U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF FORESTRY—BULLETIN No. 32.

GIFFORD PINCHOT, Forester.

A WORKING PLAN FOR FOREST LANDS NEAR PINE BLUFF, ARKANSAS.

BY

FREDERICK E. OLMSTED,

FIELD ASSISTANT, BUREAU OF FORESTRY.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1902.

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LOBLOLLY PINE AND HARDWOODS IN MIXTURE ON A PINE FLAT.

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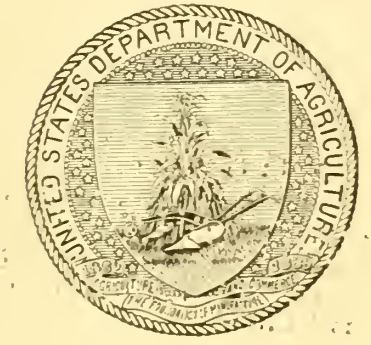

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LETTER OF TRANSMITTAL.

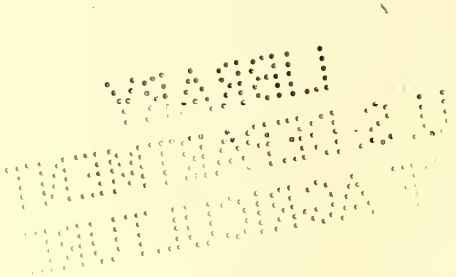
U. S. Department of Agriculture,
Bureau of Forestry,
Washington, D. C., March 12, 1902.

Sir: I have the honor to transmit herewith a report entitled "A Working Plan for Forest Lands near Pine Bluff, Arkansas," prepared by Frederick E. Olmsted, field assistant in the Bureau of Forestry, and to recommend its publication as Bulletin No. 32 of this Bureau. This working plan is now in operation.

Very respectfully,

Gifford Pinchot,
Forester.

Hon. James Wilson,
Secretary of Agriculture.



INTRODUCTION.

A working plan is simply a scheme of management for a forest tract. To prepare it a thorough study must be made not only of the present character of the forest, but also of its capacity to furnish future yields and of the conditions which will govern the transport and marketing of the timber cut. Upon this study is based a systematic plan for lumbering. The point of view is purely practical; the purpose is to prescribe cuttings which will not only pay, but will also tend toward the gradual and sustained improvement of the forest. It is a business policy recommended after an expert investigation.

In the preparation of a working plan two important points to be determined are: (1) The amount of timber standing; (2) the rate at which the principal species are growing. This known, it is possible to estimate what will be the yield of timber after a given number of years, and also to calculate the amount of merchantable timber which the forest is capable of producing each year, so that, if desired, the annual cut may be made equal to the annual production and a sustained yield of timber be assured.

On the tract of the Sawyer & Austin Lumber Company one of the chief objects in making a working plan was to determine whether the present tract is large enough to furnish a sustained yield equal to the yearly capacity of the mill, and if not, to estimate the additional area necessary to secure such a result.

The stand of timber was determined in the following way: Strips 10 chains long, of which each 10 chains in length made an area of 1 acre, were run on compass courses through the forest, and on these strips the diameters of all pine down to 2 inches and hardwoods down to 10 inches were measured with the calipers. These measurements were recorded upon tally sheets, a separate sheet for each acre, and upon them notes were made of the silvicultural condition and the merchantable quality of the stand. The strips were so run through all types of forest as to afford a basis for a close estimate of the stand. These "valuation surveys" covered 1,900 acres, or about 2 per cent of the total forest area.

The table giving the merchantable contents of pine in board feet was constructed by scaling the logs of 625 felled trees. The rate of growth

for Shortleaf and Loblolly Pine was calculated from "stem analyses" of the same number of specimens. These stem analyses included the following measurements:

Diameter at 4.5 feet from the ground.

Diameter on the stump and at the top of each log, inside and outside the bark.

Height of stump.

Length of each log and of the crown.

The rings were counted on the stump and at the end of each log, and the distance to each ten-year point from the bark was measured. From these measurements it was possible to ascertain the rate of growth of the trees both in height and in diameter. No investigations were undertaken of the rate of growth of the hardwoods.

The field expenses necessary to the preparation of this working plan were borne by the Sawyer & Austin Lumber Company.

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A WORKING PLAN FOR FOREST LANDS NEAR PINE BLUFF, ARKANSAS.

PART I.

THE TIMBERLANDS.

GENERAL DESCRIPTION.

The timberlands of the Sawyer & Austin Lumber Company are situated in portions of Grant, Jefferson, and Saline counties, Ark., and lie south of the Arkansas River about 100 miles from where it empties into the Mississippi. They comprise 105,000 acres, about 5 per cent of which is bare of merchantable timber. The property is very much cut up by farm lands and other private holdings.

The tract is generally flat, except in the extreme northern portion, where it is somewhat hilly. The elevation above sea level varies from 200 to 300 feet. All the principal streams flow in a southerly direction. The most important are Saline River, Lost Creek, Hurricane Creek, and Darysaw Creek, each of which has a very slight fall and an exceedingly winding course. During the rainy season of March and April, and after any heavy rainfall, the streams overflow their banks and flood the bottom lands, making travel difficult or impossible.

