of this survey is presented in this paper.

The trees examined in the main species or species groups were: white oaks, 274; red oaks, 261; sweetgum, 127; hickories, 99; yellow-poplar, 82; blackgum, 53; red maple, 28; elms, 26; and others, 50. Defect data were not taken on trees less than 8 inches d.b.h. The percent in each diameter class was as follows: 8.0 to 9.9 inches, 29; 10.0 to 11.9 inches, 27; 12.0 to 15.9 inches, 31; and 16.0 inches up, 13.

Knottiness was found to be the commonest degrading character in all species examined. The mean number of knots and adventitious or epicormic shoots observed on the next-poorest face[1/] of 16-foot butt logs ranged from 26 in yellow-poplar to 40 in water oak. Most knots appeared to have originated from epicormic branches, the incidence of which was found to be correlated with aspect. A high proportion of such branch growth occurred on the warmer south and west faces.

1/ The face used in applying Forest Service standard hardwood log grades.

In the following tabulation summarizing incidence of other defect each percentage is based upon the total number of trees surveyed. Most of the trees examined exhibited several types of defect.

Defect	Trees affected (Percent)
Insect damage	35
Sweep and crook in butt log that reduce board-foot volume	22
Stem disease	
Cankers	7
Unidentified heart and butt rot after firescarring	5
Other unidentified heart and butt rot	4
Birdpeck	14
Firescar	12

Excluding knots, the most common defect is insect damage, mostly caused by various borers. The five species with highest percentage of insect attack are: red maple, 79; black oak, 76; willow oak, 71; scarlet oak, 67; and southern red oak, 55. The percent incidence of insect-damaged trees on various sites is as follows: ridge, 26; slope, 40; cove, 32; and lowland or bottom, 32.

If sweep and crook will cause a butt log to lose an estimated 15 percent or more of its volume, these defects are considered degrading. On this basis, 22 percent of the 16-foot butt logs examined showed degrading sweep and crook. A further breakdown of cull in butt logs due to this defect shows 31 percent of the logs with 15 to 29 percent cull, 19 percent with 30 to 49 percent cull, and 11 percent with 50 percent or more cull.

Stem disease was indicated by sporophores, cankers, heart and butt rot, or butt scar resulting from fire or other injuries. The chief identified agents of heart rot in the oaks are: Poria spiculosa in 7.7 percent of the red oaks; Polyporus hispidus in 3.4 percent of the red oaks, but only 0.4 percent of the white oaks; and Fomes everhartii in 1.0 percent of the oaks. Endothia parasitica is believed responsible for cankers observed in 14.3 percent of the post oaks. Poria spiculosa is the main cause of heart rot in the hickories and was recorded for 8.1 percent of all hickories examined.

Birdpeck was observed on 14 percent of all plot trees. Of this total, 13.5 percent were rated "light" in intensity and 0.5 percent "heavy." The species with the highest frequency of birdpeck were the hickories, with 44 percent, red maple, with 42 percent, and the elms, with 30 percent. In terms of resulting degrade, the damage to the hickories probably is most significant.

Twelve percent of all plot trees showed signs of fire injury. In Georgia, 17 percent of the trees had been noticeably injured by fire; in North Carolina, 9 percent; and in South Carolina, 7 percent. Fire intensity also appeared to have been higher in Georgia than in the other states surveyed. For those plots with a history of fire, in Georgia 27 percent of the trees had been injured, in North Carolina 19 percent, and in South Carolina 15 percent.

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Agriculture--Asheville

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 116 January 1958

A "MODIFIED DOYLE" RULE-OF-THUMB FOR ESTIMATING BOARD-FEET IN SMALL LOGS

The board-foot volume of 16-foot logs that are less than 18 inches in diameter can be estimated by using the formula $\left(D-\frac{2D}{10}\right)^2$, where D is the scaling diameter in inches. To perform this arithmetic mentally, merely divide the doubled diameter by ten and round the result to the nearest inch, subtract this value from the diameter, and square the remainder. The answer is an estimate of lumber outturn from 16-foot logs. The volume of an 8- or 12-foot log can be approximated by taking one-half or three-quarters of this amount.

The rule-of-thumb for 16-foot logs is a modification of the Doyle rule, $(D-4)^2$. The modification consists of substituting the correction factor $\frac{2D}{10}$, which increases directly with diameter, for the constant correction factor 4 used with all diameters in the Doyle rule.

Although one reason for the continued use of the Doyle rule has been its simplicity, it grossly underestimates the volume of small-diameter logs. For example, the Doyle estimate for a 6-inch log is only 20 percent of its true board-foot content, and for a 13-inch log is only 70 percent. This inaccuracy in estimating the volume of small-diameter logs reduces the usefulness of the Doyle rule in many areas of the Southeast. In one mill study in the Piedmont of South Carolina, for instance, 90 percent of the pine logs at 25 mills were between 6 and 13 inches in diameter.

Foresters and timber owners who must occasionally make quick, on-the-spot volume estimates will obtain much more accurate results than formerly for the general run of logs sawn if they use this simple rule-of-thumb. The "Modified Doyle" rule will be superior to the straight Doyle rule for all logs less than 18 inches in diameter (see graph on reverse side of this sheet).

Walter C. Anderson
Division of Forest Economics Research

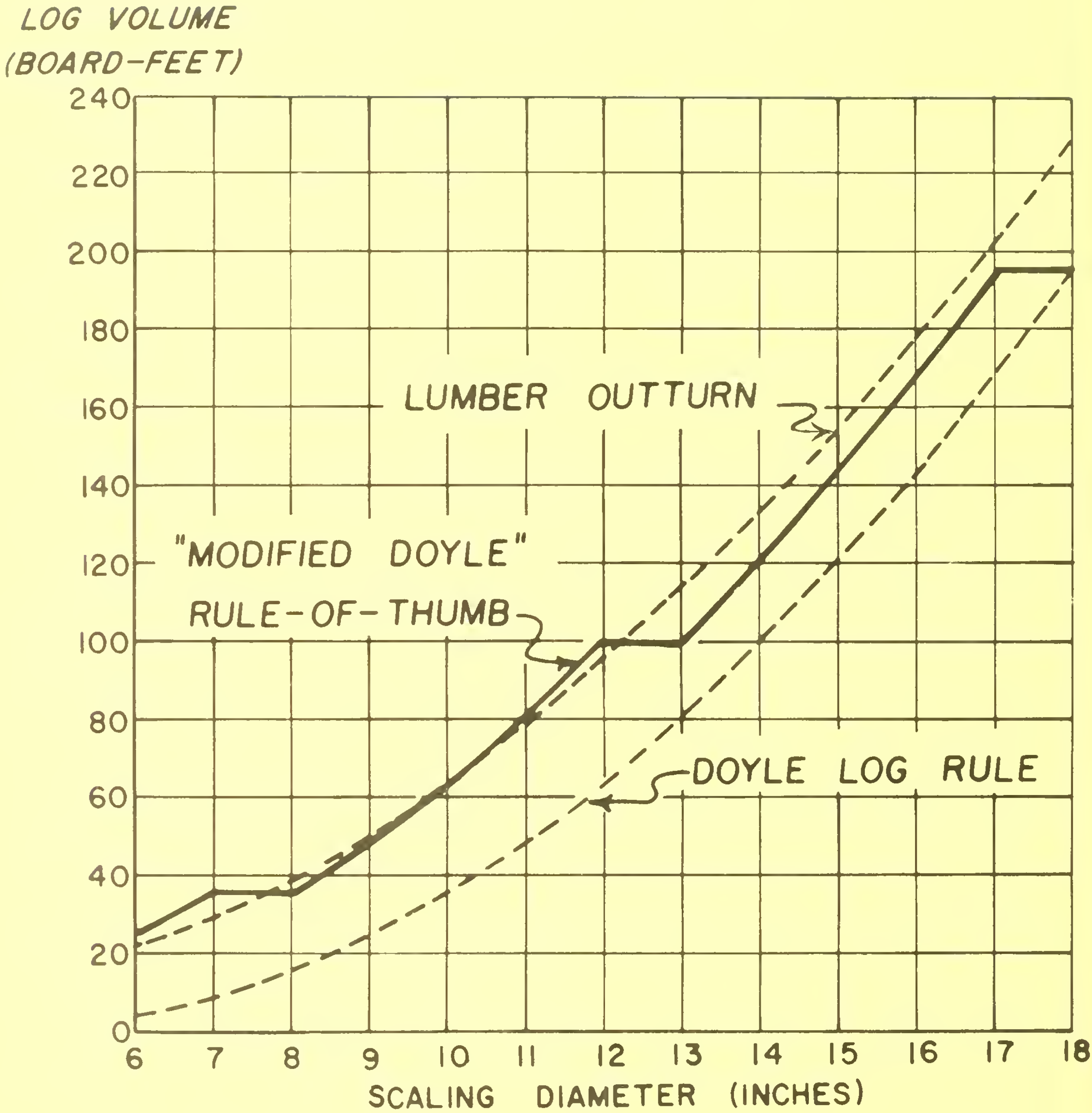

Figure 1.--A comparison of Doyle rule, Modified Doyle, and lumber outturn.

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 117

April 1958

RELATIVE FIRE DANGER DESCRIPTIONS
For Meter 8 and Meter 8-100

Forest fire danger meter type 8 is used exclusively throughout Forest Service Region 7, and meter type 8-100 is widely used throughout Forest Service Region 8. The two meters are exactly the same except for the scale of burning index. Burning index on meter 8 is exactly double that on meter 8-100 for any given condition.

The following fire danger descriptions are intended primarily to assist field men in interpreting the meter they are using. It is emphasized that the ranges of burning index listed for each fire danger condition are not rigid, but may be regrouped to describe the change in burning conditions of a particular fuel type for local district application.

BURNING INDEX		RELATIVE OCCURRENCE AND FIRE BEHAVIOR
METER 8	METER 8-100	
1 to 2	1	Low Fire Danger Cured grass may burn freely in the open a few hours after rain, but there is little danger of accidental fires in the forest. An occasional low-intensity woods fire may occur as the forest litter dries out. Such fires usually creep or smoulder, have irregular fingers, and consume only a portion of the surface litter. There is little danger of spotting, even with fairly high winds.
3 to 11	2 to 5	Moderate Fire Danger The average occurrence potential is approximately 3 times the low fire danger condition, assuming a similar risk. Fires in open cured grassland will burn briskly and spread rapidly with the wind. Woods fires start easily and spread slowly to moderately fast. The average fire in pine or hardwood litter is of moderate intensity, although heavy concentrations of draped fuel may burn hot. Short-distance spotting over the line may occur, but is usually not persistent.

BURNING INDEX		RELATIVE OCCURRENCE AND FIRE BEHAVIOR
METER 8	METER 8-100	
12 to 35	6 to 17	Medium (or Average) Fire Danger The average occurrence potential is approximately 3 times the moderate fire danger condition, assuming a similar risk. All fine forest fuels ignite readily, and as fire intensity builds up, twigs and small brush usually become part of the available fuel. The rate of spread on level terrain is rapid, and though fires proceed primarily as a flame front, short-distance spotting is common. Unattended brush and camp fires are likely to escape. Control of fires may be of more than average difficulty, especially in the upper burning index ranges of the medium fire danger condition, unless fires are hit hard and fast. Fires burning upslope, especially if the prevailing wind is with the slope, may spread furiously and may temporarily assume characteristics of the high fire danger condition.
40 to 95	20 to 45	High Fire Danger The average occurrence potential is approximately 3 times the medium fire danger condition, assuming a similar risk. Fires in the very dry fuels characteristic of the high fire danger condition will immediately after ignition spread rapidly, and increase quickly in intensity. There is usually considerable spotting over the line, and because of the dry fuels, spot fires are a constant danger. High-intensity fires may develop intense convection activity to a considerable height, evidenced by dark rolls and surges in the smoke column above the fire front. A favorable condition for this development is a decreasing wind aloft above a strong ground wind (described as an adverse wind profile). The worst features of high-intensity burning, such as long-distance spotting, fire whirlwinds, and strong updrafts and downdrafts, are associated with the well-developed smoke column. Fires burning in light fuels may quickly develop high-intensity characteristics when they burn into heavier fuels, or the triggering mechanism may be the result of an upslope run or two fires burning together without a change in fuel type.
100 to 200	50 to 100	Extreme Fire Danger The average occurrence potential is approximately 2 times the high fire danger condition, assuming a similar risk. Fires in all fuel types may burn intensely and spread furiously. Crowning and spot fires are common. Development into high-intensity burning will usually be faster and occur in the case of smaller fires than in the high fire danger condition. Fires may quickly develop a high-intensity head, or heads, each with its own active smoke column, when adverse wind profiles are present. Fires that develop headway in heavy slash or dense conifer stands may be unmanageable until the weather subsides or the fuel supply lessens.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 118 May 1958

CATTLE STOCKING AND HERBAGE YIELD ON BURNED FLATWOODS RANGES

Determining proper cattle stocking on newly-burned flatwoods range poses some problems, because little forage is produced the first few weeks following a burn. Thus, range that will support 100 cows 60 days after a burn may support only 20 after the first 3 weeks.

Herbage yield was measured periodically, March to November, at the Caloosa Experimental Range [1] after a February 1957 burn. The findings, illustrated in figure 1, should be of value to ranchers concerned with providing enough forage for cattle grazing on burns.

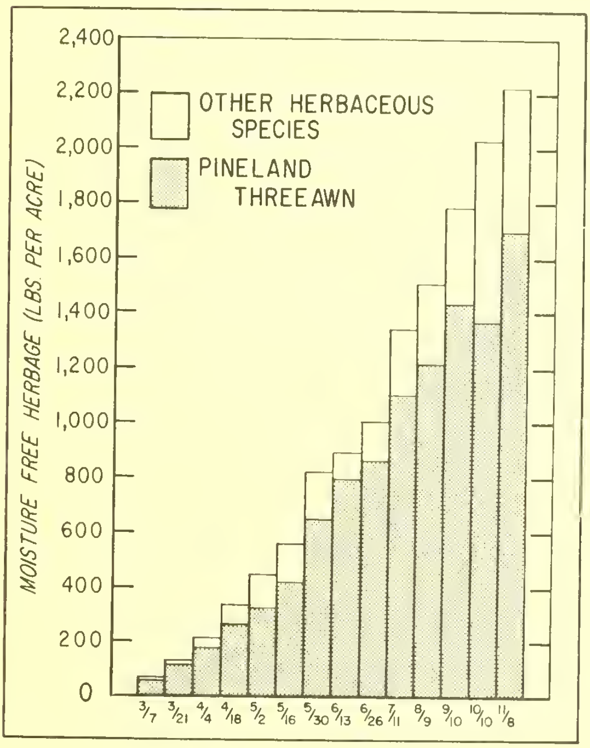

Figure 1.--Herbage yield by sampling date on range burned February 14, 1957.

The study area had a cover of native "wiregrass" vegetation with some saw-palmetto, and was located on Adamsville soil. Grass and other herbaceous plants were clipped from small plots at 14- to 30-day intervals, starting on March 7, 1957. Yield was computed on a moisture-free basis for each series of plots from burning to date of clipping. Cattle were not permitted on the area; hence the yields represent total growth without grazing.

Growing conditions were good in 1957, and spring rainfall was greater than normal. In years of cold, dry winters and springs, herbage yields probably would be less than those obtained in 1957.

Twenty-one days after burning, total herbage yield was 66 pounds per acre (fig. 1). This quantity of forage would carry 1 cow only 4 days if all 66 pounds were consumed. If half the herbage were left unutilized

1/ Maintained in Charlotte County, Florida, by the Forest Service in cooperation with the Babcock Florida Company, owner of the land, and the Florida Board of Forestry.

to benefit the range, the 33 pounds available for grazing would carry 1 cow only 2 days. On this basis, then, a herd of 100 cows would require about 45 acres of burn per day.

Yield on April 18, 63 days after burning, was 338 pounds per acre. With 50 percent utilization, this would carry 11 cows for approximately 1 day. One-hundred cows would need 9 acres of burn per day.

Maximum cumulative herbage yield of 2,225 pounds per acre was obtained in November, 9 months after burning. Although the yield is high, herbage of this age is very low in nutritive value.

Shrub yields are not included in the data for figure 1. They varied from less than 5 pounds moisture-free per acre on April 4 (49 days after burning), to approximately 350 pounds per acre on November 8. No measurable amounts of shrubs were produced prior to April 4.

Pineland threeawn (Aristida stricta), commonly called wiregrass, was the most abundant plant species throughout the year. It was the first to regrow. Twenty-one days after the burn, it made up 97 percent of the total herbage on a moisture-free weight basis. Later in the season, other grass, grasslike and weed plants comprised as much as one-third of the total herbage.

Among the grasses and grasslike plants were umbrellagrass (Fuirena scirpoidea), perennial goobergrass (Amphicarpum muhlenbergianum), commonly called blue maidencane, a silver broomsedge (Andropogon capillipes), fringed razorsedge (Scleria ciliata), and beakrushes (Rhynchospora spp.). Several weeds including yelloweyegrass (Xyris spp.), golden aster (Chrysopsis spp.), and goldenweed (Bigelovia nudata) appeared. Saw-palmetto (Serenoa repens) and seminoletea pawpaw (Asimina reticulata) were the most abundant shrubs.

The carrying capacities reported herein are based on the amount of herbage at sampling time without grazing, and hence do not include the herbage which would have been added by regrowth during a grazing period. Further measurements of total forage production under grazing use are needed to show proper stocking of cattle on burned areas.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 119 May 1958

MOUNTAIN FARM WOODLAND GRAZING DOESN'T PAY

Using mountain farm woodland in the Southern Appalachians for pasture will damage soil, destroy young tree seedlings, and lower growth rates of timber. Furthermore, cattle on woodland pasture gain weight slowly or may even lose weight.

At the Coweeta Hydrologic Laboratory near Franklin, N. C., an average of six head of cattle were grazed on a 145-acre woodland area from May to September for the 13 years from 1941 through 1953. The grazed area was a typical oak-hickory forest with a little cove hardwood along the streams and a pine-hardwood mixture on the upper slopes and ridgetops. An adjacent 7 acres of seeded pasture was also used, along with another 6 acres of pasture that were added in 1950. Thirty-four observation plots, each 2 chains square, were located at random over the woodland area, of which 17 were fenced and 17 left unfenced. The cattle were "yearling past" and were weighed individually at the beginning of the season, at periodic intervals during the season, and at the end. Different cattle were used each year.

The cattle were grazed solely in the woodland the first year. They quickly browsed all yellow-poplar in reach. Little browsing occurred on the upper slopes and ridgetops, where there was a cover of mountain laurel. The cattle gained weight during the earlier part of the season, but began to lose weight in August. This seasonal pattern was typical for the entire experiment. Although there was a net gain in weight, weight losses occurred near the end of the season. This was also true even in later years when cattle were fed a supplement and alternated between woods and pasture.

Beginning with the second season the cattle were alternately grazed in the woods and in the pasture. Vegetation in the woods did not regrow between periods of grazing, even with ample rainfall. By the end of the third growing season the coves and lower slopes were practically bare of ground vegetation and a browse line was evident.

From 1944 through 1953, the cattle were fed a daily supplement of grain and cottonseed meal (fig. 1). Net weight gains still were low and actual weight losses occurred in August, even in 1946 when the cattle were allowed to move at will between woods and pasture.