The tract is, for the most part, abundantly supplied with roads, but as a rule these are poorly made and badly cared for, and are practically impassable in wet weather.

With the exception of a small area in the northern portion of the tract the geological formation is alluvial. The soils are deep sandy loams and loamy sands, and contain a slight admixture of clay. Beds of gravel or pebble are very rare. On the small area in the north, igneous rocks, chiefly granites, occur to some extent, and local deposits of bauxite have recently been discovered and are now being mined. Where granites occur the soils are shallower than on the alluvial plain.

Both the low, flat country of the south and the hilly land of the north are covered almost entirely by virgin growth of mixed pine and hardwoods, while a pure hardwood forest is characteristic of the bottom lands along the streams.

MARKET, TAXES, AND TRANSPORTATION.

Although present prices for Yellow Pine are somewhat lower than usual, there is a very good demand for all descriptions of pine lumber. The higher grades are shipped to the States of the Middle West or

East, while the lower grades find a ready market in the Southwest. There is every reason to believe that this demand will steadily increase.

The average taxes amount to about $18 per $1,000 of valuation, or 1.8 per cent. As yet no assessment value has been placed on cut-over lands, but it is expected that these will be assessed at $1 per acre. This is much too high and plainly unfair, since they are hard to sell at 50 cents per acre. Taxes on cut-over lands play a very important part in conservative lumbering, and it is to be hoped that every effort will be made to secure just and fair taxation.

An excellent system of transportation is already in operation. It consists of a main line of railroad with radiating branch lines. The main line, of which 12 miles are already completed, runs from the mill at Pine Bluff through the center of operations in the woods, and is intended to serve eventually as a freight and passenger line connecting Pine Bluff with Sheridan and Benton. The "spurs," or branch lines, are merely temporary, and are built in such a way that after serving their purpose by transporting to the main line the timber from the area which they tap, the ties and rails may be taken up and laid again through that next to be logged.

In this way the logs are transported by rail direct to the mill. This system has proved to be the best one under the local conditions.

LUMBERING.

The lumbering done upon the tract previous to its purchase by the Sawyer & Austin Lumber Company was insignificant. Only over very small areas in the hardwood bottom lands Cow Oak and White Oak had been cut for staves, and on the pine lands little patches here and there were thinned out long ago for the small mills. In the spring of 1900 the company began lumbering about 10 miles from Pine Bluff, and cuttings have since continued steadily. It is now intended to carry on the lumbering both winter and summer until the whole tract of 100,000 acres has been cut over.

Following the recommendations of Mr. Griffith, of the Bureau of Forestry, who made the preliminary examination of the tract, pine is now being cut to a diameter limit of 18 inches on the stump. The trees are cut at about 18 inches from the ground, and the last log-cut is made well up in the crown, generally at a diameter of about 14 inches. As the hardwood trees growing in mixture with the pine are of inferior quality, it is only very rarely that one is felled. Lumbering of the hardwoods on the bottom lands has not as yet been begun.

The logs are either snaked or hauled to the railroad by horses, or skidded to the tracks and loaded upon cars by a steam skidder, the latter method having so far proved cheaper and fairly satisfactory. (See Pl. IX, fig. 2.) The company's mill at Pine Bluff is expected to saw annually from 40,000,000 to 50,000,000 feet of lumber.

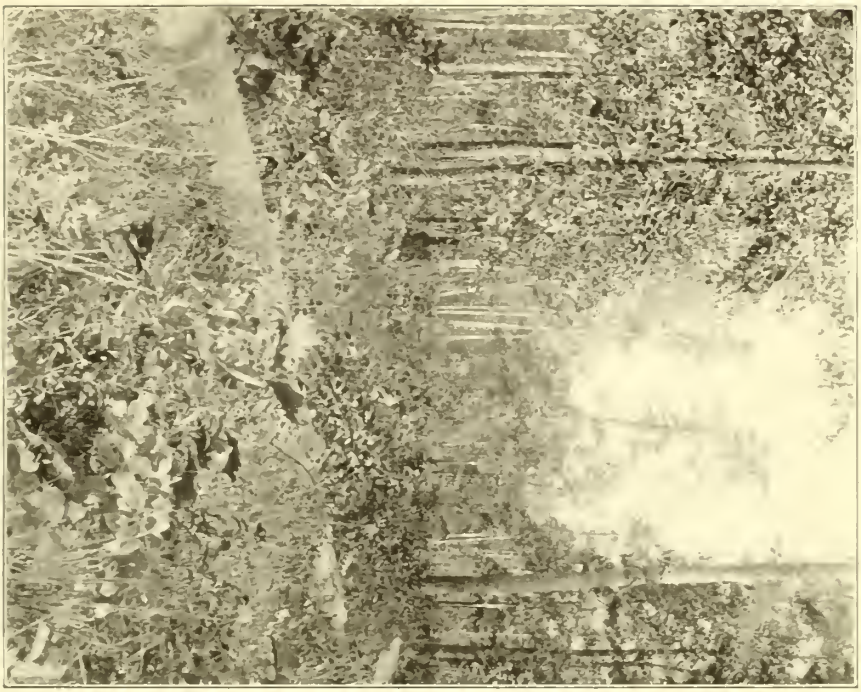

FIG. 1.—BLANK CAUSED BY LUMBERING.

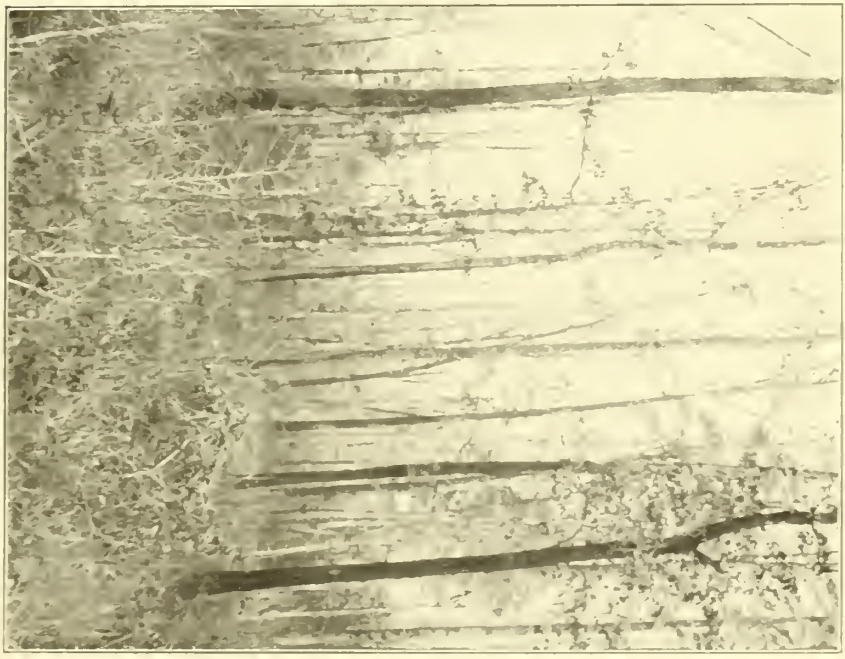

FIG. 2.—HARDWOODS ON A PINE RIDGE.

FIG. 1.—PINE RIDGE CUT OVER TEN YEARS AGO. RUN OVER BY FIRE.

FIG. 2.—PINE FLAT CUT OVER TEN YEARS AGO. RUN OVER BY FIRE.

FIRE: ITS INFLUENCE UPON THE FOREST CROP.

Conservative lumbering can never be successfully carried out in this region unless precautions are taken against fire.

On the valuation surveys notes were kept of fire damage, and it was found that only 5 per cent of the total area had escaped more or less serious fire during the last ten years. In this region the fires are seldom more than ground fires, consuming the leaf mold, grass, and other ground cover, seedlings, and young growth of all kinds, but very rarely burning a tree which has passed the sapling stage. Where the flames rise to a height of 10 feet the fire is considered severe.

Only a small proportion of the mature pine has been damaged, since the bark of both the Shortleaf and the Loblolly Pine possesses excellent resisting power. On some badly burned areas examined all young growth below about 20 feet in height has been completely destroyed. Yet, although all the mature pine and the high poles had been very severely scorched and charred, often to a height of 40 feet from the ground, they were apparently perfectly sound and healthy, nor had their growth been appreciably checked.

In many localities, however, the mature pine has been cut into, 3 or 4 feet from the ground, to determine whether the wood splits easily and hence is suitable for the making of shingles. A notch about a foot square and 6 inches deep is chopped out, and if the wood is found to be unsuitable the tree is left standing. From this wound the pitch flows freely, hardening in irregular masses on the trunk, and thus offering the best of fuel for the next fire. As a rule, fire will burn in such a tree for some time, often eating a large hole halfway or more through the trunk and weakening it to such an extent that it succumbs to the first hard wind. A large part of the "down" timber on the tract has been thrown in this way. Where litter and dry branches collect around the foot of a tree the danger is increased.

The mature oaks, especially White and Post Oak, are much more sensitive to fire than the mature pines, and are often killed simply by a severe scald. The same is true of Hickory and Sweet Gum. But as these hardwoods growing on pine lands are of but little commercial value, no great loss is caused by their death.

In the case of young growth, fire is very disastrous. When fire reaches the top of a young pine the tree is, with rare exceptions, killed. An ordinary ground fire, therefore, is pretty sure to kill all pine under 6 feet in height and 5 or 6 years old. Seedling growth of all kinds is consumed down to the roots. But the young hardwoods, and to a large extent both Loblolly and Shortleaf Pine, have the power of sending up sprouts after fire. These sprouts come up from the roots just below the surface, and if not interfered with there is every reason to believe that they will grow into timber trees. No evidence is at hand to show just how many times a young pine may be killed

back by fire and still be able to sprout, but it may be safely assumed that it can do so after two or three such setbacks. Both Loblolly and Shortleaf can produce these shoots up to the age of 15 or 20 years.