One object of supplemental feeding was to give the cattle energy for more extensive foraging over the woodland; instead they tended to stay around the feeding area. Beginning in 1949, however, they were fed a larger supplement and ranged more widely over the area, since forage was no longer available in the coves and on the lower slopes.

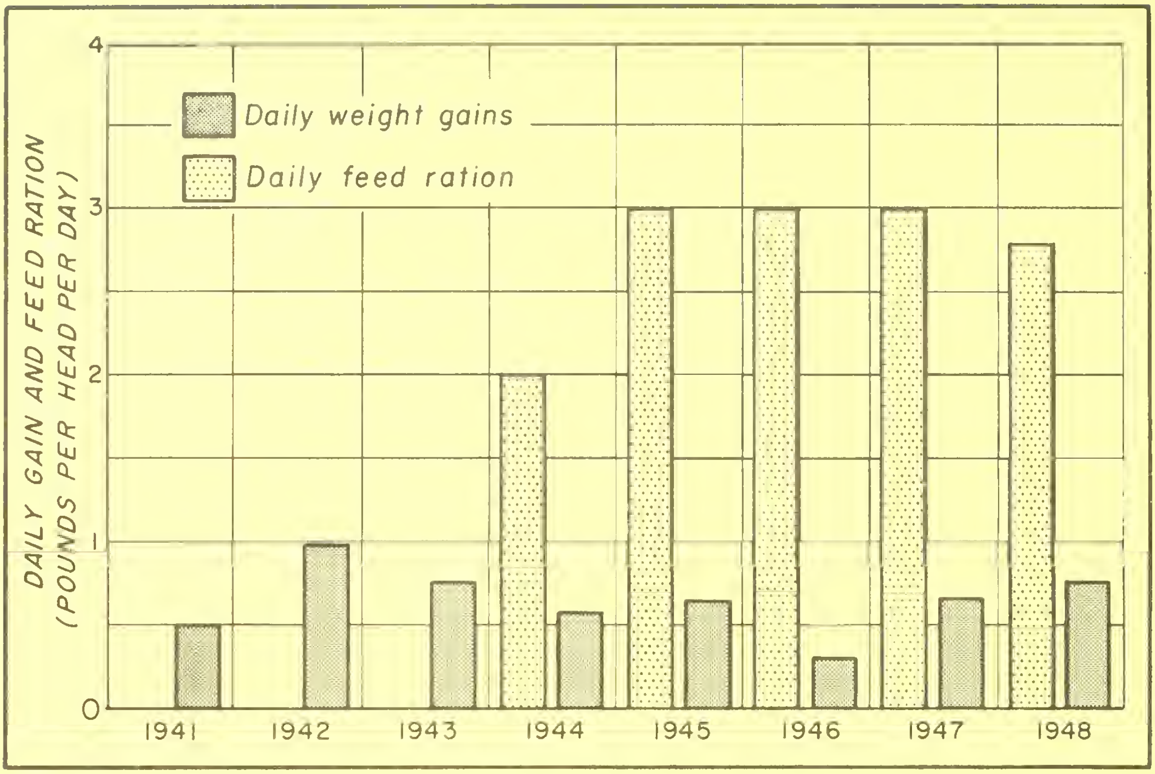

Figure 1.--Average weight gain and supplemental feed ration. The feed consisted of about 1 part cottonseed meal to 8 parts crushed corn (including cob). Data are not given for 1949 through 1953 because cattle were fed an average of 12.7 pounds of supplemental feed per head per day during that period, and weight gains are thus considered a reflection of feeding rather than of grazing. It should be noted that, although cattle can gain up to 2 pounds per head per day on good pasture, the gains shown above are in all cases less than 1 pound.

At the end of the ninth growing season, growth measurements on the vegetation plots showed that yellow-poplar in the 3- to 9-inch diameter class had 50 percent less radial growth on the unfenced plots than on the fenced plots; similarly, hickory had 30 percent less and red maple had 27 percent less. Soil compaction and erosion had developed to serious proportions by the ninth growing season.[1/]

This experiment clearly shows that the practice of using mountain farm woodlands for pasture is detrimental to woodland and of little real benefit to cattle.

1/ This study is given a more detailed treatment by E. A. Johnson in the February 1952 Journal of Forestry, and by R. E. Dils in "A Guide to the Coweeta Hydrologic Laboratory," issued by the Southeastern Station September 1957.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 120 May 1958

VOLUME TABLES FOR SOUTH FLORIDA SLASH PINE

(Pinus elliottii var. densa, Little and Dorman)

Because existing volume tables were found to be inaccurate for South Florida slash pine (Pinus elliottii var. densa, Little and Dorman), new tables were compiled for use in the Station's current growth and yield studies. Three of these volume tables--which should be useful to foresters in estimating volume for timber sales, management plans, damage appraisals, and other forest management work--are presented in this research note. A more complete set of mimeographed volume tables, including form-class tables, is available on request from the Lake City Research Center, P. O. Box 92, Lake City, Florida.

These tables were prepared by regression methods using the general formula, $V = a + bD^2H$. Table 1 is based on the measurements of 51 pulpwood-size trees, and tables 2 and 3 on 80 saw-log-size trees. The minimum top diameter limits were 3.5 inches inside bark for pulpwood and 7.5 inches inside bark for saw logs. The trees were selected purposely to cover the range of site conditions, form, and tree sizes found in south Florida.

Table 1.--Merchantable cubic-foot volume, outside bark, for South Florida slash pine, by diameter and total tree height [1]

D.b.h. (Inches)	Total height (feet)						
	30	40	50	60	70	80	90
	Cubic feet						
5	1.69	2.40	3.11	3.82	4.53	--	--
6	2.63	3.65	4.67	5.69	6.72	--	--
7	3.73	5.13	6.52	7.91	9.30	--	--
8	5.01	6.83	8.65	10.46	12.28	14.10	15.92
9	6.46	8.76	11.06	13.36	15.66	17.96	20.26
10	8.08	10.92	13.76	16.60	19.44	22.28	25.12

1/ Tabular values from equation: $V = 0.00284D^2H - 0.44$; standard error of mean = ± 0.11 cu. ft. or ± 1.19 percent; coefficient of determination = 98.37 percent.

Table 2.--Board-foot volume, by the ¼-inch International Rule, for South Florida slash pine, by diameter and total tree height 1/

D.b.h. (Inches)	Total height (feet)					
	40	50	60	70	80	90
			- - - - Board-feet - - - -			
10	12	30	47	64	81	98
12	42	67	92	116	141	166
14	78	112	145	179	212	246
16	119	163	207	250	294	338
18	166	221	276	332	387	443
20	218	286	354	423	491	560
22	275	358	441	523	606	689

1/ Tabular values from equation: $V = 0.0171\ D^2H - 56.0$; standard error of mean = ± 2.5 bd.-ft. or ± 1.29 percent; coefficient of determination = 97.63 percent.

Table 3.--Board-foot volume, by the ¼-inch International Rule, for South Florida slash pine, by diameter and merchantable log length 1/

D.b.h. (Inches)	Merchantable length (feet)			
	16	32	48	64
		- - - - - - Board-feet - - - - - - -		
10	23	61	98	136
12	40	94	148	202
14	59	133	207	280
16	82	178	274	371
18	107	229	351	473
20	136	286	437	587
22	168	350	532	714

1/ Tabular values from equation: $V = 0.0235\ D^2L - 14.4$; standard error of mean = ± 3.8 bd.-ft. or ± 1.97 percent; coefficient of determination = 94.51 percent.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

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TIMBER CULL IN VIRGINIA AND THE CAROLINAS

One of the most troublesome tasks of the timber estimator is deducting for sound or rotten cull in standing trees. With conversion to a particular product in mind, he must be able to compute the volume loss related to crook, wounds, bulges, or other evidences of cull. A summary of data collected in a series of cull studies in Virginia and the Piedmont and mountains of North Carolina and South Carolina provides a general view of the amount and relative importance of different types of cull. These studies included 300 randomly selected forest survey plots in which detailed measurements were made of 2,559 sound trees, 582 sound culls, and 122 rotten culls.

Sawtimber trees can be combined by species into a few broad groups that have similar types and amounts of cull. Two groups of hardwood had the heaviest board-foot cull, averaging about 11 percent of the gross volume. The group with the least cull, about 2 percent, was the "Other softwoods," made up mainly of white pine, hemlock, and redcedar (table 1). The predominant cause of cull was roughness, which included sweep, crook, forks, and large limbs. Rot was an important cause of volume loss in the hardwood groups, but was less serious than cull attributed to roughness.

Table 1.--Average board-foot cull by species and cause of volume loss in merchantable sawtimber trees

Species	Cull from roughness			Cull from other causes				Total cull
	Sweep and crook	Forks and large limbs	Total	Butt wounds	Hollow or rotten stubs, blind knots, healed stubs	Other miscellaneous	Total	
PERCENT OF GROSS VOLUME								
Virginia pine	6.3	0.2	6.5	0.2	--	0.3	0.5	7.0
Other yellow pines	3.0	.1	3.1	.1	--	.3	.4	3.5
Other softwoods	1.3	.1	1.4	.2	--	.5	.7	2.1
All softwoods	3.1	.1	3.2	.1	--	.4	.5	3.7
Yellow-poplar, sweetgum, hickory	3.2	.9	4.1	1.5	0.1	.8	2.4	6.5
Blackgum, soft maple, other soft hdwds.	5.5	1.7	7.2	2.3	.2	1.0	3.5	10.7
White oak, swamp chestnut oak, red oaks	2.7	.9	3.6	1.6	.1	2.0	3.7	7.3
Chestnut oak, post oak, other hard hdwds.	6.8	1.0	7.8	1.8	.1	1.0	2.9	10.7
All hardwoods	4.1	1.1	5.2	1.7	.1	1.3	3.1	8.3
All species	3.7	.6	4.3	1.0	.1	.8	1.9	6.2
PERCENT OF CULL VOLUME								
Virginia pine	90	3	93	2	--	5	7	100
Other yellow pines	86	3	89	2	--	9	11	100
Other softwoods	62	2	64	11	--	25	36	100
All softwoods	84	3	87	3	--	10	13	100
Yellow-poplar, sweetgum, hickory	49	14	63	23	1	13	37	100
Blackgum, soft maple, other soft hdwds.	52	16	68	21	2	9	32	100
White oak, swamp chestnut oak, red oaks	37	13	50	21	2	27	50	100
Chestnut oak, post oak, other hard hdwds.	63	10	73	17	1	9	27	100
All hardwoods	50	13	63	20	2	15	37	100
All species	59	10	69	16	1	14	31	100

Sweep, crook, forks, and large limbs accounted for 87 percent of the board-foot cull in softwoods and 63 percent in hardwoods (table 1). Volume loss resulting from butt wounds amounted to 20 percent of the cull in hardwood sawtimber and 3 percent of softwood cull. Ten percent of the cull in softwoods and 15 percent in hardwoods was attributed to miscellaneous other causes including imbedded fence wire, lightning wounds, and broken tops.

The analysis of timber cull by cause points out the fact that a large proportion of the cull is easily recognized and not difficult to measure. Volume loss from sweep or crook is readily computed, as are short sections lost because of forks, large limbs, imbedded fence wire, and other causes. Cull resulting from rot usually can be localized to all or a certain fraction of a short section so that volume loss can be computed with fair accuracy. In average timber, well over 90 percent of the board-foot cull is of types that can be easily seen and evaluated. Where careful deductions are made for such cull, there should remain only a fraction of one percent of the gross volume that might require the experienced estimator's interpretation of bark abnormalities, bumps, rotten limbs, etc. for detection.

Cubic-foot deductions based on fuelwood as the minimum standard of utilization (table 2) were made for volumes of rotten or missing wood and for excessively rough portions of trees. The quality and stand-size classes were those used by Forest Survey. Cubic-foot cull percents for sound sawtimber trees are small compared with the figures for board-feet. Softwood cubic-foot cull amounts to only one-tenth of one percent, while board-foot cull is 3.7 percent of the gross volume. Hardwood cull percents were 1.7 for cubic-foot volume and 8.3 percent for board-foot volume.

Hollow trees for which exact causes of cull could not be determined and trees with broken tops accounted for the high cubic-foot cull percents recorded under miscellaneous causes for rotten culls.

Table 2.--Average cubic-foot cull by quality class, species group, tree size, and cause of volume loss

Species group and quality class	Cause of cull								Total cull	
	Forks and large limbs		Butt wounds		Hollow or rotten stubs, blind knots, healed stubs		Other miscellaneous			
	Pole size	Sawtimber size	Pole size	Sawtimber size	Pole size	Sawtimber size	Pole size	Sawtimber size	Pole size	Sawtimber size
	- - - - - Percent of gross volume - - - - -									
Sound trees:										
Softwoods	--	--	0.1	--	--	--	--	0.1	0.1	0.1
Hardwoods	0.7	0.6	.1	0.5	--	0.1	--	.5	.8	1.7
Sound culls:										
Softwoods	--	--	.6	.6	--	--	--	1.2	.6	1.8
Hardwoods	.4	.9	1.9	5.2	0.1	1.2	0.2	4.9	2.6	12.2
Rotten culls:										
Softwoods	--	--	3.9	--	--	--	--	58.3	3.9	58.3
Hardwoods	.1	.8	8.1	20.0	.1	7.1	11.3	37.4	19.6	65.3

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
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EFFECTS OF FUNGICIDES ON POLLEN GERMINATION OF SLASH AND LONGLEAF PINE

Southern cone rust, Cronartium strobilinum, appears to have been on the increase through much of the pine flatwoods of the lower Coastal Plain for the past few years. This may be the result of an increase in slash pine (Pinus elliottii), the favored cone host, and oaks (Quercus spp.), the alternate hosts, incident to better protection from fire. The rust has been causing major losses to the cone crops of slash pine, and to a lesser extent of longleaf (Pinus palustris), and is of particular concern in seed production areas and seed orchards.

Control through the use of fungicides involves the possibility of chemical toxicity to pollen grains, since the time of infection coincides with the pollinating period. An experiment to measure effects on pollen germinability caused by fungicide application has just been completed.

Four fungicides, each at a high and a low concentration (table 1), were tested on fresh slash and longleaf pine pollen.

Table 1.--Descriptions of fungicides and their concentrations used in pollen toxicity study

Fungicide	General chemical make-up	Dosage: High	Dosage: Low
Ferbam	An iron carbamate	2 lbs. per 100 gallons water	0.2 lb. per 100 gallons water
Captan 50-W	Complex organic	2 lbs. per 100 gallons water	0.2 lb. per 100 gallons water
Basi-cop	Tribasic copper sulfate	2 lbs. per 100 gallons water	0.2 lb. per 100 gallons water
Puratized Agricultural Spray (P.A.S.)	An organic mercury	2 pints per 100 gallons water	0.2 pint per 100 gallons water

Each pollen sample was placed in a shell vial and 5 cc. of the fungicide preparation was added. Vials were stored in an incubation chamber at 26° C. for about 80 hours. Five replications were made of each of four pollen sources, for each species and treatment, including the check.

After the incubation period a drop of the pollen suspension from each vial was placed on a slide and examined microscopically. One hundred pollen grains were counted and germination recorded. Thus a total of 500 grains were examined for each species, treatment, and pollen source. Results, expressed in germination percent, are shown in table 2.

Puratized Agricultural Spray (P. A. S) was 100-percent lethal in all tests. Captan 50-W and Basi-cop inhibited germination markedly, especially at the higher concentration.

Ferbam not only had no toxic effects on pollen, but actually increased germination. For untreated (check) samples of slash pine pollen average germination was 40 percent as compared with 56 percent for Ferbam treatment. Corresponding figures for longleaf pine were 66 and 80 percent. These differences were highly significant, statistically.

Concentration of Ferbam of itself did not affect results, but differential response between slash and longleaf--shown in table 2--did attain significance. Thus, the higher concentration was more effective in increasing germination of longleaf pollen, while slash pollen showed greater response with the weaker dosage.

Table 2.--Effects of fungicides on the germination of slash and longleaf pine pollen

Fungicide and concentration [1]	Slash pine pollen source					Longleaf pine pollen source				
	1	2	3	4	Avg.	1	2	3	4	Avg.
	--- Percent of pollen grains germinated ---									
Ferbam										
High	40	64	45	48	49	85	89	91	71	84
Low	71	50	53	72	62	76	78	76	73	76
Captan 50-W										
High	3	15	8	9	9	14	35	24	17	22
Low	10	16	19	19	16	41	41	42	43	42
Basi-cop										
High	0	0	0	0	0	18	4	4	5	8
Low	18	3	11	12	11	29	32	29	31	30
P. A. S.										
High	0	0	0	0	0	0	0	0	0	0
Low	0	0	0	0	0	0	0	0	0	0
Check										
A	34	28	46	43	38	79	64	70	65	69
B	54	26	36	51	42	62	61	65	70	64

1/ See table 1 for dilutions.

There was also a highly significant species difference in pollen germination. Longleaf was superior to slash for all treatments, concentrations of fungicides, and for all of the four sampling units.

The favorable effect of Ferbam may be due to the presence of iron. Echols and Mergen[1] reported 96 percent germination of slash pine pollen when an organic iron complex was used as a medium. This was the highest percentage attained with the 38 media tested, including the standard 10-percent sucrose solution.

It may be concluded from this test that Puratized Agricultural Spray, Captan 50-W, and Basi-cop should not be used for control of cone rust regardless of their fungicidal effectiveness. Ferbam, on the other hand, cannot only be used with safety, but germination of pollen may be increased with its use as a conelet spray. Whether Ferbam is an effective fungicide for *Cronartium strobilinum*, however, remains to be determined, and this is now being tested at both the Lake City Center and at Gulfport, Mississippi.

1/ Echols, R. M., and Mergen, Francois. Germination of slash pine pollen *in vitro*. Forest Science 2: 321-327. 1956.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
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EARLY TRENDS IN A SLASH PINE SEED SOURCE STUDY IN SOUTH FLORIDA

Third-year observations of five seed sources of slash pine (*Pinus elliottii* var. *elliottii* Engelm.) planted outside its natural range in south Florida [1] show significant differences in survival, height growth, and insect attack. Early indications are that seedlings from seed sources in the central part of the natural slash pine range (Taylor and Baker Counties, Florida, and McIntosh County, Georgia) have grown better in south Florida than those from the northern (Dooly County, Georgia) or the southern (Volusia County, Florida) fringes of the range. These early findings, by no means conclusive, are based on 100-tree plots of seedlings with four replications.

Survival.--Seedlings from the Taylor, Baker, and McIntosh County seed sources had the best survival after 3 years in the field. The Dooly County source was intermediate, and Volusia the poorest, as shown in the following tabulation:

Seed source	Survival [1] (Percent)
Taylor Co., Fla.	83.0
Baker Co., Fla.	79.5
McIntosh Co., Ga.	76.0
Dooly Co., Ga.	65.0
Volusia Co., Fla.	47.0

(Brackets: Taylor, Baker, McIntosh; McIntosh, Dooly.)

1/ Any two averages not included in the same bracket are significantly different at 5-percent level.

The poor survival of the Volusia source showed up 1 month after planting, when its survival of 89 percent was significantly different from the survival of the other seed sources. By the end of the first year the trends indicated above had been established.