These fires, occurring as they do every three or four years, have had a disastrous effect on the character of the forest. The older trees, both pine and hardwood, continue to live for a number of years at least, but reproduction is checked. Not that no young growth whatever succeeds; almost any cut-over area which has been swept by repeated fires proves the contrary. Many pine and hardwood seedlings will be found growing up in spite of the fires, favored by chance or some local condition. But such young growth is meager and very inferior to what would be obtained if fires were kept out. Areas cut perhaps twenty years ago, and visited by frequent fires since, are generally covered with open groups of hardwood saplings, and in these groups, as well as scattered about through the whole area, is a sprinkling of young pines, which at times form open and scraggy groups by themselves. Such a sparse, open, and irregular growth is bound to be of very little commercial value. The saplings will grow up into badly formed trees with many low branches, and the timber produced will be knotty and inferior.

On the other hand, in localities which have been exempt from fire large, dense groups of young pine and hardwood have sprung up. Reproduction of this kind may be seen on limited areas in several parts of the tract. If fire were excluded, it is perfectly reasonable to expect that this condition would obtain generally, and that such groups would gradually spread until they had occupied most of the cut-over area. This young growth would produce tall, straight trees, free from branches, and containing the most valuable kind of timber. Even with ample protection against fire, the whole cut-over area would of course never grow up to a dense, even-aged growth of pine so long as a large proportion of mature hardwood remained standing after the lumbering; but the percentage of pine in the young growth would be largely increased, and the commercial value of the future forest would be much higher.

Apart from the damage done by fire to the young growth, the forest as a whole suffers very severely from the complete destruction of the humus or leaf mold. It is a noticeable fact that the soil throughout the tract is covered by so thin and scattered a layer of leaves and needles as to be almost entirely bare. Fire consumes the leaf litter completely every time it passes over the ground, and in so doing destroys the best fertilizer and protector of the forest soil, leaving it exposed to the deteriorating action of sun, wind, and rain. As a consequence, the rate of tree growth suffers.

By far the largest number of fires are started intentionally by people owning farms or small bodies of timber surrounded by or bor-

dering on the company's land. They are set in order to burn away the underbrush and open the woods for hunting and hog ranging. Thirty or forty years ago the whole forest was burned over regularly each year in order to improve the grazing, but this custom has been but little followed of late. A few of the fires are caused by the carelessness of loggers or campers.

The effect of fire on this forest may be summed up as follows:

(1) The young growth of all species, but especially that of pine, is very seriously damaged or totally destroyed.

(2) Mature and middle-aged trees are damaged to some extent.

(3) The soil is constantly impoverished through the destruction of the leaf litter.

If the forest is to be managed with a view to future crops, it is necessary to obtain young growth which will develop into a first-class stand of timber. This is impossible unless fire is kept out. A partial protection is worse than none, for if the forest be guarded for five or six years and then burned over, the fire feeds on the accumulated litter, and the damage done is much greater than if light fires occurred each year. Therefore, if protection is attempted it should be thorough.

The diagram herewith (fig. 1) is exceedingly significant. It illustrates the occurrence of pine according to diameter classes, and it reveals a peculiar irregularity in the number of trees in these classes. This irregularity is in all probability due to the damaging effects of forest fires in past years. The diagram shows the average number of trees per acre of Shortleaf and Loblolly Pine, separately and combined, of diameters from 2 to 40 inches. It will be seen that the three curves for diameters from 40 to 22 inches are quite regular, the number of trees per acre increasing steadily as the diameter decreases. At 22 inches, however, a decided break occurs, and from this point down to 14, 15, and 16 inches the same increase in the number of trees per acre does not take place. From these points down to 2 inches the increase again becomes very regular.

Now it is apparent that if no breaks occurred in the curves at the 22-inch point, the lines would have continued on as indicated by the short broken lines of the diagram, and the number of trees per acre of smaller diameter would have been much larger. In other words, the number of trees in the smaller diameter classes at the present time is insufficient to maintain the present stand of mature trees.

Loblolly Pine, when 22 inches in diameter, is about 100 years old. The curves show that the proportion of younger trees has been reduced by some disturbing influence. Such an influence is fire — not a great fire, but repeated fires of ordinary severity, such as the forest now suffers from. As the region was slowly entered by settlers these fires would begin. The trees which are now one hundred years old had by that time reached such a development that they were not affected; the injury was then, as now, chiefly to the young growth.

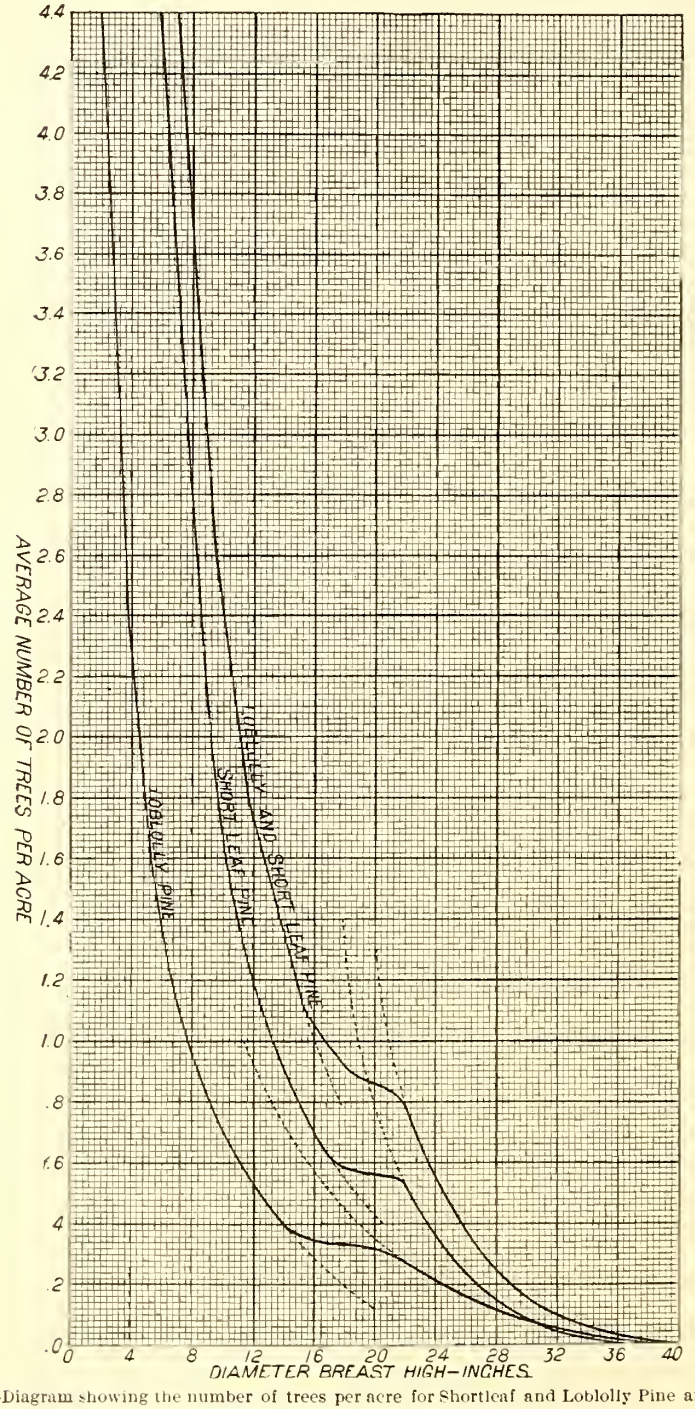

FIG. 1.—Diagram showing the number of trees per acre for Shortleaf and Loblolly Pine and for the two species combined, on a diameter breasthigh.

How old the trees must have been to escape damage would depend chiefly on the intensity of the fires. It is probable that the first ones were the most severe, from the accumulation of fuel which they would find. On the whole, one would conjecture from the condition of the forest that they began about seventy-five years ago.

It was in 1819 that Arkansas, acquired by the United States as a part of the Louisiana Purchase in 1803, received a separate Territorial organization, and in 1837 that it was admitted as a State. The settle-

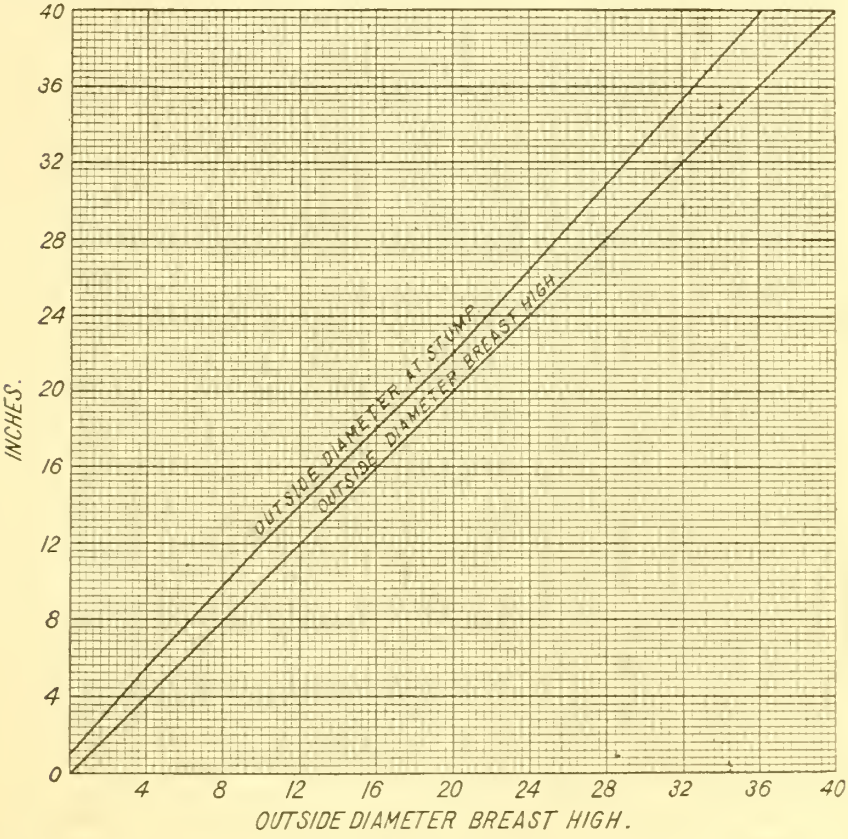

FIG. 2.—Diagram showing the relation between diameter on the stump and diameter breasthigh for Shortleaf and Loblolly Pine.

ment of the country took place, therefore, at the time when the condition of the forest leads us to infer that fires began.