Total height.--The Taylor County seed source led in all-around height growth, with best average height of 2.98 feet, greatest percentage (about 47 percent) of trees taller than 3 feet, and tallest tree 6.7 feet. The Dooly County source showed the poorest growth. The tallest tree in this source was 4.1 feet; the percentage of trees taller than 3 feet was only 7 percent; and the average height of all trees was 1.94 feet. The other three sources were intermediate in height growth. A summary of average heights and percent of trees taller than 3 feet follows:

1/ This planting is one of six established in Georgia and Florida and was made in Collier County in cooperation with The Atlantic Land and Improvement Company, LaBelle, Florida, and the Florida Board of Forestry.

Seed source	Average height [1/] (Feet)	Trees 3 feet high or taller [1/] (Percent)
Taylor Co., Fla.	2.98	46.5
Volusia Co., Fla.	2.60	33.4
McIntosh Co., Ga.	2.60	31.7
Baker Co., Fla.	2.48	26.9
Dooly Co., Ga.	1.94	6.5

1/ Any two averages not included in the same bracket are significantly different at 5-percent level.

Insects.--Larvae of three insects, tip moth (Rhyacionia spp.), sawfly (Neodiprion spp.), and pine webworm (Tetralopha robustella), were observed attacking the seedlings. There was an appreciable buildup of tip moth and sawfly infestation the second and third year after planting. During the first year, only the pine webworm was observed (average infestation 11 percent), but this decreased the second and third year (third year average infestation 2 percent). The following tabulation shows, by seed source, the percent of living trees attacked by the three insects during the third year:

Seed source	Tip moth (Percent)	Sawfly (Percent)	Webworm (Percent)
Taylor Co., Fla.	23.0	12.3	2.9
Volusia Co., Fla.	16.6	7.8	1.1
McIntosh Co., Ga.	16.4	1.9	1.5
Baker Co., Fla.	14.1	8.9	1.8
Dooly Co., Ga.	4.8	2.2	2.6

The seedlings were only slightly damaged by the sawfly and webworm attacks. Most of them have outgrown previous webworm attacks, and the sawfly defoliations have been very minor, with only an occasional tree being appreciably defoliated.

The effects of the tip moths were more severe, particularly where the attacks had centered on the terminal bud. Although in such cases a lateral bud usually assumed terminal leader growth, a certain amount of deformity resulted. What the long-term effect will be in terms of final growth-form is not known, but it may be a very important consideration in the evaluation of a seed source. These leader attacks also seem to center on the more vigorous or faster-growing trees. A comparison of the tabulations of total height and tip moth attack partly bears out this observation. The greatest percentage of attacks occurred on the seed source with the tallest seedlings.

Early results from this study show that some of the differences attributable to racial variation in forest trees are survival, height growth, and resistance to pests. Additional observations will be necessary before the type and range of racial variation in slash pine and their practical significance can be determined.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
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EFFECTIVENESS OF THREE CONCENTRATIONS OF ALDRIN ON PALES WEEVIL CONTROL METHODS

Efforts to find a method of protecting seedlings under different planting conditions from pales weevil mortality began in 1954.[1/] By 1957 it was determined that dipping the tops of seedlings in insecticide prior to planting, spraying the seedlings and surface of the soil surrounding them, or dipping the tops of seedlings prior to planting plus granular insecticide on the soil around the base of seedlings following planting prevented serious weevil damage.[2/] In 1958 the study reported here was made to determine if lower concentrations than those previously used would be equally effective in preventing seedling mortality.

Three plots were established at Bent Creek, North Carolina, in the spring of 1958 on bark-beetle-killed or cutover pine areas. On each plot untreated seedlings and three concentrations of aldrin dip, spray, and dip plus granular treatments were replicated four times in randomized rows each containing 25 white pine seedlings (table 1).

The protection afforded by all of the treatments was very good when compared with the mortality of the untreated trees; none of the treatments caused abnormal seedling mortality.

From the economical standpoint, the increased protection provided by the higher concentrations of spray and granular material may be offset by the increased cost of the insecticide. Therefore, under general conditions, only the lower concentrations of material may be justified when these methods of protection are used.

In the dip treatment the small increased cost of the 2-percent material is more than offset by the higher survival of the seedlings. Therefore, this concentration is recommended for the dip treatment.

To show an example of the comparative cost of insecticides to value of killed seedlings, table 2 has been constructed for various control methods.

All insecticides are poisonous when handled improperly. When handling insecticide, treating, and planting trees, personnel should wear gloves with a rubberized or plastic coating.

1/ Speers, Charles F. Pales weevil control with insecticides: first year results. U. S. Forest Serv. Southeast. Forest Expt. Sta. Res. Note 96, 2 pp. 1956.

2/ Speers, Charles F. Pales weevil rapidly becoming a serious pest of pine reproduction in the South. Jour. Forestry 56: 723-726. 1958.

Table 1.--Effects of three aldrin concentrations applied by three treatments on pales weevil control. Bent Creek, 1958

Treatment [1]	Total treated	Killed by pales weevil feeding	Control due to treatment	Control range
	- - Number of seedlings - -		- - Percent - -	
DIP				
Top of seedling immersed in insecticide down to the small rootlets prior to planting.				
½ percent	300	32	89	85-96
1 percent	300	28	91	83-98
2 percent	300	18	94	90-100
SPRAY				
Applied 2 ounces to seedling and soil surface around base of tree following planting.				
½ percent	300	11	96	92-100
1 percent	300	6	98	97-99
2 percent	300	4	99	98-99
DIP PLUS GRANULAR				
Top dipped in 2 percent emulsion prior to planting plus 2 percent 30-60 mesh granular material on soil around base of seedling following planting.				
1 teaspoon	300	11	96	93-100
2 teaspoons	300	3	99	98-100
3 teaspoons	300	1	100	99-100
CHECK (no treatment)	300	93	69	58-89

1/ Aldrin emulsion was used in this test. However, earlier studies showed heptachlor to be equally effective.

Table 2.--Comparison of concentrations, survival, and cost of three treatments in pales weevil control

Treatment	Approximate cost of insecticide per acre	Survival of seedlings	Seedlings killed per acre	Value of killed seedlings
	Dollars	Percent	Number [1]	Dollars [1]
DIP				
½ percent	0.07	89	83	1.66
1 percent	.14	91	68	1.36
2 percent	.28	94	45	.90
SPRAY				
½ percent	.77	96	30	.60
1 percent	1.54	98	15	.30
2 percent	3.08	99	8	.16
DIP PLUS GRANULAR				
1 teaspoon	.83	96	30	.60
2 teaspoons	1.38	99	8	.16
3 teaspoons	1.93	100	0	.00
CHECK (no treatment)		69	233	4.66

1/ Figures based on the assumption that 750 seedlings are planted per acre at a stock and planting cost of 2 cents each.

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RESEARCH NOTES

SOUTHEASTERN FOREST EXPERIMENT STATION

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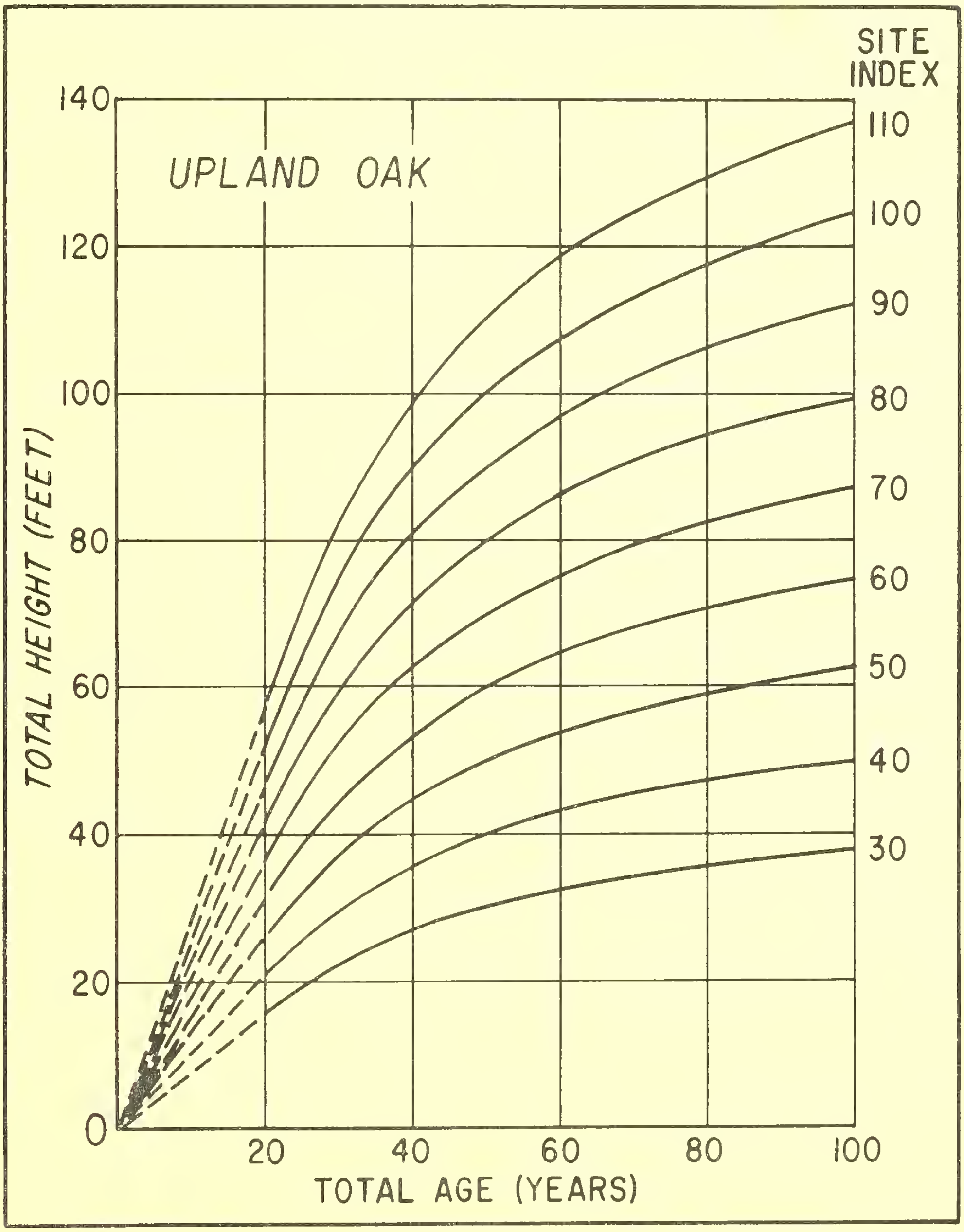
SITE INDEX CURVES FOR UPLAND OAK IN THE SOUTHEAST

These site index curves are based on 697 observations of height on age for white, northern red, southern red, scarlet, black, and chestnut oak in the Virginia-Carolina Piedmont and the Southern Appalachian Mountains. The curves were constructed using equations of the form, $\text{Log Height} = a + b \left(\frac{1}{\text{Age}}\right)$.



Levels of Site Index Among the Oaks

The species data were analyzed separately, but were pooled because the slope coefficients (rates of height growth) showed no statistically significant differences. There were real differences in the a-intercept, however, reflecting different levels of mean site indices by species and regions. The individual equations and mean site indices are presented in table 1.

Table 1.--Site index relationships for upland oak

Oak species or group	Region	Plots	Mean site index	Site index equations 1/	
				a-intercept	Slope coefficient (b)
		Number	Feet		
Chestnut	Mountains	105	58	1.953	2/ -9.5639
White	Mountains	54	60	1.968	
Scarlet	Mountains	167	65	2.001	
Black	Mountains	60	68	2.022	
Northern red	Mountains	42	72	2.049	
White-southern red	Piedmont	133	69	2.028	
Black	Piedmont	59	72	2.052	
Scarlet-northern red	Piedmont	77	78	2.082	

1/ Logarithm total height = a + b (reciprocal of total age).
2/ Constant for all equations.

The mean site indices in the Piedmont are somewhat higher than the mean site indices for the same species in the mountains. Within regions, the species levels in table 1 are significantly different. The practicing forester will have to assess his reasons for taking oak site index data in order to plan field work. If mean oak yield tables are to be used, an average of height and age for all oak species on a plot will suffice. If there is interest in the potential of a particular oak species, the data should be stratified by species. In either case, the upland oak site index curves can be used.

The sites encountered in this study made it possible to extend the site curves beyond the upper limit of 85 feet presented by Schnur.[1/] A number of the plots had site indices over 85 feet and some had site indices over 100 feet.

1/ Schnur, G. Luther. Yield, stand, and volume tables for even-aged upland oak forests. U. S. Dept. Agr. Tech. Bul. 560. 1937.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
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INTERNATIONAL $\frac{1}{4}$-INCH BOARD FOOT VOLUME TABLES FOR OLD-FIELD SLASH PINE PLANTATIONS IN THE MIDDLE COASTAL PLAIN OF GEORGIA

On the reverse page are presented International $\frac{1}{4}$-inch board foot volume tables for use in old-field slash pine plantations in the middle coastal plain of Georgia. The increasing number of plantations in this region reaching sawtimber size emphasizes the need for such tables.

Volume data from 149 sample trees to minimum top diameters of 6 and 7 inches (inside bark) were analyzed by regression techniques. The product of diameter at breast height squared and total height accounted for about 93 percent of the variation, and use of the one variable gives a valid estimate of tree volume. The estimating equations for the two minimum top diameters are:

Board foot volume (6-inch top d.i.b.) = $0.012546D^2H - 27.85$
Board foot volume (7-inch top d.i.b.) = $0.013520D^2H - 39.38$

where d.i.b. represents diameter inside bark, D^2 represents diameter at breast height squared, and H represents total height of the tree. The values in tables 1 and 2 were calculated from these equations. To apply these tables, a representative sample of heights is necessary to provide a reliable curve of height over diameter.

It is known, of course, that form class affects tree volume, and when this variable is accurately measured, the accuracy of the estimate is increased. However, this factor is difficult to measure and when applied in the field is invariably estimated. Consequently, for plantations that approximate the average, little is gained by attempting to estimate form class. However, for plantations that deviate from the average in form, or for those instances where a reliable measure of form is obtained, the following equations may be used to calculate board foot volumes:

Board foot volume (6-inch top d.i.b.) = $0.012876D^2H + 1.342631FC - 0.801619H - 83.31$
Board foot volume (7-inch top d.i.b.) = $0.014167D^2H + 1.612712FC - 1.054960H - 102.55$

where D^2H and H are as above and FC represents Girard form class.[1]

For those who prefer tables based on merchantable height rather than total height, tables 3 and 4 meet this need. The prediction equations from which these tables were derived are:

Board foot volume (6-inch top d.i.b.) = $0.015248D^2MH - 0.073$
Board foot volume (7-inch top d.i.b.) = $0.017274D^2MH + 0.184$

where D^2 again represents diameter at breast height squared and MH represents merchantable height. The one variable accounts for about 97 percent of the variation. The volumes in tables 3 and 4 were calculated from these equations. Of course, the board foot volume for a given merchantable height and diameter class is higher for a 7-inch top d.i.b. than for a 6-inch top d.i.b. Any given cell in the 7-inch top d.i.b. section of the table is represented by trees of a higher merchantable height in the 6-inch d.i.b. section.

1/ The ratio of diameter inside bark at the top of the first 16-foot log to diameter outside bark at breast height.

As with the total height tables, if a particular plantation is thought to deviate from the regional average with respect to form class, the following equations are provided:

Board foot volume (6-inch top d.i.b.) = $0.014266D^2MH + 0.699065FC - 47.42$
Board foot volume (7-inch top d.i.b.) = $0.016097D^2MH + 0.709498FC - 48.01$

Table 1.--Board foot volumes (International $\frac{1}{4}$-inch) based on d.b.h. and total height to minimum top diameter inside bark of 6 inches

DBH	Total tree height								
	35	40	45	50	55	60	65	70	75
	Board feet								
9	8	13	18	23	28	33	38	43	--
10	16	22	29	35	41	47	54	60	--
11	--	33	40	48	56	63	71	78	86
12	--	44	53	62	72	81	90	99	108

Table 2.--Board foot volumes (International $\frac{1}{4}$-inch) based on d.b.h. and total height to minimum top diameter inside bark of 7 inches

DBH	Total tree height								
	35	40	45	50	55	60	65	70	75
	Board feet								
9	--	4	10	15	21	26	32	--	--
10	8	15	21	28	35	42	49	55	--
11	18	26	34	42	51	59	67	75	83
12	--	38	48	58	68	77	87	97	107

Table 3.--Board foot volumes (International $\frac{1}{4}$-inch) based on d.b.h. and merchantable height to minimum top diameter inside bark of 6 inches

DBH	Merchantable height							
	8	16	24	32	40	48	56	64
	Board feet							
9	10	20	30	39	49	--	--	--
10	12	24	37	49	61	73	--	--
11	15	29	44	59	74	88	103	--
12	--	35	53	70	88	105	123	140
13	--	41	62	82	103	124	144	165

Table 4.--Board foot volumes (International $\frac{1}{4}$-inch) based on d.b.h. and merchantable height to minimum top diameter inside bark of 7 inches

DBH	Merchantable height						
	8	16	24	32	40	48	56
	Board feet						
9	11	23	34	45	56	--	--
10	14	28	42	55	69	83	--
11	17	34	50	67	84	101	--
12	--	40	60	80	100	120	139
13	--	47	70	94	117	140	164

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 127 April 1959

SITE INDEX CURVES FOR OLD-FIELD SLASH PINE PLANTATIONS

Index curves of height over age are used to classify the productive capacity of forest lands. This classification permits the owner or timberland manager to make adjustments in stocking levels, cutting cycles, and rotation lengths in relation to the indicated productive potential of his lands. Site index curves suitable for use in old-field slash pine plantations of the middle coastal plain of Georgia and the Carolina Sandhills appear on the reverse of this paper.

These curves are based on an index age of 25, and were derived through regression analysis of dominant and codominant height and age data collected on 310 sample plots well distributed throughout the above-named territory. The final regression equation reads as follows:

$$\text{Logarithm of site} = \text{Logarithm of height} - 5.40638 \left(\frac{1}{25} - \frac{1}{\text{age}}\right)^{*}$$

To establish the site index of any old-field slash pine planting between the ages of 10 and 25 years, it is only necessary to determine the age and the average height of the dominant and codominant trees and apply this information to the curves on the reverse page.

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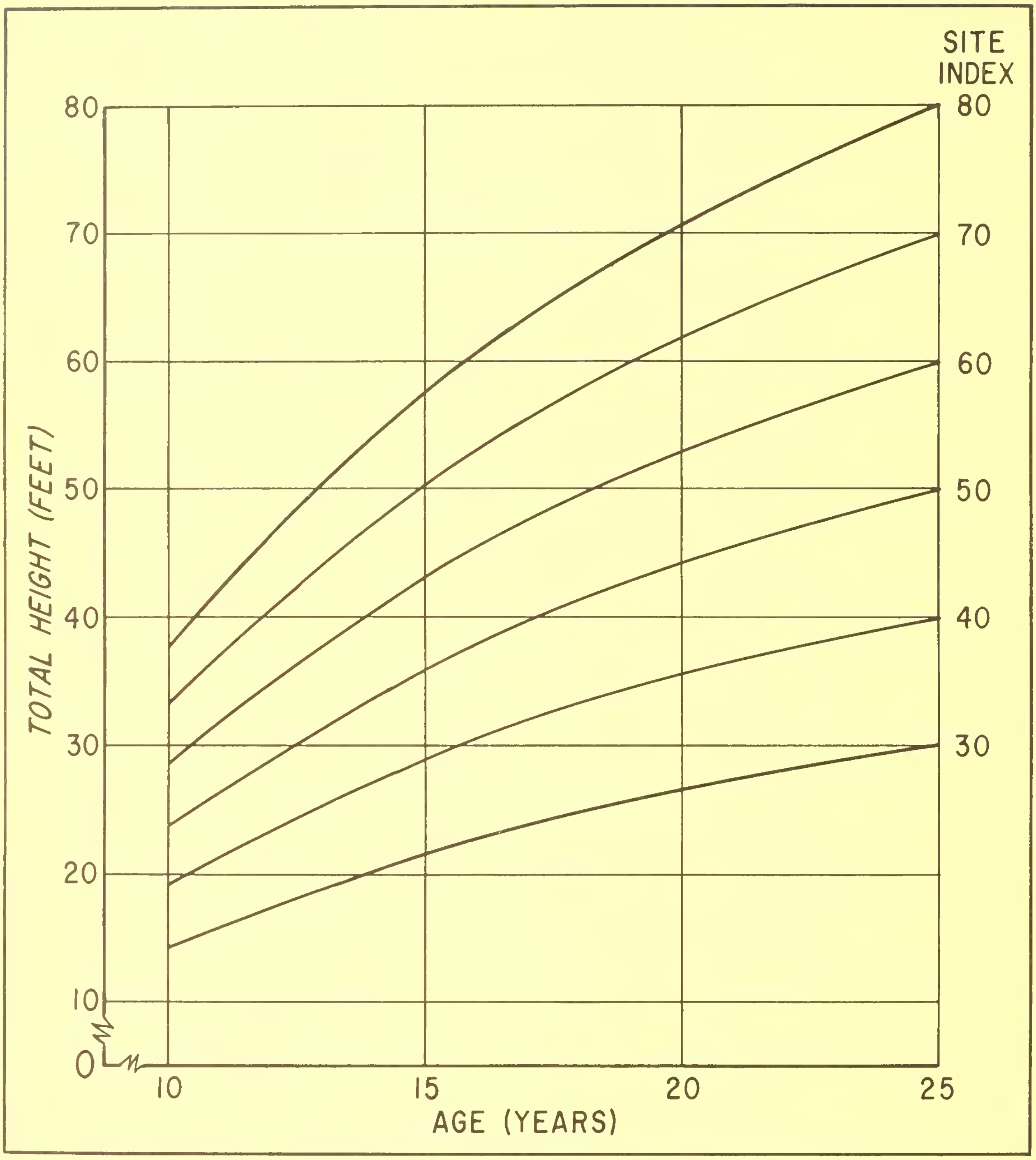
* Plantation age, not age from seed.



Site curves at an index age of 25 years for old-field slash pine plantations of the middle coastal plain of Georgia and the Carolina Sandhills.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
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WEIGHT OF MERCHANTABLE WOOD WITH BARK FROM PLANTED SLASH PINE IN THE CAROLINA SANDHILLS

Eventually most pulpwood transactions may involve measurements based on wood weight rather than the units of cubic volume now in general use. Consequently, timber growers and buyers will need to translate the diameters and heights of standing trees directly into pounds of wood. There is little information available for southern pine to facilitate this translation. A recently completed study, sampling a wide range of plantations, has made it possible to construct a table of merchantable wood weight for slash pine planted on old fields in the Sandhills of North and South Carolina.[1/]

Two hundred fifty randomly selected trees (2 per plantation) provided the basis for the following table. The trees ranged from 5 to 12 inches d.b.h. and 9 to 25 years of age. The sampling involved only sound trees of good form, and they were cut and immediately weighed during the period June to September 1957. Each tree had to have at least one 5-foot bolt beginning at a stump height of 0.5 foot to a top diameter outside bark of 2.0, 3.0, or 4.0 inches. The regression equations used to calculate this table will be supplied upon request.

1/ In cooperation with the South Carolina State Commission of Forestry, the Savannah River Project of the Atomic Energy Commission, the North Carolina State Department of Conservation and Development, Westvaco Experimental Forest of the West Virginia Pulp and Paper Company, and Duke University School of Forestry.

Merchantable weight, including bark, for slash pine planted on old fields in the Carolina Sandhills
(In pounds)

TOP DIAMETER 4.0 INCHES OUTSIDE BARK

D.b.h. (Inches)	Total tree height in feet-- 20	25	30	35	40	45	50	55	60	65	70	75
5	--	32	45	64	82	100	119	137	155			
6	42	67	94	120	146	173	199	226	252	279		
7		115	151	187	223	259	295	331	367	403	439	
8			217	264	311	358	405	452	499	546	593	640
9				351	411	470	530	589	649	708	768	827
10					522	596	669	743	816	890	963	1037
11					646	734	824	913	1001	1090	1179	1268
12					781	887	992	1098	1204	1310	1416	1521

TOP DIAMETER 3.0 INCHES OUTSIDE BARK

D.b.h. (Inches)	20	25	30	35	40	45	50	55	60	65	70	75
5	49	67	84	102	120	138	156	174	192			
6	81	106	131	158	183	209	235	261	287	313		
7		153	188	223	258	293	328	364	399	434	469	
8			252	298	344	390	436	482	528	574	620	666
9				384	443	502	560	619	678	737	795	854
10					552	624	696	767	839	911	983	1054
11					672	758	845	932	1019	1106	1193	1279
12					804	907	1012	1116	1220	1324	1429	1533

TOP DIAMETER 2.0 INCHES OUTSIDE BARK

D.b.h. (Inches)	20	25	30	35	40	45	50	55	60	65	70	75
5	71	89	107	124	142	160	177	195	213			
6	102	128	154	179	205	231	256	281	307	333		
7		174	209	244	279	314	349	384	418	453	488	
8			273	319	364	410	455	501	547	592	638	683
9				403	461	519	576	634	692	749	807	865
10					569	640	712	783	854	925	997	1068
11					689	775	861	947	1034	1120	1206	1292
12					820	922	1025	1125	1230	1332	1435	1537

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 129 May 1959

CUBIC FOOT VOLUME TABLES FOR SLASH PINE PLANTATIONS OF THE MIDDLE COASTAL PLAIN OF GEORGIA AND THE CAROLINA SANDHILLS

Proper management of any timber species or type requires valid estimates of volume from time to time. Tables 1 and 2 were constructed to meet this need for the expanding area of slash pine plantations in the middle coastal plain of Georgia and the Carolina Sandhills.

Measurements, both inside and outside bark and to minimum top diameters of 2-, 3-, and 4-inches outside bark, were obtained from 553 trees, well distributed throughout the above areas, and analyzed by regression methods. The product of diameter at breast height squared and total height was found to account for about 98 percent of the total variation in volume per tree. This was accepted as giving a simple, yet valid, estimate of cubic foot volume. Regression equations by which these tables were calculated will be supplied upon request.

Frequently values in cords rather than cubic feet are desired. To convert these cubic tables to cords, a ratio of 92 cubic feet per standard cord of 128 cubic feet may be used. This is based on a check of pulpwood as it arrived at the mill by railway car.

Table 1.--Cubic foot volumes (outside bark) for slash pine plantations

TOP DIAMETER 4.0 INCHES OUTSIDE BARK

D.b.h. (Inches)	Total tree height in feet-- 20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	.31	.65	.98	1.32	1.66	2.00	2.34	2.68	3.01			
6	.90	1.39	1.88	2.36	2.85	3.34	3.83	4.31	4.80	5.29		
7		2.27	2.93	3.60	4.26	4.92	5.59	6.25	6.91	7.57	8.24	
8			4.15	5.02	5.88	6.75	7.61	8.48	9.35	10.21	11.08	11.94
9				6.63	7.72	8.82	9.91	11.01	12.11	13.20	14.30	15.39
10					9.78	11.13	12.48	13.84	15.19	16.54	17.89	19.25
11					12.05	13.69	15.33	16.96	18.60	20.24	21.87	23.51
12					14.54	16.48	18.44	20.39	22.33	24.28	26.23	28.18

TOP DIAMETER 3.0 INCHES OUTSIDE BARK

D.b.h. (Inches)	20	25	30	35	40	45	50	55	60	65	70	75
5	.93	1.27	1.60	1.94	2.27	2.60	2.94	3.27	3.60			
6	1.52	2.00	2.48	2.96	3.44	3.92	4.40	4.88	5.36	5.84		
7		2.87	3.53	4.18	4.83	5.49	6.14	6.79	7.45	8.10	8.76	
8			4.73	5.58	6.43	7.29	8.14	9.00	9.85	10.70	11.56	12.41
9				7.17	8.24	9.33	10.41	11.49	12.57	13.65	14.73	15.81
10					10.28	11.61	12.94	14.28	15.61	16.95	18.28	19.61
11					12.52	14.13	15.74	17.36	18.97	20.59	20.20	23.82
12					14.97	16.89	18.81	20.73	22.66	24.58	26.50	28.42

TOP DIAMETER 2.0 INCHES OUTSIDE BARK

D.b.h. (Inches)	20	25	30	35	40	45	50	55	60	65	70	75
5	1.20	1.53	1.87	2.20	2.54	2.87	3.21	3.54	3.87			
6	1.79	2.27	2.75	3.23	3.71	4.19	4.67	5.15	5.63	6.11		
7		3.14	3.79	4.44	5.10	5.75	6.40	7.06	7.71	8.37	9.02	
8			4.99	5.84	6.70	7.56	8.41	9.26	10.11	10.97	11.82	12.68
9				7.43	8.52	9.60	10.68	11.76	12.84	13.92	15.00	16.08
10					10.54	11.88	13.21	14.54	15.88	17.21	18.55	19.88
11					12.78	14.40	16.01	17.63	19.24	20.86	22.46	24.08
12					15.24	17.16	19.08	21.00	22.92	24.84	26.76	28.67

Table 2. --Cubic foot volumes (inside bark) for slash pine plantations

TOP DIAMETER 4.0 INCHES OUTSIDE BARK

D.b.h. (Inches)	Total tree height in feet--											
	20	25	30	35	40	45	50	55	60	65	70	75
	Cubic feet											
5	--	.25	.52	.79	1.06	1.33	1.60	1.87	2.14			
6	.46	.85	1.24	1.62	2.01	2.40	2.79	3.18	3.57	3.95		
7		1.55	2.08	2.61	3.14	3.66	4.19	4.72	5.25	5.78	6.31	
8			3.05	3.74	4.43	5.12	5.81	6.50	7.19	7.88	8.57	9.26
9				5.02	5.89	6.77	7.64	8.52	9.39	10.26	11.14	12.01
10					7.54	8.61	9.69	10.77	11.85	12.93	14.01	15.08
11					9.35	10.65	11.96	13.26	14.57	15.87	17.18	18.48
12					11.33	12.88	14.44	15.99	17.54	19.10	20.65	22.20

TOP DIAMETER 3.0 INCHES OUTSIDE BARK

D.b.h. (Inches)	20	25	30	35	40	45	50	55	60	65	70	75
5	.37	.64	.91	1.18	1.44	1.71	1.98	2.24	2.51			
6	.90	1.28	1.67	2.05	2.43	2.82	3.20	3.59	3.97	4.36		
7		1.97	2.50	3.02	3.54	4.07	4.59	5.11	5.64	6.16	6.68	
8			3.41	4.09	4.77	5.46	6.14	6.82	7.50	8.19	8.87	9.56
9				5.36	6.22	7.09	7.95	8.82	9.68	10.55	11.41	12.28
10					7.85	8.91	9.98	11.05	12.12	13.18	14.25	15.32
11					9.64	10.93	12.22	13.52	14.81	16.09	17.39	18.68
12					11.60	13.14	14.68	16.22	17.75	19.30	20.83	22.38

TOP DIAMETER 2.0 INCHES OUTSIDE BARK

D.b.h. (Inches)	20	25	30	35	40	45	50	55	60	65	70	75
5	.57	.84	1.10	1.37	1.64	1.91	2.17	2.44	2.71			
6	1.04	1.43	1.81	2.19	2.58	2.96	3.35	3.73	4.12	4.50		
7		2.12	2.64	3.17	3.69	4.21	4.74	5.26	5.78	6.31	6.83	
8			3.60	4.29	4.97	5.65	6.34	7.02	7.70	8.39	9.07	9.76
9				5.56	6.42	7.29	8.15	9.02	9.88	10.75	11.61	12.48
10					8.05	9.12	10.18	11.25	12.32	13.39	14.46	15.52
11					9.84	11.13	12.42	13.72	15.01	16.30	17.59	18.89
12					11.81	13.34	14.88	16.42	17.96	19.49	21.03	22.57

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 130 August 1959

WET SITE SURVIVAL AND GROWTH

In January 1955, yellow-poplar, eastern cottonwood, slash pine, and loblolly pine were planted on low, wet sites at the George Walton Experimental Forest in Dooly County, Georgia. The purpose of the test was to compare survival and growth of pines and hardwoods on wet sites of the middle coastal plain.

The test was installed with three species replications on each of two sites. These sites were generally wet, but were subject to drought conditions after prolonged dry spells. Although they were poorly drained, they did not flood. With normal amounts of rainfall throughout most of the 4-year test period, the moisture requirements of the hardwood species were probably satisfied.

Test plantings were made on two types of plots, cultivated and uncultivated. The cultivated plots were burned and disked to field conditions, and cultivated during the first growing season. The uncultivated plots were merely burned and the shrubby undergrowth removed. Because of space limitations at the cultivated site, the uncultivated plots were located on nearby areas similar to the cultivated ones.

At the end of the first growing season survival on the cultivated eastern cottonwood plot was 45 percent, while it was 71 percent on the uncultivated plot (table 1). The other three species had fair to good survival on both types of plots. However, at the end of 4 years, eastern cottonwood had suffered complete mortality on both sites, while the yellow-poplar survival on the cultivated and uncultivated sites was 26 and 40 percent, respectively (table 2). In comparison, the two pine species had much higher survival at the end of the 4-year period.

Table 1.—Average survival after the first growing season on cultivated and uncultivated sites for slash and loblolly pine, yellow-poplar, and eastern cottonwood

Species	Cultivated	Uncultivated
	- - Percent - -	
Slash pine	81.6	87.8
Loblolly pine	86.2	89.0
Yellow-poplar	62.5	59.8
Eastern cottonwood	45.3	71.4

The complete mortality of eastern cottonwood after 4 years can probably be attributed to competing vegetation. It is also possible that the cuttings did not root sufficiently to supply the needs of the plants.

Table 2.—Average survival and height after the fourth growing season on cultivated and uncultivated sites for slash and loblolly pine, yellow-poplar, and eastern cottonwood

Species	Cultivated		Uncultivated	
	Survival	Height	Survival	Height
	Percent	Feet	Percent	Feet
Slash pine	80.2	9.1	82.3	3.5
Loblolly pine	82.9	7.2	80.9	3.2
Yellow-poplar	25.9	1.0	40.1	1.4
Eastern cottonwood	0	0	0	0

Site preparation apparently had little effect on survival of slash and loblolly pine, but height growth of each species more than doubled (table 2). At 4 years of age the average height of the cultivated slash pine is 2.60 times that of the uncultivated; for loblolly it is 2.25 times as great. This difference parallels results obtained at the Alapaha Experimental Range near Tifton, Georgia.[1] There, after 2 years, the height growth of cultivated slash pine was about twice that of a previous uncultivated planting on the same area.

The untilled yellow-poplar plots were higher in both survival and height growth than the cultivated ones. Similar results were obtained in a test in Illinois where this species, planted in dense hardwood sprouts and seedlings, had better height growth and survival than when planted in an old field.[2]

At the end of the fourth growing season, cultivated slash pine averaged 1.9 feet taller than the cultivated loblolly, a 26 percent difference. On the uncultivated site the difference was only 0.3 foot in favor of slash, or about a 9 percent difference. Possibly this disparity in height between the two species is correlated with Nantucket pine tip moth (Rhyacionia frustrana (Comst.)) attack. On the cultivated plots, 99 percent of the loblolly suffered severe attack, while on the uncultivated plots only 79 percent were attacked. Slash pine showed little evidence of attack on either site. No other insect damage or disease was present in meaningful amount.

1/ U. S. Forest Serv. Southeast. Forest Expt. Sta. Ann. Rpt. 72 pp., illus. 1958. (See page 26.)

2/ Green, Alan W., and Neebe, David J. Early development of yellow-poplar on two planting sites. U. S. Forest Serv. Cent. States Forest Expt. Sta. Note 106, 2 pp., illus. 1957.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
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SITE INDEX CURVES FOR SOUTHERN APPALACHIAN WHITE PINE PLANTATIONS

Eastern white pine (Pinus strobus) is the most frequently planted tree in the Southern Appalachians. During the 1958-1959 planting season around 7 million white pine were set out in western North Carolina alone. This is enough seedlings to reforest 7,000 acres of old fields. A question commonly asked is, "How well will these plantations grow?" The answer depends, in part, on the quality of the site where the trees are planted.

Site index curves, which show the future height of trees whose present age and height are known, furnish a convenient measure of site quality. Site index as used here means the average total height of dominant and codominant trees at an age of 25 years from seed. The curves on the back of this sheet may be used to estimate site index of old-field white pine plantations in the Southern Appalachian region.