GRAZING.

Cattle are not ranged extensively on the Sawyer & Austin tract and they do practically no damage to the forest. Of sheep grazing there is none.

Hogs are numerous and hog ranging is common. This should be encouraged, since the hogs eat the acorns and thus work against the

reproduction of the oak, while the damage they do to pine seedlings is trifling. They also tear up and loosen the soil, thus preparing it well for the germination of pine seed.

THE FOREST.

Although the forests of this locality are commonly known as "pine woods," pine being the principal merchantable species, a pure growth of pine very seldom occurs. Except over limited areas the pine is always in mixture with the hardwoods. On the bottom lands along the streams, pure hardwood forests occur. Several distinct types of forest growth may therefore be observed, and are distinguished by the lumbermen. These types are:

1. Pine ridge.
2. Pine flat.
3. Hardwood bottom.

Since no topographical maps of the tract were available, and since the occurrence of these types is dependent mainly upon differences in elevation and slope, it is impossible to estimate accurately the area occupied by each. From the valuation surveys, however, a rough idea of their extent was obtained, and the per cent of the total forest area each occupies is assumed to be about as follows:

	Per cent.
Pine ridge	65
Pine flat	20
Hardwood bottom	15

As each of these types has a tree growth in many ways peculiar to itself, the forest will be described silviculturally under these three headings. From the standpoint of the lumberman, however, the first two types may be thrown together under the general heading "Pine lands," since from this point of view there is very little to distinguish them. In the first place, the forests of the pine lands will be briefly described, from the standpoint of their merchantable product.

THE MERCHANTABLE FOREST.

PINE LANDS.

Occupying about 85 per cent of the total area, the pine lands form, and will continue to form, the prineipal source of income. Although the lands of the hardwood-bottom type contain much valuable timber, they cover too small an area to compete in commercial value with the pine lands.

The stand on the pine lands is shown by the table following, which gives the average number of trees, the perecntage in mixture, and the average diameter at breastheight ($4\frac{1}{2}$ feet)[a] of the most important

[a] All the tables contained in this report are based on diameter measurements made at breastheight, or $4\frac{1}{2}$ feet from the ground. To reduce approximately diameter breasthigh to diameter on the stump, add 2 inches to the former. The exact relation between these two diameters is shown in fig. 2.

species 12 inches and over in diameter. It may be noted here that the lumberman makes no distinction between Loblolly and Shortleaf Pine, nor is any distinction made in the trade, both being sold under the name of "Yellow Pine." In the woods, however, the lumbermen distinguish two kinds of timber—Heart Pine and Bull Pine. The latter is called also Second Growth Pine. These terms apply roughly to the two different species, the Heart to the Shortleaf and the Bull

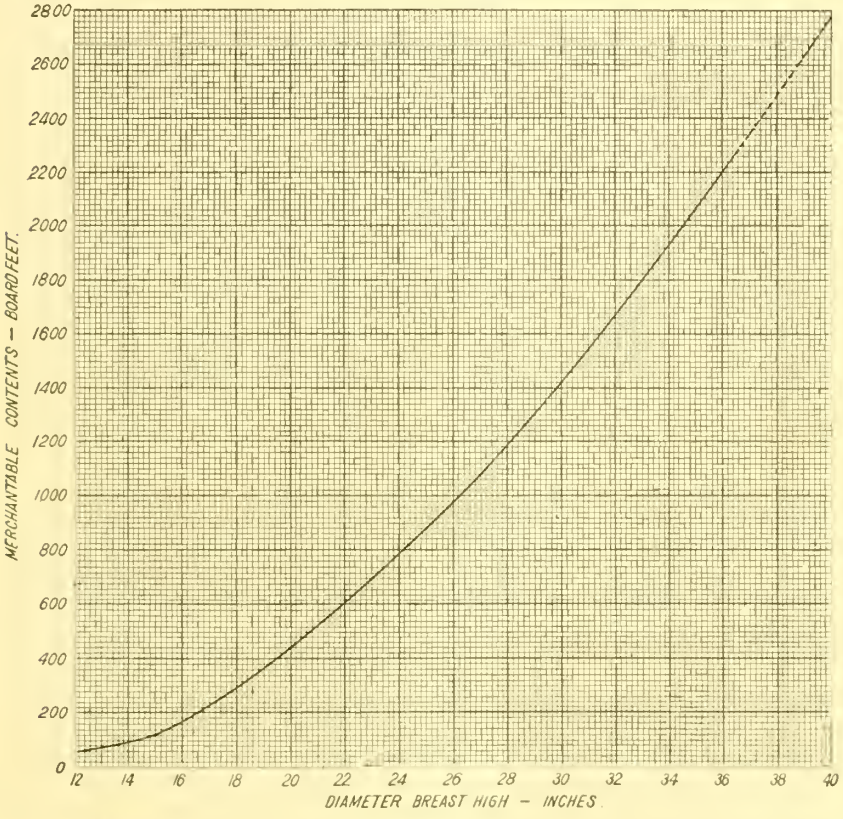

FIG. 3.—Diagram showing the merchantable contents in board feet for Shortleaf and Loblolly Pine on the basis of diameter breasthigh. (Contents by Doyle's Rule.)

to the Loblolly, because by "Heart" Pine is understood a pine whose wood is mostly heart, with very little sap; and by Bull Pine, a pine with a large amount of sapwood; and as a rule the Loblolly contains a greater percentage of sapwood than the Shortleaf. "Heart" Pine is supposed to have a thin bark and "Bull" Pine a thick bark. This rule, however, was found to be very uncertain, and can never be relied upon as a botanical distinction between the Loblolly and the Shortleaf.