Height and age determinations on 111 sample plots furnished the basic data for these curves. Most of the plots were in western North Carolina, but a few were located in north Georgia or eastern Tennessee. The curves were constructed from a regression equation in which the logarithm of site index was estimated from the logarithm of height and the reciprocal of age:

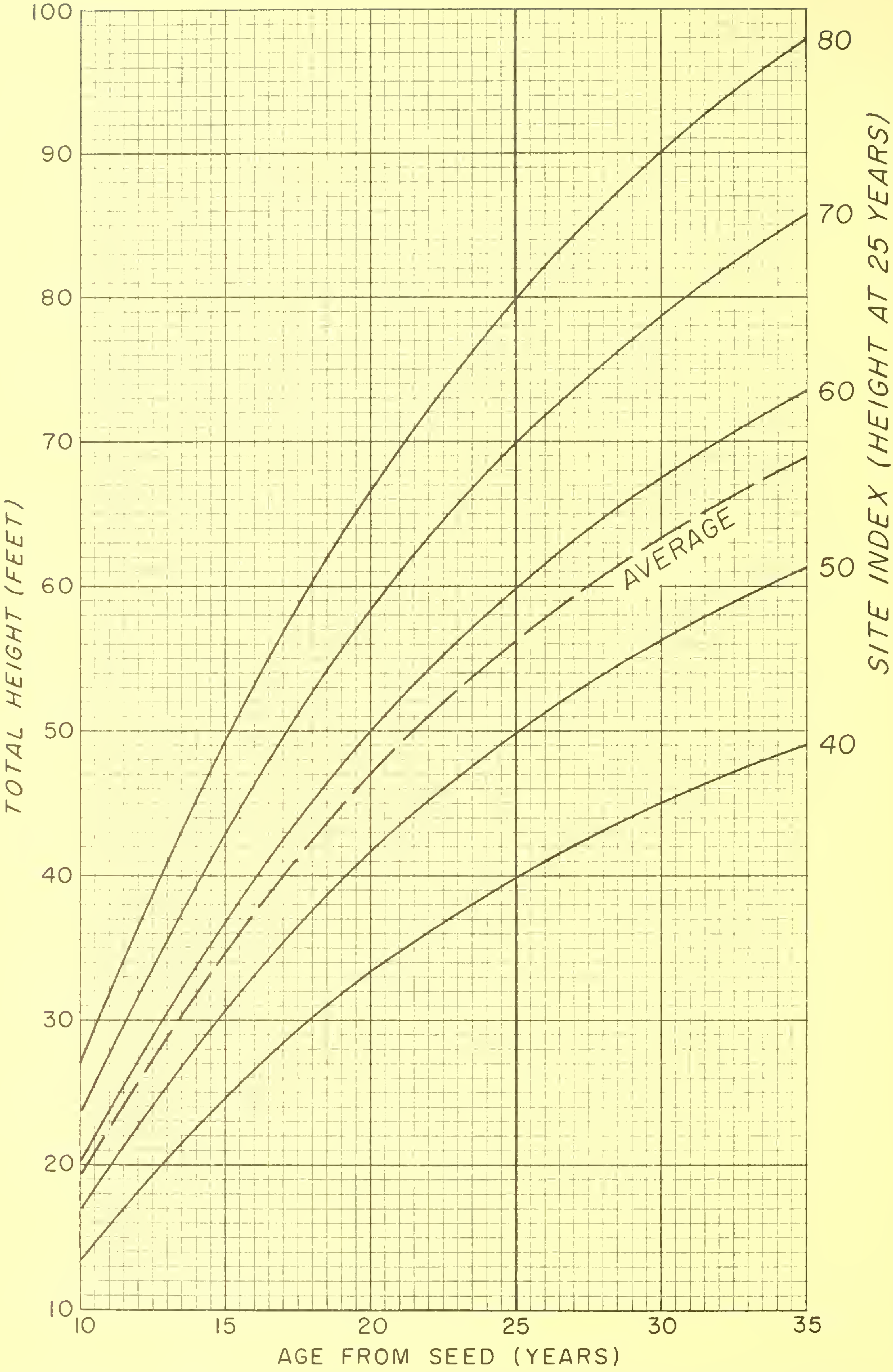
$$\text{Logarithm site index} = \text{logarithm height} - 7.819225\left(\frac{1}{25} - \frac{1}{\text{age}}\right).$$

To estimate the site index of a plantation, find the age of the trees from seed, measure the height from tip to ground of 5 to 7 dominants or codominants, and calculate the average height of the measured trees. For example, suppose a plantation was set out 16 years ago with 2-year-old seedlings. The age from seed is now 18 years. Suppose, also, that 6 of the tallest trees in the plantation have heights of 43, 47, 47, 44, 46, and 43 feet. Then the average height is 45 feet. Referring to the chart, we find that this plantation has a site index of 60; we would expect these trees to average 60 feet tall in 7 more years. This plantation should grow more wood than one with a site index of 50 but less than one with a site index of 65, other things being equal.

Site quality, as expressed by site index, does have a striking effect on the yield of wood from plantations. For instance, a 25-year-old plantation with 800 trees per acre and a site index of 70 yields twice as many cubic feet of wood as a similar plantation with a site index of 50, as shown in the tabulation.

Site index at 25 years	Yield per acre to a 3-inch top (Cubic feet)
40	2,040
50	3,070
60	4,600
70	6,880

The average height of the plantations measured for this study was 41 feet and the average age was 17 years. Thus, the average annual height increase was about 29 inches--a very satisfactory rate.



Site index curves for old-field white pine plantations in the Southern Appalachians. Index age is 25 years.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
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RESPONSE OF PLANTED YELLOW-POPLAR TO DIAMMONIUM PHOSPHATE FERTILIZER

Yellow-poplar is the major hardwood species grown in nurseries and available for planting in the southern states. Survival and growth of this species varies greatly with differences in planting sites. One of the prime factors affecting growth on these sites may be the nutrient content of the soil, particularly nitrogen. In the Central States, height growth of yellow-poplar was greater when interplanted with black locust which improved soil nitrogen conditions.[1/] A greenhouse study has shown that maximum height growth of yellow-poplar seedlings resulted from additions of nitrogen to potting soil at the rate of from 40 to 100 pounds per acre.[2/] Heights decreased as amounts varied above and below this range.

First-year observations of height and survival of a yellow-poplar planting fertilized with diammonium phosphate (20-52-0)[3/] show a definite increase in height growth with increasing rates of application. The one-year-old seedlings used in this study were lifted from the Hightower Nursery near Gainesville, Georgia, and planted within 24 hours in a small stream bottom on the Watson Springs Forest in Green County, Georgia. This bottom had previously been pastured and was considered a medium to good yellow-poplar site. Prior to planting, the area was plowed and smoothed with a disc harrow. Soil was sampled to a depth of 6 inches and was found to be low in nitrogen, phosphorous, potassium, and calcium by agricultural standards.

The design was in the form of four complete, randomized blocks, each containing four rates of fertilization--0, 250, 500, and 1000 pounds of diammonium phosphate per acre. Plots contained 4 rows of 5 trees at a 6 x 6 foot spacing. An additional single row isolation strip was shared by adjacent plots.

Initial height measurements were taken immediately after planting in January 1958. The fertilizer was broadcast by hand over the entire plot in early May. Survival and height measurements were taken in June. Survival was 97.5 percent for the entire experiment with no single plot having lost more than 2 trees. Height data were analyzed by analysis of variance and seedlings on all fertilized plots were significantly (1-percent level) taller than controls. There were no significant differences among fertilized plots.

1/ Finn, Raymond F. Foliar nitrogen and growth of certain mixed and pure forest plantings. Jour. Forestry 51: 31-33. 1953.

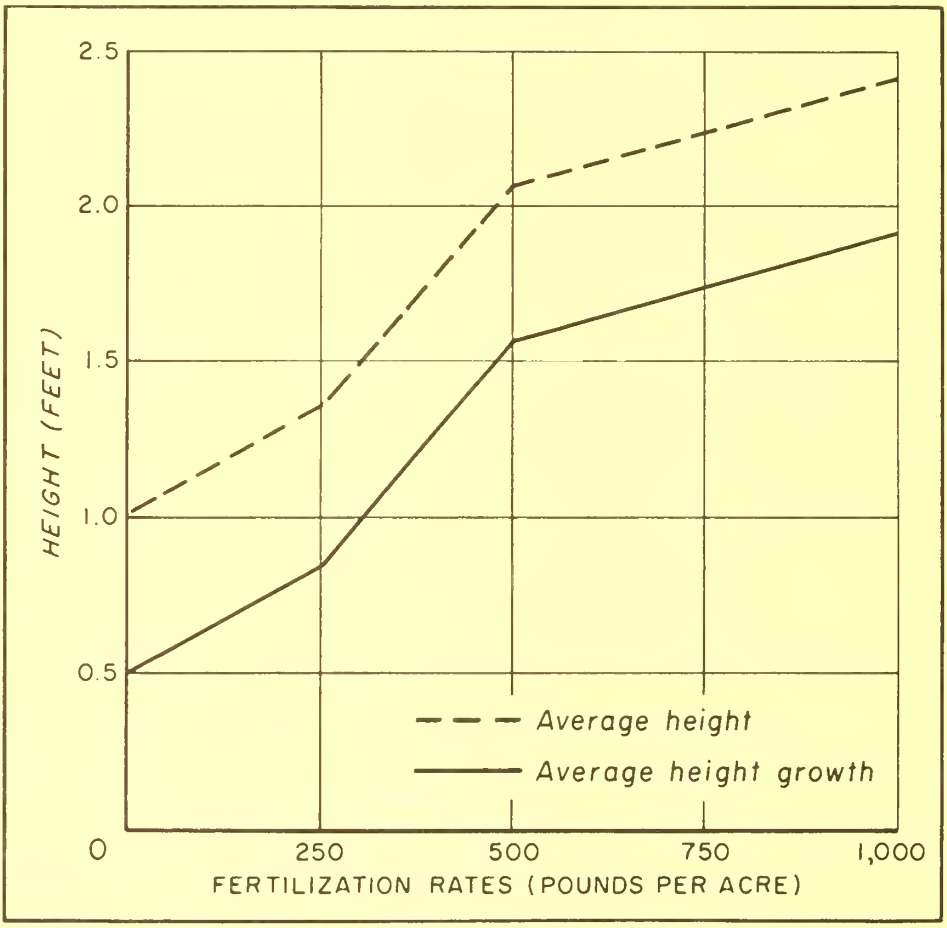
2/ Chapman, A. G. Some effects of varying amounts of nitrogen on the growth of tulip poplar seedlings. Ohio Jour. Sci. 33(3): 164-181. 1933.

3/ Special fertilizer prepared by the Tennessee Valley Authority at Muscle Shoals and furnished by the Forestry Investigations Branch, Tennessee Valley Authority, Norris, Tennessee.

Response to fertilization was evident throughout the growing season. The entire experiment resembled a checkerboard with rank, dark-green foliage on fertilized plots contrasting with the sparse, pale-green growth on the controls.

Final measurements were made in September. No differences in survival could be attributed to treatment. Survival was 92.5 percent for the experiment as a whole. Analysis of height growth showed that all fertilized plots had significantly greater height growth than the control plots. The 500- and 1000-pound rates gave greater response than the 250-pound rate, but there was no significant difference between the 500- and 1000-pound rate of fertilization.

This planting will be observed for 5 years without additional fertilization to determine how long the response to fertilization continues. Measurement of heights will be restricted to the inner 6 trees in each plot to eliminate the chance of root extension into adjacent plots.



Height growth of yellow-poplar seedlings attributable to application of diammonium phosphate fertilizer

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School of Forestry, University of Georgia

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 133 October 1959

SITE INDEX CURVES FOR SOUTH FLORIDA SLASH PINE

Site index curves, the relationship of total height to age referenced to an index age, is the commonly used measure of forest land productivity. The site index curves on the reverse of this paper were developed for South Florida slash pine (Pinus elliottii var. densa) because the previously available curves were based on data from the entire range of both varieties (P. elliottii var. elliottii and var. densa) or from only a portion of the range of the northern variety.

These South Florida slash pine site index curves were based on measurements taken on 90 permanent growth plots. The stands sampled ranged in average age and height from 8 to 61 years and 11 to 81 feet; the average site index at age 25 was 50 feet. The regression of the logarithm of total height (H) on the reciprocal of age was computed and is expressed in terms of site index at age 25 years:

$$\text{Logarithm of site index (age 25 years)} =$$
$$\text{Logarithm of height} + 4.628\ (1/\text{Age} - 1/25)$$

These curves were compared with site index curves for slash pine. In general the existing curves overestimated the site index of South Florida slash pine in the younger ages and lower site index classes. This new equation was also tested against an unpublished equation derived from Forest Survey data in South Florida slash pine, and it compared favorably.

To use these site indices, determine the average age and height of the dominant and codominant trees in the stand, plot this point on the graph, and then by inspection or interpolation determine the site index.

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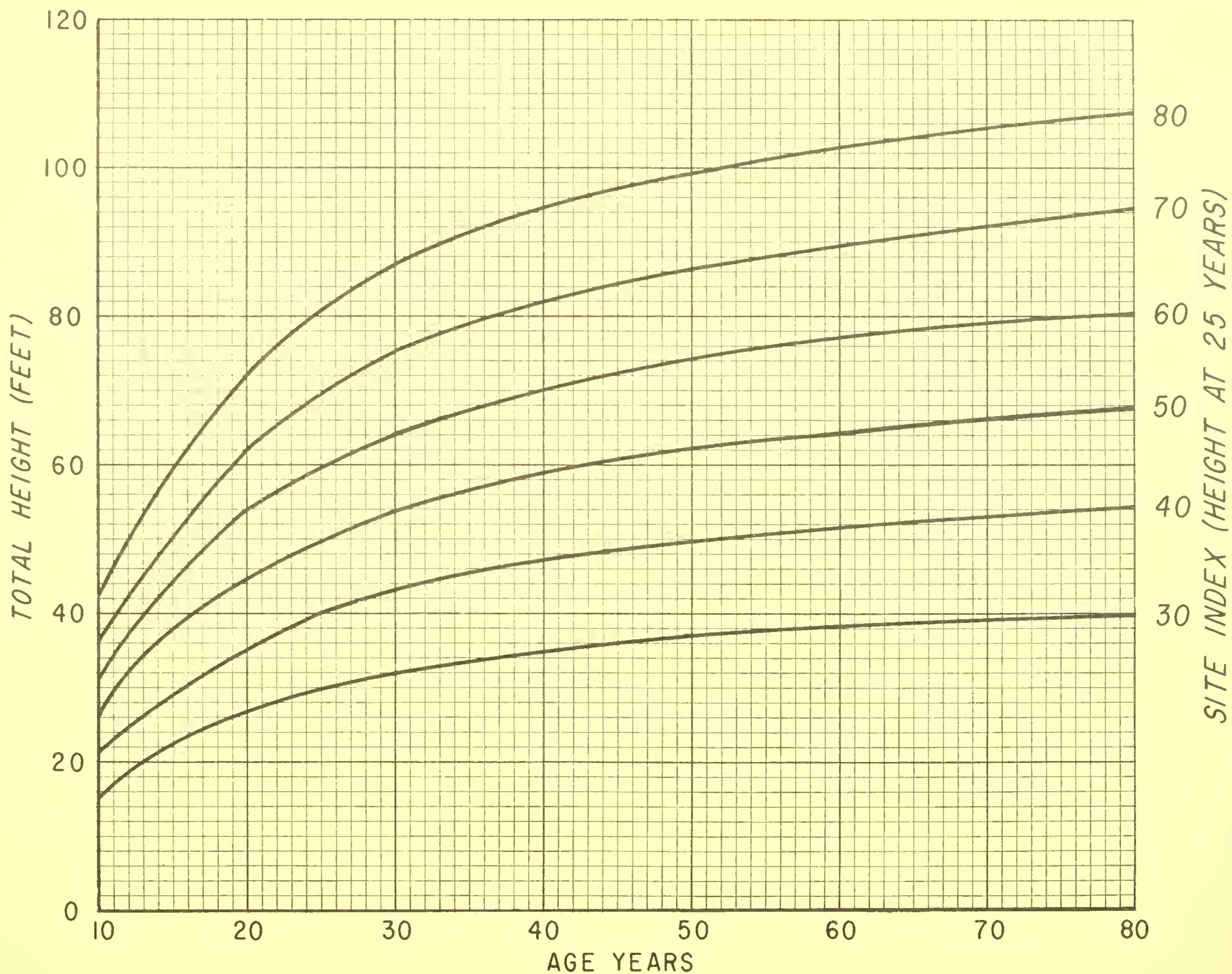

Site index curves at index age of 25 years for South Florida slash pine.

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
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Number 134 November 1959

SAPSTREAK DISEASE OF SUGAR MAPLE AND YELLOW-POPLAR IN NORTH CAROLINA

In 1944, Hepting[1/] reported a new vascular killing disease of sugar maple (Acer saccharum Marsh.) in the Big Ivy section of the Pisgah National Forest, near Barnardsville, North Carolina. It had first been noted in 1939. The disease was caused by a fungus morphologically indistinguishable from Ceratocystis coerulescens (Münch) Bakshi,[2/] a common cause of sapstain in hardwood logs and lumber.

In 1941 a 13-acre observation plot was established within the general diseased area, on which 78 sugar maple trees ranging in size from 7 to 36 inches d. b. h. were examined annually for symptoms of the disease. Through 1958, 10 percent of these trees, none of them suppressed, had become diseased and died. The remainder of the trees remained healthy.

In June 1949, while investigating yellow-poplar (Liriodendron tulipifera L.) mortality on Jacob's Creek, on the Cherokee National Forest, in northeast Tennessee, we found one tree infected with C. coerulescens.[3/] About a year later, a yellow-poplar infected with this fungus was found on the Bent Creek Experimental Forest, near Asheville, North Carolina. The fungus was isolated from both of these trees. Since that time, no naturally infected yellow-poplar trees have been recorded. No sugar maples infected with the fungus have been detected outside the initial infection area.

As described by Hepting, a series of inoculations was made on large sugar maple trees near Barnardsville, North Carolina, in 1940. Additional inoculations, by means of the poultice method, were made on sugar maples in the same area in 1943, 1949, 1950, and 1951. After C. coerulescens had been isolated from diseased yellow-poplar, inoculations were also made using that host species. A total of 152 sugar maples and 120 yellow-poplars were inoculated with the fungus. Only 14 percent of the sugar maples and 4 percent of the yellow-poplars have become diseased and died (table 1). The reasons for the low percentage of successful inoculations in both species are not known. Once infection took place beyond the immediate locality of the inoculum, it spread rapidly through the sapwood, symptoms became evident, and trees of either species died in from 1 to 3 years.

All trees becoming infected as a result of the inoculations did not show external symptoms the first or second year following inoculation; table 2 shows the number of years after inoculation that symptoms first appeared in the tree crowns. It is quite evident that the fungus may live in the stems of sugar maple and yellow-poplar for many years before causing visible crown symptoms.

In one series of inoculations, 16 of the trees were 4 inches d. b. h. or less when inoculated. Although none of these small trees became diseased, 3 of 16 trees in the 8 to 10 inch class inoculated at the same time became diseased. It would appear from these and other data that older trees are more likely to succumb to the disease. However, it is evident from the small number of successful inoculations that age is not the only factor influencing lethal infection.

When inoculating trees with C. coerulescens, we used isolates from diseased sugar maples, diseased yellow-poplars, and blue-stained yellow-poplar lumber. All of the 21 positive infections in sugar maple resulted from single-spore cultures from diseased sugar maples. Of the 5 positive infections in yellow-poplar, 1 isolate was from a diseased yellow-poplar, 1 from a sugar maple, and 3 were from yellow-poplar lumber obtained at a local mill. Thus, it is evident that cultures from all three of the above sources are capable of producing the disease under favorable conditions. It should be noted, however, that only one species crossover occurred; i. e., a sugar maple isolate infecting a yellow-poplar tree. The isolates from all sources used in this study appeared similar in culture.

Whether many or all isolates of C. coerulescens from sapstained lumber can cause the disease is an unanswered question. In one experiment, 3 trees were killed by inoculation with a lumber isolate. In another experiment, a lumber isolate failed in 4 inoculations, whereas 3 out of 4 large trees inoculated with an isolate from a diseased tree were dead of sapstreak in 2 years.

1/ Hepting, George H. Sapstreak, a new killing disease of sugar maple. Phytopathology 34: 1069-1076. 1944.

2/ Hunt, John. Taxonomy of the genus Ceratocystis. Lloydia 19: 1-59. 1956.

3/ Hepting, George H., and Toole, E. Richard. Some southeastern tree diseases--1948 and 1949. Plant Dis. Rptr. 34: 135-137. 1950.

Table 1. --The success of inoculations with Ceratocystis coerulescens

SUGAR MAPLE

Series	Date established	Uninoculated checks	Inoculated trees	
		Number[1]	Number	Percent diseased
1	April 1940	4	16	31
2	Sept. 1943	4	8	13
2	Sept. 1943	8	[2] 32	9
3	Oct. 1949	6	12	25
4	May 1950	[3] 6	12	25
5	May 1951	6	72	8
Total		34	152	14

YELLOW-POPLAR

Series	Date established	Uninoculated checks	Number	Percent diseased
3	Oct. 1949	6	12	8
4	Sept. 1950	6	24	0
4	May 1950	6	12	17
5	May 1951	6	72	3
Total		24	120	4

1/ Checks, not inoculated but wounded in the same way as inoculated trees, all remained healthy.

2/ All trees inoculated were 9 inches d.b.h. and larger, with the exception of one-half of the trees in this series.

3/ One of the checks in this series became diseased, apparently from natural infection.

Table 2. --Time lapse, after inoculation, before crown symptoms became evident

Species	Years after inoculation that disease became evident--								
	1	2	3	4	5	6	7	8	9
	Number of trees showing symptoms								
Sugar maple	2	8	7	1	0	1	0	1	1
Yellow-poplar	0	1	0	1	1	2	0	0	0
Total	2	9	7	2	1	3	0	1	1

On the 13-acre observation area mentioned earlier, only 8 of the 78 trees have died in the 17 years this area has been under study. There has not been any obvious infection or mortality on the plot during the last 4 years, which indicates that conditions may not have been favorable for infection or for disease development.

Although C. coerulescens is capable of killing large sugar maple and yellow-poplar trees when conditions for infection are favorable, the fungus is not an aggressive killer under normal conditions. Any fungus, however, that can kill large trees in 2 to 3 years is potentially dangerous, and in areas where the disease has been found, both sugar maples and yellow-poplars should be kept under observation and logging practices adjusted to avoid undue losses.

Many competent observers have been watching sugar maple stands over the East and Lake States for sapstreak symptoms during the last few years, but no cases have been reported outside a restricted area in western North Carolina and the one case in northeastern Tennessee. The disease is now endemic in the Big Ivy section of western North Carolina--an area where much of the large-sized sugar maple was cut in the late 1940's following excessive losses from sapstreak.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 135 November 1959

SITE INDEX CURVES FOR PIEDMONT VIRGINIA PINE

Virginia pine (Pinus virginiana Mill.) is the dominant species of many forest lands in Maryland, Virginia, and the Carolinas. Just a few years ago, Virginia pine was classed as a forest weed and commonly called "scrub pine." In recent years, the good pulping qualities of its wood, its heavy yields per acre, and its acceptance as sawtimber have lead to increasing interest in the productive capacity of Virginia pine. Index curves of height over age provide a basic tool for classifying this capacity.

Height and age determinations on 166 sample plots were used in the construction of site index curves. The majority of the plots (107) were taken in Virginia, 38 were in North Carolina, 13 in Maryland, and 8 in South Carolina. Both old-field and forest stands occurring principally in the Piedmont region were represented, but 80 percent of the plots fell in old fields. Ages of the stands sampled varied from 10 to 70 years.

Site index curves based on an index age of 50 years were constructed, using the coefficient of variation method as described by Osborne and Schumacher.[1] These curves appear on the reverse of this paper. Examination of the data indicated the regression of logarithm height over the reciprocal of age to be linear and solution by the regression method would have produced similar curves.

Average site index at 50 years for the plots sampled was 65.5; the total range of plots sampled was from site index 50 to 83. Ninety-five percent of the plots had site indexes from 55 to 80 and 60 percent ranged from 60 to 70 feet, thus indicating a narrow range and a lower site index than the average encountered for Virginia pine on the Hill Demonstration Forest (75.5 feet at 50 years).[2]

Within the portion of the Virginia pine range sampled, site index increased with a decrease in latitude:

State	Average site index
Maryland	64.5
Virginia	63.9
North Carolina	67.6
South Carolina	77.0

McIntyre, working in Pennsylvania,[3] and Besley in Maryland,[4] found average site indexes of 46 feet and 59 feet, respectively. Their findings add weight to the hypothesis that the better Virginia pine sites are located in the southern portion of its range.

To establish the site index of Virginia pine within Maryland and the Piedmont of Virginia and the Carolinas, it is only necessary to determine the age and average height of the dominant and codominant trees and apply this information to the curves on the reverse page.

1/ Osborne, James G., and Schumacher, Francis X. Construction of normal-yield and stand tables for even-aged timber stands. Jour. Agr. Res. 51: 547-564. 1935.

2/ Slocum, G. K., and Miller, W. D. Virginia pine: reproduction growth and management on the Hill Demonstration Forest, Durham County, N. C. N. C. Agr. Expt. Sta. Tech. Bul. 100, 52 pp. 1953.

3/ McIntyre, A. C. Virginia pine in Pennsylvania. Pa. State Col. Bul. 300, 31 pp. 1933.

4/ Besley, Lowell. Yield tables for scrub pine (Pinus virginiana) in Maryland. 1932. (Unpublished thesis. Yale University School of Forestry.)

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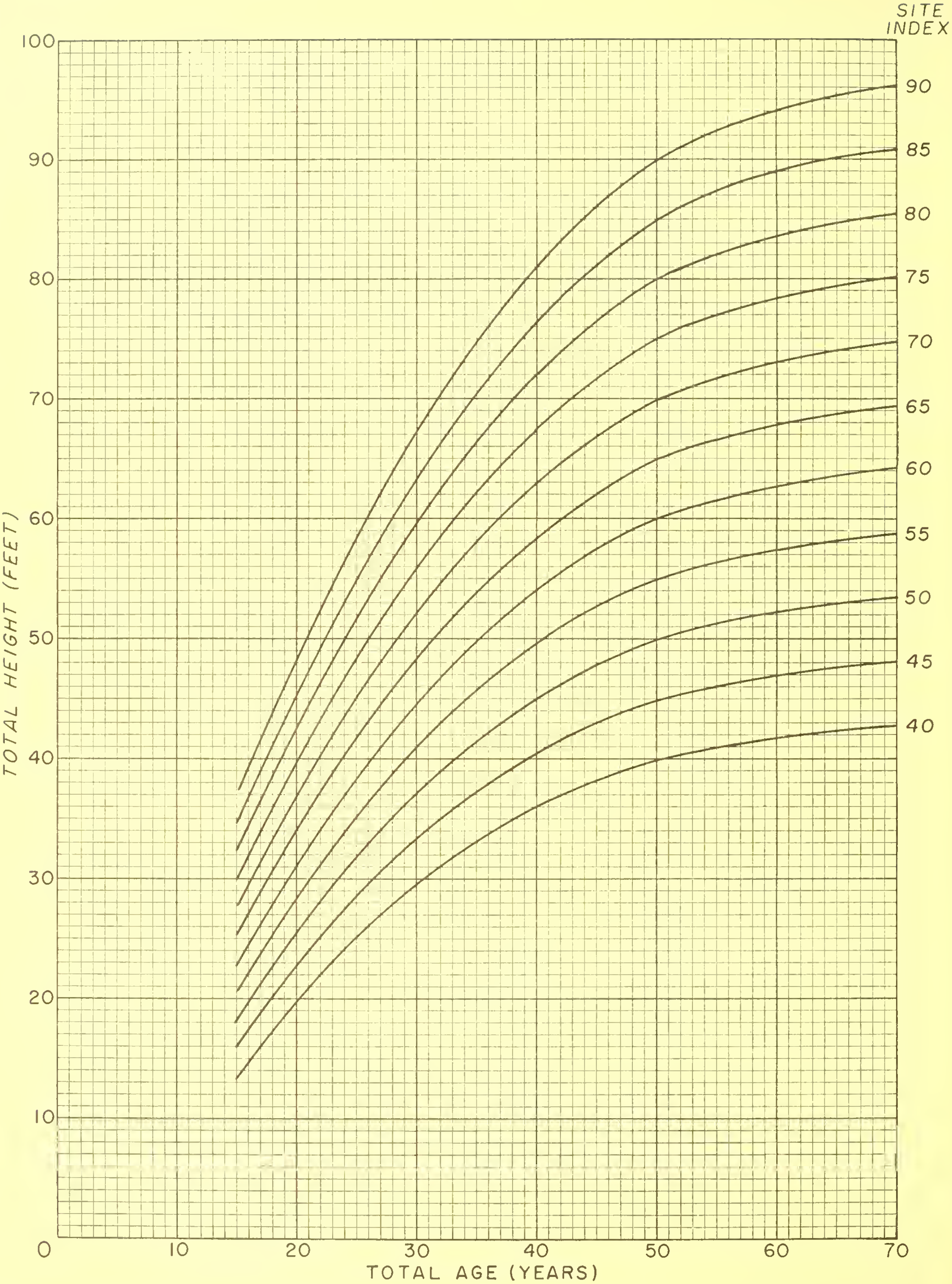

Site curves at an index age of 50 years for natural stands of Virginia pine in Maryland and the Piedmont of Virginia and the Carolinas.

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 136 November 1959

PULPWOOD PRICE TRENDS IN THE SOUTHEAST

Pulpwood prices in the Southeast remain stable at record levels, in spite of a drop of over a million cords in the pine market since 1956. The latest survey of pulpwood prices in Florida, Georgia, North and South Carolina, and Virginia revealed only slight changes from the previous two years, thus checking an upward price trend that has been interrupted only twice before in the past 20 years. These interruptions coincided with the recessions of 1949, 1954, and 1957. The only year in which pine prices actually declined was 1949, and they recovered the following year.

Rough pine pulpwood which sold for $3.60 in 1938, brought $11.70 in 1948 and $15.50 in 1958. Hardwood prices have advanced from $11.05 to $13.45 in the last decade. Although the hardwood price trend has been generally upward, it has advanced at a slower rate than that for pine. The term "rough pulpwood" refers to wood with bark--as contrasted with peeled wood, sawmill chips, veneer cores, or other wood residues used for pulp.

These trends and the others shown in the table are based on 70 percent of all the rough pulpwood currently purchased in the 5-state area. Four price series are shown--one for wood f.o.b. railroad cars, one for wood purchased at pulpwood yards, one for wood trucked to pulpmills, and one for all-wood. Although mechanized pulpwood yards first appeared in the Southeast about 1950, prices at these yards are not available prior to 1957. The all-wood prices are weighted averages of all rough pulpwood purchased. Therefore, they are applicable to total regional volumes of production or consumption, as they reflect changes in the proportion of rail, yard, and truck wood purchased, as well as changes in prices.

As an indication of the role pulpwood plays in the economy of the Southeast, nearly 157 million dollars were paid for the 10,289,000 cords of rough pulpwood produced during 1958, on a basis of all-wood prices. Pine pulpwood accounted for 88 percent of this total dollar value.

Average price of rough pulpwood in the Southeast, by year 1/

Year	Pine				Hardwood			
	Rail wood 2/	Yard wood 3/	Truck wood 4/	All-wood 5/	Rail wood 2/	Yard wood 3/	Truck wood 4/	All-wood 5/
1938	3.55	--	3.85	3.60	--	--	--	--
1939	3.75	--	4.40	3.90	--	--	--	--
1940	4.00	--	4.60	4.15	--	--	--	--
1941	4.50	--	5.00	4.60	--	--	--	--
1942	5.90	--	6.65	6.00	--	--	--	--
1943	7.15	--	8.00	7.25	--	--	--	--
1944	8.15	--	8.70	8.20	--	--	--	--
1945	8.35	--	9.15	8.45	8.10	--	8.55	8.10
1946	9.90	--	10.75	10.10	9.50	--	10.55	9.70
1947	10.80	--	11.70	10.95	9.70	--	10.55	9.80
1948	11.65	--	12.30	11.70	11.00	--	11.25	11.05
1949	10.85	--	11.80	11.00	10.75	--	11.25	10.80
1950	11.85	--	12.55	11.90	10.70	--	11.50	11.00
1951	13.65	--	14.70	13.85	12.40	--	13.15	12.75
1952	13.70	--	14.70	13.90	12.40	--	13.15	12.80
1953	13.70	--	14.70	13.90	12.35	--	13.15	12.75
1954	13.75	--	14.75	13.95	12.30	--	13.15	12.75
1955	14.15	--	15.05	14.35	12.50	--	13.45	13.05
1956	15.15	--	16.45	15.45	12.90	--	13.90	13.50
1957	15.20	15.40	16.35	15.50	12.65	12.70	13.75	13.35
1958	15.20	15.40	16.10	15.50	12.45	12.50	13.85	13.45

1/ Per cord of 128 cubic feet of 5-foot wood with bark. Includes dealers' allowances in cases where they are paid. Prices are rounded to the nearest 5 cents.

2/ F.o.b. railroad car.

3/ Delivered to mechanized pulpwood yard.

4/ Delivered to pulpmill.

5/ Weighted average of all wood loaded on railroad cars, trucked to pulpwood yards, and delivered to pulpmills.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 137 November 1959

MONOAMMONIUM PHOSPHATE SHOWS PROMISE IN FIRE RETARDANT TRIALS

Monoammonium phosphate ($NH_4H_2PO_4$) solutions applied to flammable fuels in south Georgia have successfully stopped fast-moving head fires. The material appears to be an excellent fire retardant, and has other qualities that should favor its use in fire control. The salt readily goes into solution with water when the mixture has been recirculated through a centrifugal pump for approximately 10 minutes. A fertilizer containing 12 percent nitrogen and 61 percent P_2O_5, the material is not toxic to plant life. When compared with other retardants, monoammonium phosphate (MAP) is relatively light in weight, at 9.2 pounds per gallon (18-percent concentration). Later work may show even lower concentrations to be adequate.

After preliminary small plot trials showed that asbestos slurries, borate slurries, and MAP solutions were equally effective in retarding light surface fires, a full-scale field trial was made. The materials tested were: borate, 4 pounds per gallon of water; powdered asbestos, 1-1/4 pounds per gallon of water; and monoammonium phosphate, 1-2/3 pounds per gallon of water. All mixtures were dropped from Georgia's TBM aerial tanker at an altitude of 75 feet and 100 feet ahead of hot head fires. Results from water drops were used as a base for rating the different retardants.

The area used for testing the materials had been recently clear cut, leaving a 10-year rough of palmetto, gallberry, and grass, in addition to lopped pine tops. Fires burned extremely hot, so hot that a 220-gallon load of water merely slowed a test head fire which ultimately consumed all fuel. An equal quantity of retardant was used for each of the comparison-drops. All these drops were replicated once to check response of the set head fires. Fuel moisture was 7.5 percent or less; wind speed varied between 6 and 12 miles per hour. MAP stopped the fires completely within a short distance of the outer edge of the drop zone along a line at least 175 feet long. Borate treatment did not stop the fires, although islands of unburned material were left in the drop zone. Results with asbestos were well below expectancy, in that fuels were completely consumed by the fires. Several hours after the drops had been made and the retardant material had dried on the vegetation, the unburned portions of the borate plots were reignited with a drip torch, whereas the MAP plots could not be reignited.

One drawback of MAP is that it is somewhat corrosive to aluminum. This condition can be corrected by adding approximately 220 parts per million of sodium silicofluoride and 20 parts per million of ammonium molybdate to the solution. An area covered with MAP cannot be readily distinguished from the air, and this presents difficulties. Tests with coloring agents are now in progress.

MAP costs $120 per ton f.o.b. Baltimore, Maryland, at present. Thus, a TBM tanker load of 500 gallons of MAP solution would contain $50 worth of chemical, excluding freight charges.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

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A GUM YIELD TABLE FOR 3/4-INCH, ACID-TREATED STREAKS ON SLASH PINE

A new gum yield table for slash pine (below) replaces the earlier one for the 5/8-inch streak that is no longer used.[1/] It shows expected yields from trees with faces equal in width to one-third of the tree circumference and 3/4-inch bark-chipped streaks sprayed with 50-percent sulfuric acid. The yields in the table are from faces worked biweekly by well-trained labor using the best chipping and spraying techniques.

First-year gum yields[1/] from single-faced slash pines for six diameter classes and five crown ratio classes

D. b. h. (inches)	Gum yields by crown ratios of--				
	0.20	0.30	0.40	0.50	0.60
	- - - - - - - - - - - - - Barrels - - - - - - - - - - - - -				
9.0	172	190	208	226	244
10.0	209	227	245	263	281
11.0	246	264	282	300	318
12.0	283	301	319	337	355
13.0	320	338	356	374	392
14.0	357	375	393	411	429
15.0	394	412	430	448	466

1/ In barrels (435 pounds) of gum per crop of 10,000 faces obtained from 16 biweekly streaks; no advance streak applied.

The new table was derived from measurements of 1,306 trees divided among 10 plots distributed over a distance of about 200 miles between Dodge County, Georgia, and Levy County, Florida. Site index among plots ranged from 72 to 99 feet at 50 years; age of trees ranged from 19 to 45 years.

1/ Schopmeyer, C. S., and Larson, Philip R. Gum yield tables for slash and longleaf pine on poorer than average sites. U. S. Forest Serv. Southeast. Forest Expt. Sta. Res. Note 69. 1954.

U. S. Department of Agriculture - Forest Service

Analyses of these data showed that first-year gum yields on slash pine depend primarily on diameter, and that crown ratio also affects gum yield. No effect could be demonstrated for either site index or tree age within the observed ranges, after the yields were adjusted for differences in diameter between trees.

Previous studies showed that crown ratio has a greater effect on gum yields over a period of three or more years than on first-year yields. 2/ On trees with crown ratios of 0.40 to 0.55, first-year gum yields were maintained during three successive years of work. On trees with very large crown ratios of about 0.60, yields increased each year for three successive years of work and leveled off in the fourth year. 3/ Yields from trees with crown ratios of less than 0.40 decreased with successive years of work. These effects of crown ratio on gum yields should be considered in selecting trees for gum production over a period of several years.

2/ Schopmeyer, C. S., and Larson, Philip R. Effects of diameter, crown ratio, and growth rate on gum yields of slash and longleaf pine. Jour. Forestry 53: 822-826. 1955.

3/ Snow, Albert G., Jr. Progress in development of efficient turpentining methods. U. S. Forest Serv. Southeast. Forest Expt. Sta. Paper 32, pp. 28-29. 1954.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 139 December 1959

OVERRUN IN SECOND-GROWTH YELLOW-POPLAR

Second-growth yellow-poplar is reaching merchantable size in the Southern Appalachians in increasing quantities each year. Although the timber is young and logs are small, it produces lumber of sufficiently high quality to supply the needs of Carolina wood-using industries.

One of the difficulties in appraising second-growth yellow-poplar stumpage has been lack of overrun information. This research note helps fill the void by reporting bandmill overrun studies by log grades (table 1) and diameter classes (fig. 1).

Table 1. --Board feet and percent overrun of second-growth yellow-poplar by log grade from two bandmills

Mill	Log grade	Lumber tally	Scale: International ¼-inch	Scale: Scribner Decimal C	Scale: International ¼-inch	Scale: Scribner Decimal C
		- - - - - Board feet - - - - -			- - - Percent overrun 1/ - - -	
A	1	8,173	7,380	675	10.7	21.1
	2	12,079	10,436	957	15.7	26.2
	3	10,565	9,773	855	8.1	23.6
	Total	30,817	27,589	2,487	11.7	23.9
B	1	9,452	9,330	873	1.3	8.3
	2	14,828	14,765	1,371	.4	8.2
	3	12,574	11,695	1,064	7.0	18.2
	Total	36,854	35,790	3,308	3.0	11.4
Combined	1	17,625	16,710	1,548	5.5	13.9
	2	26,907	25,201	2,328	6.8	15.6
	3	23,139	21,468	1,919	7.8	20.6
	Total	67,671	63,379	5,795	6.8	16.8

1/ Percent overrun = $\frac{\text{Lumber tally - net log scale}}{\text{net log scale}}$

Nearly 500 factory grade logs from 200 trees were sawed at two bandmills and the resulting lumber tallied and graded. When the International ¼-inch rule was used, overrun totaled 6.8 percent; when Scribner Decimal C was used, overrun totaled 16.8 percent. There was no clear correlation between overrun and log grade; as usual the smaller logs showed a higher overrun than larger logs. Cull was a minor item in these studies, averaging less than 3 percent.