TABLE No. 1.—*Average number of trees per acre—percentage in mixture and average diameter of all trees 12 inches and over in diameter breasthigh.*

PINE LANDS.

[Average of 1,745 acres.]

Species.	Average number of trees per acre.	Percentage of each species.	Average diameter breast-high.
			Inches.
Shortleaf Pine	9.91	35.66	18.9
Loblolly Pine	5.26	18.93	20.4
White Oak	3.79	13.64	20.5
Post Oak	3.28	11.80	16.5
Gum	2.09	7.52	16.3
Spanish Oak	1.25	4.50	18.0
Black Oak	.69	2.48	18.6
Hickory	.75	2.70	15.1
Other species	.77	2.77	14.5
All species	27.79	100.00	18.7
All species except pine	12.62	45.41	17.7
Pine	15.17	54.59	19.4

From this it is seen that pine forms but a trifle over 50 per cent of the total stand 12 inches and over in diameter, and that the quantity of Shortleaf Pine is nearly twice that of Loblolly. After pine, the most common trees are White Oak, Post Oak, and Gum, the Spanish and Black Oak and the Hickory being but sparsely represented.

The occurrence of Shortleaf and Loblolly Pine by diameters from 2 to 36 inches will be found in the following table:

TABLE No. 2.—*Average number of trees per acre of Shortleaf and Loblolly Pine and of the two species combined, for diameters from 2 to 36 inches.*

Diameter (inches).	Shortleaf.	Loblolly.	Shortleaf and Loblolly.	Diameter (inches).	Shortleaf.	Loblolly.	Shortleaf and Loblolly.
2	10.55	3.90	14.45	20	0.53	0.28	0.81
3	9.87	3.53	13.40	21	.59	.31	.90
4	7.60	2.62	10.22	22	.53	.27	.80
5	5.50	1.72	7.22	23	.42	.23	.65
6	4.74	1.51	6.25	24	.33	.21	.54
7	3.59	.99	4.58	25	.29	.19	.48
8	2.83	.87	3.70	26	.24	.16	.40
9	2.39	.61	3.00	27	.18	.15	.33
10	1.66	.71	2.37	28	.13	.12	.25
11	1.40	.60	2.00	29	.08	.10	.18
12	1.22	.55	1.77	30	.07	.11	.18
13	1.04	.42	1.46	31	.03	.03	.06
14	.92	.41	1.33	32	.03	.04	.07
15	.79	.36	1.15	33	.01	.02	.03
16	.72	.35	1.07	34	.01	.02	.03
17	.62	.35	.97	35	.002	.01	.012
18	.59	.33	.92	36	.007	.01	.017
19	.58	.30	.88				

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FIG 1.—SHORTLEAF PINE ON A PINE RIDGE.

FIG. 2.—LOBLOLLY PINE ON A PINE FLAT.

The number of trees per acre below 22 inches in diameter is disproportionately small, as was shown by figure 1, which is a graphic representation of this table. The trees now approaching merchantable size are not sufficient in number to maintain the present proportion of mature timber. This has a serious influence on future yields, since it lengthens considerably the time required for the production of a second crop equal to the present one, and it shows, moreover, that the land is capable of producing a much larger stand of timber than it is now maturing.

The following table gives the average contents of standing pine in board feet, by Doyle's Rule, on a basis of diameter at breastheight, and holds good for both Shortleaf and Loblolly Pine. Figure 3 is a graphic representation of this table.

TABLE No. 3.—*Contents of pine, in board feet, according to diameter breasthigh.*

[By Doyle's Rule.]

Diameter breast-high.	Merchantable contents.	Diameter breast-high.	Merchantable contents.	Diameter breast-high.	Merchantable contents.
Inches.	*Board feet.*	*Inches.*	*Board feet.*	*Inches.*	*Board feet.*
15	120	24	780	33	1,800
16	180	25	880	34	1,930
17	240	26	980	35	2,060
18	300	27	1,080	36	2,200
19	370	28	1,190	37	2,340
20	440	29	1,300	38	2,490
21	520	30	1,420	39	2,630
22	600	31	1,550	40	2,780
23	690	32	1,680		

STAND OF MERCHANTABLE PINE.

The following table shows the average stand per acre in board feet of merchantable pine on the pine lands, cutting to various diameters:

TABLE No. 4.—*Average stand of merchantable pine per acre, in board feet, cutting to diameter limits of 12, 14, 16, 18, and 20 inches, breasthigh.*

Cutting limit, diameter breasthigh	Average merchantable stand per acre.
Inches.	*Board feet*
12	6,067
14	5,845
16	5,597
18	5,130
20	4,561

The heaviest stand of pine per acre observed upon the tract lies near the southern boundary of section 27, township 5 south, range 11 west. The table below shows its composition and amount.