The difference in overrun between mills was principally caused by differing end products. In Mill A, where overrun totaled nearly 12 percent above International $\frac{1}{4}$-inch log scale, over 41 percent of the total production was in stock 5/4 inches and larger. Mill B, with a total overrun of 3 percent above the same scale, concentrated its cut in 4/4 inch stock.

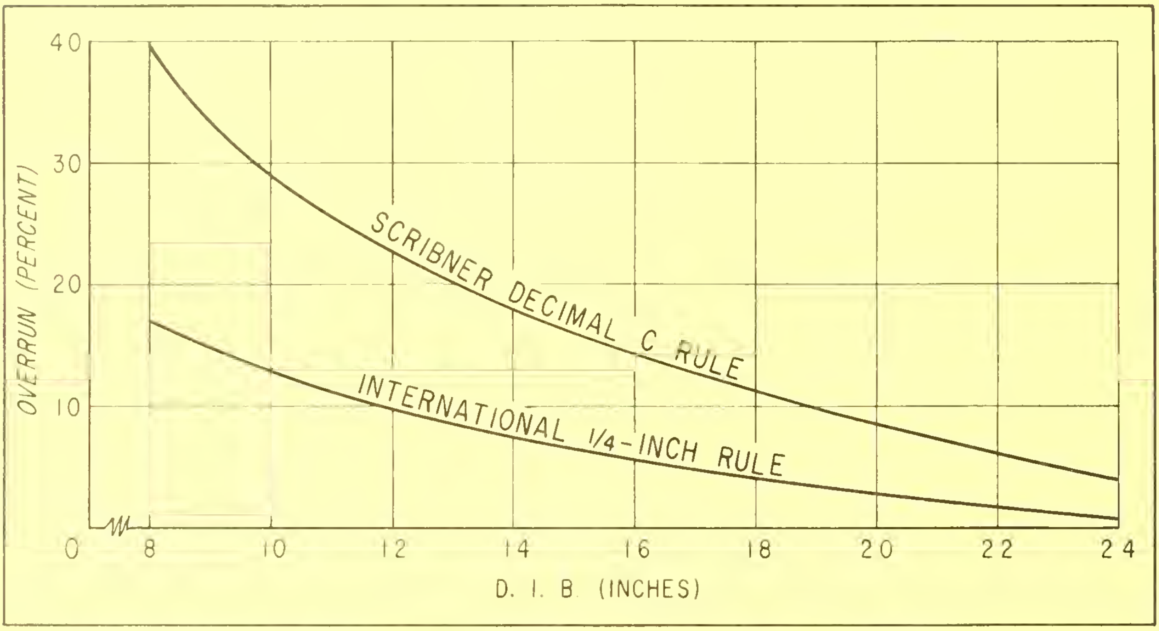

Figure 1. --Relationship of log diameter (inside bark at small end) to percent overrun in second-growth yellow-poplar sawed in bandmills (factory grade logs).

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 140 March 1960

THE EFFECT OF SITE PREPARATION ON SURVIVAL AND GROWTH OF SYCAMORE CUTTINGS

Sycamore (Platanus occidentalis L.), like most hardwoods, requires site preparation prior to planting for best survival and growth. A screening study to determine promising methods of ground preparation was begun in the fall of 1956. The study area was an old field in the overflow bottoms along the Oconee River in Greene County, Georgia

An acre of land was divided into ten, 1/10-acre plots among which 5 ground preparations, each with and without fertilizer, were randomly distributed. Ground preparations were:

1. Control (no treatment)
2. Double furrow
3. Disc harrowed without further cultivation
4. Disc harrowed followed by two cultivations during first year
5. Preplanting herbicide (T. C. A.) in aqueous spray

Preplanting ground preparations were begun in October. Double furrowed strips were laid open by a Rome fire plow. Disc harrowing was accomplished by a tractor-drawn disc plow. T. C. A. (sodium trichloroacetate) in an aqueous spray was applied at the rate of 10 pounds per acre to reduce grass and weed competition. Two other plots received no ground preparation prior to planting.

Cuttings were gathered locally from 1-year-old sprouts, trimmed to 20 inches and stored in moist sawdust. In mid-January of 1957, the cuttings were planted at a spacing of 9 x 9 feet, with the upper 4 inches of the cuttings remaining above ground. Cuttings in ground preparation No. 2 were planted in the bottoms of the double furrows.

Fertilizer was applied at planting time by placing 1 ounce of 8-8-8 fertilizer in the bottoms of planting holes and covering with 3 to 4 inches of sand prior to insertion of the cuttings. In April, cuttings were side dressed with $1\frac{1}{2}$ ounces of 8-8-8 in each of two dibble holes located 4 inches away and on opposite sides of the cuttings. Depth of fertilizer placement was about 1 foot. Cultivated plots were treated twice, late spring and midsummer of 1957, with a tractor-mounted row cultivator.

Survival and height measurements were taken during and at the ends of the first and second growing seasons (table 1). Survival was poor in all fertilized plots except those double furrowed. This poor survival may have been due to root damage from fertilizer placed in the planting holes. Conceivably, water standing after rains in the double furrows reduced "fertilizer burn" on the double-furrow plots.

Table 1.--Survival and growth of sycamore, as affected by site preparation

Treatment	Survival 1957	Survival 1958	Average height 1957	Average height 1958	Average height Difference
	Percent		- - - - Feet - - - -		
1. A. No ground preparation--control	74	65	1.69	2.60	0.91
B. No ground preparation, with fertilizer	53	51	2.47	3.00	.53
2. A. Double furrow, no fertilizer	88	88	2.00	3.10	1.10
B. Double furrow, with fertilizer	92	90	3.22	4.87	1.65
3. A. Disc harrow, no fertilizer	86	82	1.92	2.98	1.06
B. Disc harrow, with fertilizer	41	39	3.18	4.86	1.68
4. A. Disc harrow and 2 cultivations--no fertilizer	86	86	4.18	7.67	3.49
B. Disc harrow and 2 cultivations--with fertilizer	65	65	5.00	8.38	3.38
5. A. T. C. A.--no fertilizer	84	80	1.80	2.65	.85
B. T. C. A.--with fertilizer	71	69	2.53	3.97	1.44

Height growth at the end of the first year was best in the fertilized plot disc-harrowed prior to planting and cultivated twice during the year. Growth in the non-fertilized companion plot was nearly as good, and survival was better. The fertilized trees in double furrows and in the disc-harrow treatment without cultivation grew well. Trees on the plots treated with T. C. A., although taller than those on plots receiving no treatment, did not grow well, and weed competition became severe during the latter part of the season. T. C. A. also damaged some of the young sycamores.

During the second year, height growth followed trends similar to those of the first growing season. The little additional mortality was caused by weed competition and was most severe on T. C. A. and control plots.

Disc harrowing with additional cultivation was best for getting maximum height growth from sycamore, but the double furrow treatment gave better survival and satisfactory height growth. The former treatment is expensive and requires the land to be in relatively good condition. The latter may be applied to land which is rough, such as cutover land, and is probably least expensive of any treatments. Fertilizer increases height growth but should not be placed beneath the cuttings in the planting hole.

The three better site-preparation treatments will be further tested in replicated studies over a 3-year period to assess differences in site and planting season.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 141 March 1960

SITE INDEX CURVES FOR NATURAL STANDS OF WHITE PINE IN THE SOUTHERN APPALACHIANS

The site index curves for eastern white pine (Pinus strobus L.) shown on the reverse side of this note, were constructed as a replacement for those issued in 1934 as Appalachian Forest Experiment Station Technical Note No. 5, by L. I. Barrett.

Data for the new curves were taken in the mountains of western North Carolina and northern Georgia at elevations between 2,000 and 4,000 feet. The soils in this area are red and yellow podzols and gray-brown podzols, and they are derived almost entirely from schist, gneiss, and granite rocks. The curves are based on 105 plots of 3 to 7 dominant and codominant trees per plot, including data from which the old curves were made. Plots were selected from both pure pine and mixed pine-hardwood stands of average stocking. Tree ages ranged from a plot average of 22 to 78 years, and tree heights ranged from 36 to 114 feet. For all plots the average site index, or height at a base age of 50 years, was 83.

The new site curves were constructed by the coefficient of variation method. In use of the new curves for determining site index, the following steps are recommended:

1. Measure the total heights and breast-height ages of at least five dominant and codominant trees per location or plot.
2. Compute for each plot the average total height and average age at breast height.
3. Estimate site index in a general way; using this value as a guide, add one of the following age corrections to the average breast-height age to determine the proper average total age: 4 years for site 96+, 5 years for site 81 to 95, 6 years for site 66 to 80, and 7 years for site 65 or less.
4. Now, enter the site curves with the average total height and the average total age figures, and obtain the final site index value.

Caution: Only trees which show little or no history of suppression should be used in site index determinations. This is especially important in working with young trees (20 to 40 years old). Moreover, trees less than 20 years old should not be used with these site curves, because of (a) the lack of data for constructing that portion of the curves, (b) errors in interpolating between converging lines, and (c) a number of other errors associated with the growth of young trees in natural stands.

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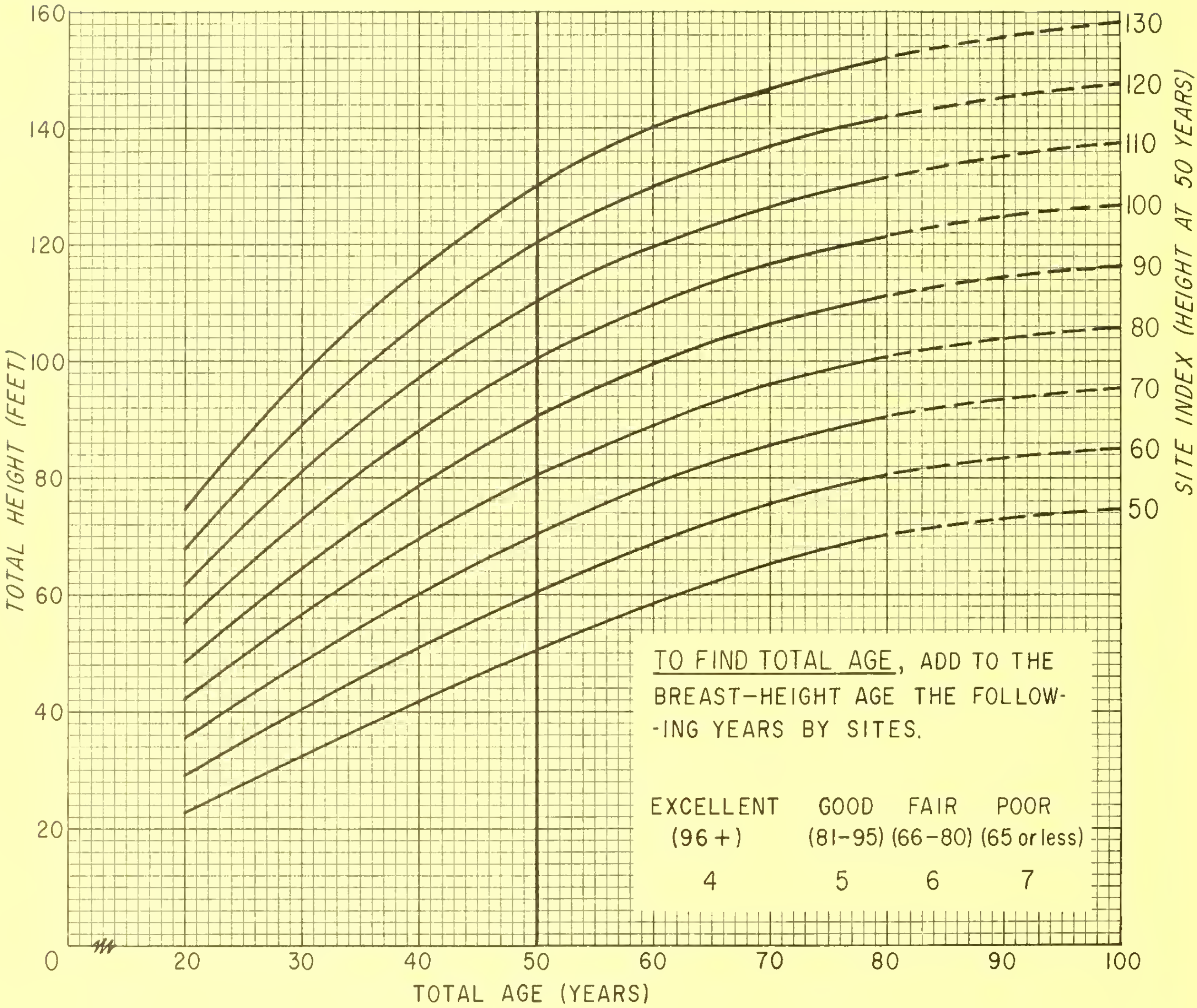

TOTAL HEIGHT (FEET)
SITE INDEX (HEIGHT AT 50 YEARS)
TOTAL AGE (YEARS)
0
20
40
60
80
100
120
140
160
130
120
110
100
90
80
70
60
50
0
20
30
40
50
60
70
80
90
100
TO FIND TOTAL AGE, ADD TO THE BREAST-HEIGHT AGE THE FOLLOWING YEARS BY SITES.
EXCELLENT (96+) 4
GOOD (81-95) 5
FAIR (66-80) 6
POOR (65 or less) 7

RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 142 March 1960

FIRING CHARCOAL KILNS WITH THE DOORS OPEN

In masonry-block charcoal kilns the charge is usually ignited after the door openings are sealed. On some kilns, openings are closed with blocks and no other ignition method is possible; however, kilns constructed with metal doors permit ignition with the doors open. This procedure was successfully followed on 36 kiln charges in a 7-cord kiln. With simple safety precautions, this method is not hazardous and offers definite advantages.

Open-door firing requires an easy-to-close metal door hung from hinges on the kiln wall or a sliding door on an overhead track. The door should be made from 14-gage steel, framed and cross braced with 2-inch angle iron. Large kiln openings must usually be hung with hinged doors and require two sections to reduce warping associated with the heating of long steel members. During coaling and cooling, the door edges are packed with glass wool insulation to produce a flexible seal. During cooling this seal is made airtight by covering with a paste of mason mix and water.

After the kiln is loaded, kindling is crib-stacked in the ignition area next to the door. The crib should be piled carefully so that the burning wood will not fall into the door opening. Kindling can be held in place with a light wire screen.

After the door has been checked to see that it closes easily, one to three gallons of fuel oil, depending upon the size of kiln and moisture content of wood, are poured over the kindling and face of the charge. After the oil has soaked into the wood for 15 to 30 minutes, the charge is ignited and will burn fiercely and spectacularly. During the 36 test burns the time between ignition and door closure averaged 7 minutes and varied from 3 to 20 minutes, depending on wind direction and dryness of the wood. Generally, the door should not be closed until the kindling is burned evenly and well. If the door is closed too soon, the fire may go out and require starting over.

To use this method most efficiently, the kiln should be instrumented with thermocouples for measuring kiln temperatures.[1/] During the initial flare-up of the fuel oil, temperatures near the kiln ceiling may reach 1000 to 1500° F. This temperature is of short duration, and after the door is closed ceiling temperatures quickly drop to 400 to 600° F. Eventually, the ceiling temperature increases to the proper coaling temperature of 850 to 950° F., which is then maintained by regulating the amount of air entering the kiln.

1/ Peter, Ralph. An inexpensive method for measuring charcoal kiln temperatures. Southeast. Forest Expt. Sta. Paper 73, 9 pp., illus. 1956.

Open-door firing results in more uniform ignition since the entire kindling area is open to ample oxygen. Precoaling temperatures are quickly established for beginning the charring process on dry wood and removing the moisture from green wood. Ignition with the door open can reduce coaling time up to twenty-four hours, depending upon the size of the kiln, condition of wood, and weather conditions.

Temperatures developed with open-door-ignition method.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 143 April 1960

REDUCTION OF FUEL ACCUMULATIONS WITH FIRE

Prescribed burning has often been used to reduce fuel accumulations, but only rarely has specific information been gathered to determine the effectiveness of a burning program. A 4-year study on the Camp Experimental Forest[1] in Sussex County, Virginia, provides a measure of the effects of repeated prescribed burns on the depth and character of the forest floor. The objectives of the burning program were seedbed preparation, fuel reduction, and the control of understory vegetation.

The stand used in this study consisted mainly of 60-year-old loblolly pine (Pinus taeda L.) in mixture with blackgum (Nyssa sylvatica Marsh.), red maple (Acer rubrum L.), and a scattering of various oaks. The average basal area per acre was 120 square feet for the pine and 35 square feet for the hardwoods.

Initially the very abundant shrub layer, composed mostly of Clethra and Vaccinium, had an average height of about 2½ feet. It probably would have prevented adequate pine regeneration after harvest unless reduced by some special treatment.

Below the dense shrub layer was a heavy accumulation of litter. Measurements of the litter depth and shrub height were taken before each fire (table 1). The average fuel accumulation was 4.8 inches deep and consisted of normal forest leaf and twig fall, along with larger pieces of wood, stumps, down trees, and other woody material. According to Metz, the average annual litter fall from such a stand is slightly more than 2 tons per acre.[2]

Table 1.--Average litter depth and shrub height before each fire

Fuel measure	Before the winter fire	Before first summer fire	Before second summer fire	Before third summer fire
			Inches	
Litter depth	4.8 ± 0.6	3.0 ± 0.4	2.5 ± 0.3	1.8 ± 0.4
Shrub height	29.3 ± 4.6	14.8 ± 1.7	8.3 ± 1.3	6.0 ± 1.4

The stand was located on two soil types: Fallsington very fine sandy loam and Othello very fine sandy loam, about equally represented. These soils have very poor drainage; water stands on the Othello most of the year. Under such conditions, normal decomposition is greatly retarded, resulting in an excessive buildup of litter and in the development of an A_0 horizon. This horizon consists of partially decomposed organic matter and contains many small leaf pieces and roots.

The A_0 horizon or mat is usually very moist and is not ignited by the ordinary prescribed burn, except when a stump or log catches fire, thus drying out the mat around it. Then a slow, smoldering ground fire is started that is very difficult to extinguish short of flooding or trenching to mineral soil. When exposed by fire or other disturbances, the residual mat forms a very good seedbed.

The study area was composed of four 40-acre compartments. One compartment was not burned, and served as a control. The others received a winter burn, and then one, two, and three summer burns respectively.

1/ Maintained in cooperation with Union Bag-Camp Paper Corporation, Franklin, Virginia.
2/ Metz, Louis J. Calcium content of hardwood litter four times that from pine; nitrogen double. U. S. Forest Serv. Southeast. Forest Expt. Sta. Res. Note 14. 1952.

The winter fires served to create more uniform conditions within each compartment, and were considered as a preparation for the summer burns to follow. These winter fires reduced the height and density of the low hardwoods and facilitated wind movement through the stands.

The summer fires, in June or July, did the heavy work of fuel reduction, control of understory vegetation, and seedbed preparation. Most of the study area was burned by head fires, although backfires were frequently used to prevent breakovers into unburned areas.

The weather characteristics were very similar for all of the summer fires. The burning index was 4 or 5[3], the relative humidity was close to 50 percent each time, and the air temperature between 84° and 92° F. The fuel moisture ranged between 5.6 and 7.6 percent. Winds were westerly, with velocities usually close to 2 to 3 m.p.h. measured at 8 feet above ground.

At the end of the burning program, samples of organic matter were collected, weighed, and separated into their woody and litter components. Sub-samples of woody and litter fuel were ovendried and a conversion factor obtained so that the dry weights could be expressed as tons per acre of dry fuel.

The results revealed that each fire caused a considerable reduction in the depth of the litter and in the average height of the shrub layer. A fuel reduction of 9.1 tons per acre resulted following a winter and one summer burn (table 2). Two additional summer fires removed another 5 tons of fuel per acre. The most surprising fact revealed by this study was the very high initial fuel weight of 36 tons per acre. This concentration can best be explained by the wet, poorly drained site and heavy stand of trees and lesser vegetation.

Table 2.--Fuel remaining following treatments

Composition	Treatments				Total reduction
	Unburned control	One winter One summer	One winter Two summer	One winter Three summer	
	Tons				
Litter	32.8	24.4	21.8	20.5	12.3
Woody	3.3	2.6	1.7	1.6	1.7
Total	36.1	27.0	23.5	22.1	14.0
Reduction	--	9.1	3.5	1.4	--

Supplementary samples were taken to determine the relative amounts of the readily flammable upper layer of litter and of the less flammable lower layers. The first series of fires (one winter, one summer) caused considerable change in the composition of the fuel; subsequent fires seem to have had little effect upon the relative amounts of the two fuel types (table 3).

Table 3.--Percent fuel by litter layers following treatment

Treatment	Upper layer of litter	Lower layer of litter
	Percent of total	Percent of total
Unburned control	23.5	76.5
One winter One summer	13.1	86.9
One winter Two summer	16.5	83.5
One winter Three summer	14.6	85.4

This study points out that on Fallsington and Othello very fine sandy loam soils, fuel accretion comes not just from leaf and twig fall, but also from below. The dark mat of partially decomposed organic matter that develops under such conditions dries out and fluffs up following a fire in the litter above, and is capable of sustaining a fire within a short time.

[3] Type 8-0 Fire Meter.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 144 May 1960

SCORCH AND MORTALITY AFTER A SUMMER BURN IN LOBLOLLY PINE

Foresters who use prescribed fires in loblolly pine management are concerned with damage to trees in hotspots. A 5-acre hotspot developed during a prescribed summer fire on the Camp Experimental Forest 1/ and gave us an opportunity to evaluate pine and hardwood mortality after the crowns were severely scorched. Most healthy loblolly pine survived despite severe needle kill, and the fire-killed timber could have been salvaged in harvest operations.

The fire, made to evaluate the reduction of hardwood competition and litter for seedbed preparation, was the first summer fire after an initial fuel-reduction burn two winters before. At 1:00 p. m. on the day of the fire the northwest wind at a weather station in the forest was less than 5 m. p. h., the air temperature was 80° F., the relative humidity was 50 percent, and the fuel moisture content was 4. 7 percent. The hotspot was the result of poor firing technique; in haste to complete the work, workers strung lines of fire on all sides. Where the fires converged, the intense heat severely scorched the crowns of the 60-year-old loblolly pine.

The amount of needle scorch 3 weeks after the fire and mortality 1 year later are shown in table 1. Sixty-five percent of the pines 5 inches d. b. h. and larger were severely scorched, with needle kill in more than two-thirds of the crown. The trees 5 to 8 inches in diameter, in the lower crown positions, were most severely scorched. Mortality was greatest among these least vigorous trees; survival increased with size. Of the pines larger than 8 inches, only 10 out of 404, or 2 percent, were killed.

Table 1. --Crown scorch and one-year mortality of loblolly pine in a 5-acre hotspot

Diameter class (inches)	Trees severely crown scorched	Mortality
	Percent	Percent
5	87	48
6	76	34
7	73	20
8	58	8
9	64	5
10	51	0
11	54	6
12	47	0
13+	37	4
Average all diameter classes	65	21

1/ Maintained in southeastern Virginia by the Southeastern Forest Experiment Station with the cooperation of the Union Bag-Camp Paper Corporation, Franklin, Virginia.

The hardwoods were generally more susceptible to fire injury than pine. Survival differences are apparent among the hardwood species (table 2). American holly, white oak, and other oaks (principally southern red, black, and post) were most susceptible. Sweetgum and red maple were more fire resistant, while blackgum was least damaged. Mortality differences by tree size were not as great as in pines, and 12 out of 19, or 63 percent, of the hardwoods larger than 8 inches were killed.

Table 2. --Hardwood top kill one year after burning

Species	Total stems		Dead		Mortality
	Number	Average d. b. h.	Number	Average d. b. h.	
		Inches		Inches	Percent
White oak	34	6.6	26	6.8	76
Other oaks	34	6.6	26	6.6	76
Holly	35	7.4	26	6.7	74
Sweetgum	26	6.0	12	5.8	46
Red maple	27	7.8	12	7.0	44
Sourwood	3	6.6	1	5.0	33
Blackgum	42	7.5	9	6.7	21

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 145 May 1960

FIFTH YEAR RESULTS OF LOBLOLLY PINE SEED SOURCE PLANTING IN GEORGIA

Loblolly pines (Pinus taeda L.) from nine locations in seven states, outplanted at the George Walton Experimental Forest, Dooly County, Georgia, show significant differences in height growth after 5 years. The planting is a portion of the Southwide Pine Seed Source Study, Loblolly Series 1.[1] Its purpose is to test the hypothesis that geographic races exist within the species, and that these races are associated primarily with temperature zones.

Each seedling lot was outplanted in four blocks of 121 seedlings in the winter of 1952-53. After 5 years, the tallest groups were 1.5 feet or 19 percent taller than the shortest group. Differences in average height between lots are highly significant (table 1).

Table 1. --Average seedling height at 1, 3, and 5 years by latitude and temperature zone of seed source and fifth-year survival

Seed source			Survival	Height 1/					
Location	Temperature zone	Latitude	Fifth year	1 year		3 years		5 years	
	°F.	°N.	Percent	Percent	Feet	Percent	Feet	Percent	Feet
Livingston Parish, La.	67	30.4	79	2/ 103	0.76	2/ 114	3.3	2/ 119	9.3
Crisp and Wilcox Counties, Ga.	67	31.7	80	137	1.01	127	3.7	119	9.3
Onslow County, N. C.	62	34.7	74	113	.84	114	3.3	115	9.0
Pamlico County, N. C.	62	35.0	84	115	.85	117	3.4	111	8.7
Angeline County, Tex.	67	31.1	85	112	.83	114	3.3	111	8.7
Cullman County, Ala.	62	34.1	86	122	.90	120	3.5	104	8.1
Jefferson County, Ala.	62	33.6	85	112	.83	107	3.1	100	7.8
Clark County, Ark.	62	33.6	92	123	.91	107	3.1	100	7.8
Somerset County, Md.	57	38.1	87	100	.74	100	2.9	100	7.8

1/ For heights 5 years after planting, any two sources not included in a single bracket differ significantly at the 5 percent probability level based on Tukey's "Q" test.
2/ Height in relation to that of the Maryland stock which was shortest at 1, 3, and 5 years.

There is a relationship between seedling height growth and average annual temperature zone; temperature zone is generally related to latitude (figure 1A). The formula for the regression line is $Y = 0.38 + 0.141x$, where Y is height at age 5, and x is average annual temperature. This relationship is significant at the 5 percent probability level. Survival is not significantly different between races, although there is a spread from 92 to 74 percent. Evidently cold damage was not a factor in survival in this planting.

The regression line $Y = 13.49 - 0.149x$, where Y is height at age 5, and x is latitude of seed source, was computed for the 5-year height data in figure 1B. Although the regression is not significant at the 5 percent probability level, the pattern of the scatter diagram is similar to that of the regression of height on temperature zone which was statistically significant. Our results seem to confirm those reported by Sherry[2] for a racial variation study of loblolly pine in South Africa.

1/ Subcommittee on Geographic Source of Seed. Working plan for cooperative study of geographic sources of southern pine seed. Southern Forest Expt. Sta. 32 pp. 1952.
2/ Sherry, S. P. The potentialities of genetic research in South African forestry. British Empire Forestry Conf., 11 pp., illus. City Printing Works, Ltd., Pietermaritzburg, South Africa. 1947.

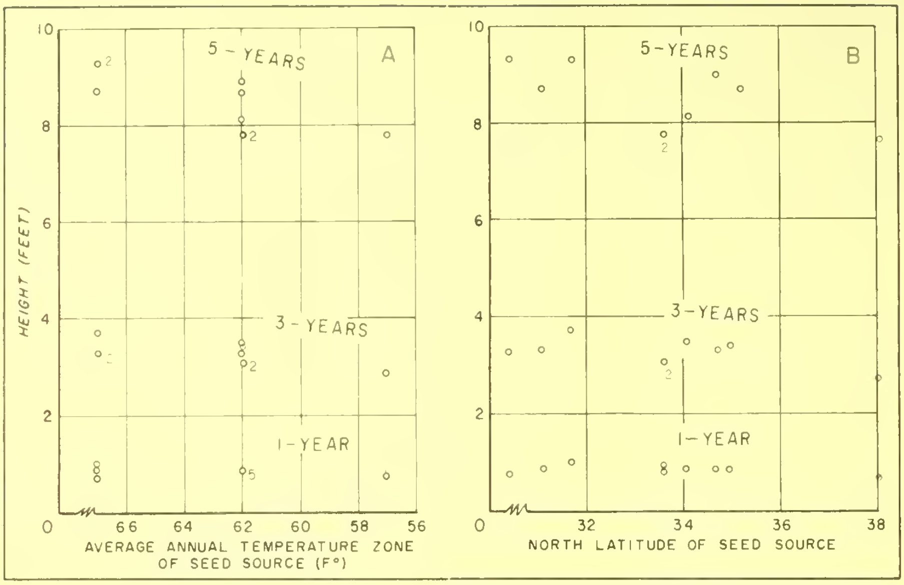

Figure 1.--Seedling heights at 1, 3, and 5 years in relation to latitude and temperature zone of the seed source.

Incidence of southern fusiform rust (Cronartium fusiforme Hedgcock and Hunt) averages 5.4 percent for the study as a whole, and stem canker infections have been found on 3.4 percent of all trees. Incidence varies significantly with seed source but not with latitude of seed source. There is apparently little correlation between rate of height growth and incidence of fusiform rust, a relationship often suggested by others. The Texas stock, with no infection, and the Arkansas stock, with very low incidence of branch cankers and no stem cankers, demonstrate a remarkable resistance to this disease. Loblolly pine stock from west of the Mississippi River had very low infection by rust in two older studies. Stock from Maryland and Virginia, however, also had an extremely low percent of rust infection.[3] The following tabulation lists the percent of southern fusiform rust (trees with stem or branch cankers) and the percent of trees with stem cankers by seed source at age 5. Any two lots not included in a single bracket differ significantly at the 5 percent probability level, based on Tukey's "Q" test.

Source	Percent trees infected	Percent trees with stem cankers
Angelina County, Texas	0.0	0.0
Clark County, Arkansas	0.6	0.0
Somerset County, Maryland	1.8	1.2
Livingston Parish, Louisiana	1.9	1.4
Onslow County, North Carolina	6.2	3.6
Pamlico County, North Carolina	8.4	6.4
Jefferson County, Alabama	9.6	5.4
Cullman County, Alabama	10.1	5.4
Crisp and Wilcox Counties, Georgia	10.1	7.4

Trees from all sources have suffered unusually severe Nantucket pine tip moth (Rhyacionia frustrana Comst.) attack during the 5-year period. This probably accounts for the poorer-than-average height growth (all plots averaged 8.5 feet in height after 5 years). Tip moth had attacked 96 percent of the trees by the end of the second year. No evidence of differences in susceptibility by sources was apparent. The infestation continued to be heavy through the fifth growing season, with each succeeding year's new growth killed back or badly deformed. As a result, excessive forking, crook, and bushiness are evident in trees of all sources.

Pine webworm (Tetralopha robustella Zell.) attacked 7 percent of the trees; however, there is no evidence of strain differences in susceptibility and little damage was done.

The poor form and deficient height growth of the trees in these tests indicate that loblolly pine should not be planted in areas where tip moth attack can be expected unless a more suitable species is not available. In the middle coastal plain of Georgia, species comparison tests have shown slash pine (Pinus elliottii Engelm.) to be superior in height growth and in resistance to tip moth.

Analysis of racial variation studies at an early age may lead to erroneous conclusions if growth patterns change before the trees reach merchantable size. If growth trends are kept under observation, however, there is some safeguard against misinterpretation. Stock from Onslow County, North Carolina, and from Texas are maintaining about the same percentage relationships in height with Maryland stock. Stock of the three southernmost latitudes--30.4°, 31.1°, and 31.7°--average the same percent superiority in height over stock from latitude 38.1° after 5 years in the field as they did at 1 and 3 years. Thus, the average difference in feet is actually increasing.

3/ Wakeley, Philip C. Importance of geographic strains. In, Report of the First Southern Conference on Forest Tree Improvement. 1951.

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RESEARCH NOTES
SOUTHEASTERN FOREST EXPERIMENT STATION
Asheville, North Carolina

Number 146 May 1960

SOURCE OF SEED AFFECTS GROWTH OF LONGLEAF PINE

– FIFTH YEAR RESULTS –

Significant differences between longleaf pine (Pinus palustris Mill.) seed sources have been demonstrated in outplantings at the George Walton Experimental Forest, Dooly County, Georgia.

The planting is a portion of the Southwide Pine Seed Source Study, Longleaf Series I.[1] The study's purpose is to test the hypothesis that racial strains exist within the species and that these strains are associated with patterns of migration rather than present-day temperature zones or other factors. This planting includes six sources from four states which were outplanted in the winter of 1952-53. All sources were in the same average annual temperature zone (67° F.) except Cleburne County, Alabama, which is in the 62° F. zone. Each source was planted in blocks of 121 seedlings and each was replicated four times.

Average height and survival figures after five growing seasons appear below:[2]

Source	Average height (Feet)
Baldwin County, Alabama	9.0
Treutlen County, Georgia	8.7
Polk, Tyler, and Hardin Counties, Texas	8.0
Washington Parish, Louisiana	7.7
Cleburne County, Alabama	6.8
Rapides Parish, Louisiana	6.2

Source	Survival (Percent)
Baldwin County, Alabama	88.8
Cleburne County, Alabama	84.7
Rapides Parish, Louisiana	84.2
Polk, Tyler, and Hardin Counties, Texas	82.6
Washington Parish, Louisiana	81.1
Treutlen County, Georgia	74.0

Stock from Baldwin County, Alabama, shows the greatest average height, with the Georgia stock second. It is interesting that between the two Alabama sources, the coastal plain (Baldwin County) source averages 2.2 feet taller than the Piedmont source (Cleburne County). For Louisiana, the Washington Parish source averages 1.5 feet taller than the Rapides Parish source, although the distance between the two locations is very small. These differences are significant at the 1 percent level. The regression of height on longitude of seed source was not significant. However, the seedlings from two locations in Louisiana are significantly shorter than those from Georgia and Alabama, while the stock from Texas is not.

Survival was not significantly affected by location of the seed source. The low average survival of the Georgia source was the result of one plot with only 31 percent survival. The other three plots of the same source have a survival of 88 percent.

This planting was established in a field cultivated the year prior to planting. The trees were sprayed semi-annually with ferbam for the first 4 years. Sixty-six percent of all seedlings had begun height growth by the end of the third year. The following tabulation lists the percentages of trees by seed sources which had initiated height growth prior to the fourth growing season:

Source	Seedlings making height growth (Percent)
Treutlen County, Georgia	82
Polk, Tyler, and Hardin Counties, Texas	79
Baldwin County, Alabama	73
Washington Parish, Louisiana	61
Rapides Parish, Louisiana	51
Cleburne County, Alabama	48

After five growing seasons only 2 percent of all seedlings remained in the "grass stage." The average height of all sources was 1.1 feet at the end of the third year, 4.1 feet at the end of the fourth year, and 7.7 feet at the end of the fifth year.

1/ Subcommittee on Geographic Source of Seed. Working plan for cooperative study of geographic sources of southern pine seed. Southern Forest Expt. Sta. 32 pp. 1952.

2/ In this and following tabulations, any two sources not included in a single bracket differ significantly at the 5 percent probability level based on Tukey's "Q" test. Survival differences were not significant.

As would be expected, length of time in the grass stage has a significant effect on height at 5 years. A linear regression with height as the dependent variable and length of time in grass stage as the independent variable is expressed by the regression equation:

$$\text{Height at age 5} = 14.3 - 2.4 \text{ (years in grass stage)}$$

When height at age 5 is adjusted by removing the effect of length of time in grass stage, some significant differences in height growth by seed source remain:

Source	Adjusted height (Feet)
Baldwin County, Alabama	8.6
Treutlen County, Georgia	8.4
Washington Parish, Louisiana	7.8
Polk, Tyler, and Hardin Counties, Texas	7.7
Cleburne County, Alabama	7.3
Rapides Parish, Louisiana	6.7

Crown width and forking were measured to secure preliminary information on tree quality by geographic seed source. These are probably the first observations of form in longleaf pine racial variation studies.

Average crown widths at the widest point vary from a high of 4.4 feet for the Georgia stock to a low of 3.0 feet for the Rapides Parish, Louisiana, stock. When the effect of height is eliminated by covariance analysis, these width differences are not significant.

Incidence of forked trees varies significantly by seed source. Over the entire planting 4.8 percent of the trees are forked. The taller sources, of course, have had more opportunity to fork, but differences in incidence of forking remain significant when adjusted for height. Percentage of forked trees by seed source is listed below:

Source	Forked (Percent)
Polk, Tyler, and Hardin Counties, Texas	1.9
Rapides Parish, Louisiana	2.3
Cleburne County, Alabama	4.9
Baldwin County, Alabama	6.2
Washington Parish, Louisiana	6.8
Treutlen County, Georgia	7.9

Insect and disease damage has been minor. Brown-spot needle blight (_Scirrhia acicola_ (Dearn.) Siggers) is the only disease of any consequence that has appeared. As stated earlier, all plots were sprayed and this spraying may have masked some of the racial differences. The total number of trees infected has been high (54 percent after the third growing season), but the severity of infection has been minor (only 12 percent of the infected trees had a degree of infection above 65 percent). The percent of all trees with brown spot infection and the percent of trees with heavy infection, by sources, at age 3 is listed in the following tabulation:

Source	Seedlings infected by brown spot needle blight (Percent)
Washington Parish, Louisiana	32
Baldwin County, Alabama	36
Polk, Tyler, and Hardin Counties, Texas	53
Treutlen County, Georgia	56
Cleburne County, Alabama	62
Rapides Parish, Louisiana	86

Source	Seedlings with over 65 percent of the needles infected by brown spot needle blight (Percent)
Treutlen County, Georgia	1.7
Baldwin County, Alabama	1.9
Washington Parish, Louisiana	3.6
Cleburne County, Alabama	6.8
Polk, Tyler, and Hardin Counties, Texas	9.2
Rapides Parish, Louisiana	18.8

Pine webworm (_Tetralopha robustella_ Zell.), tip moth (_Rhyacionia_ spp.) and pine sawfly (_Neodiprion lecontei_ Fitch) have been observed, but their incidence has been negligible.

The 5-year results of this study indicate there are significant differences in some traits of longleaf pine (height growth, time in grass stage, forking, resistance to brown spot) of different sources. There is no strong pattern, however, of variation related to longitude of the seed sources tested.

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