TABLE No. 5.—*Number of trees and merchantable contents, in board feet, for Shortleaf and Loblolly Pine on 1 acre in section 27, Township 5 south, Range 11 west, for the diameter limits of 2, 12, 14, 16, 18, and 20 inches, breasthigh.*

Diameter limit, breasthigh.	Number of trees over diameter limit.		Merchantable contents.		Total merchantable contents.
	Shortleaf.	Loblolly.	Shortleaf.	Loblolly.	
Inches.			*Board feet.*	*Board feet.*	*Board feet.*
2	4	97	.....	.....	.....
12	1	56	240	28,810	29,050
14	1	53	240	28,600	28,840
16	1	49	240	28,180	28,420
18	1	40	240	26,200	26,440
20	.....	29	.....	22,340	22,340

In the eastern part of the tract, townships 5 south, 11 west, and 5 south, 12 west, are found the heaviest stands, the western and northern portions being more lightly timbered. The heaviest stand over any considerable area is found, however, in the northwestern part of the tract—sections 3 and 4 of township 3 south, 14 west. In these sections the average stand per acre is 9,900 board feet.

THE FOREST FROM A SILVICULTURAL STANDPOINT.

PINE RIDGE.

The pine ridge type occurs on all the gently rolling or hilly portions of the tract. It includes not only the forest on the ridges themselves, but also those on the slopes and in the hollows. The so-called "ridges" are merely slight elevations with broad and nearly level tops, whose sides slope away gently at a gradient of 10 to 15 degrees. The difference in level between the hollows and tops seldom exceeds 75 or 100 feet.

Throughout this type the soils are deep, dry, and rather compact loamy sands, usually with a slight admixture of clay and with an occasional bed of gravel or pebble. Owing to frequent fires the humus is almost entirely absent, and the ground cover consists of a thin and scattered layer of needles and leaves, together with grass, weeds, and ferns. On the most open places and in irregular patches throughout the forest are more or less dense growths of Huckleberry, Laurel, Swamp Bay, and briers.

The following table shows the composition of the forest:

TABLE NO. 6.—*Average number of trees per acre, percentage in mixture, and average diameters for the most important species, for trees 12 inches and over in diameter.*

PINE RIDGE.

[Average of 1,516 acres.]

Name of species.	Average number of trees per acre.	Percentage of each species.	Average diameter, breast-high.
			Inches.
Shortleaf Pine	10.52	38.39	18.9
Loblolly Pine	4.43	16.17	20.5
White Oak	3.56	12.99	20.8
Post Oak	3.31	12.08	16.5
Gum	2.01	7.34	16.5
Spanish Oak	1.27	4.64	18.1
Black Oak	.70	2.55	18.9
Hickory	.77	2.81	15.1
Other species	.83	3.03	14.5
All species	27.40	100.00	18.7
All species except pine	12.45	45.44	17.8
Pine	14.95	54.56	19.4

Pine forms a little more than 50 per cent of the total stand, and Shortleaf is more than twice as abundant as Loblolly.

In this type of forest the pines, both Shortleaf and Loblolly, occur either in very small groups or scattered about by single trees; more commonly the latter. They tower high above the crowns of the hardwoods, forming a kind of second story over the oaks, gums, hickories, etc., which occur by single trees, quite evenly distributed. Under the old hardwoods is a growth of hardwood saplings and poles, intermixed with Shortleaf and Loblolly Pine. This undergrowth is found both in large and small groups and scattered openly and irregularly, while over large areas it is entirely absent, leaving the ground clear and bare under the mature trees. Shortleaf and Loblolly Pine seedlings are exceedingly scarce in this type of forest, owing principally to the frequent ground fires, and also to the fact that they will not flourish under too great a shade from the hardwoods.

When a forest is lumbered for all merchantable pine down to 14 inches in diameter at the stump very few hardwoods are cut, and the hardwood forest remains practically intact upon the lumbered area. The forest then consists of a few mature pines which were too unsound to cut, the original stand of young and middle-aged pine under 14 inches in diameter, and an open growth of mature and middle-aged hardwoods. Scattered groups of hardwood saplings mixed with pine form the undergrowth, generally much injured by the logging. The removal of the mature pine has admitted light to the ground and fitted it for the germination of seed, while the seed-bearing capacity of the remaining trees is increased by the addition of light and room.

The object in such a forest should be to obtain a constantly increasing stand of pine and a decreasing stand of hardwoods, as the pine is the most valuable species which this locality can produce. An increase in the stand of pine can be brought about in two ways—by the removal of a large part of the hardwoods and by the exclusion of forest fires. The quality of the young growth, and consequently of the mature forest, will depend largely upon the presence or absence of fires. Even more effective would be the removal of the hardwoods. Unfortunately, however, the quality of the stand and the condition of the market will not permit of this being done at present except at a financial loss, nor is there much reason to suppose that conditions will change to any great extent in the immediate future. Every chance, however, should be taken to cut and remove all hardwoods which show a possibility of affording even a very slight profit. It should be borne in mind that every oak or other hardwood cut tends to increase the number of pine trees in the future stand.

As will be seen later on, Loblolly grows much more rapidly than Shortleaf, reaching a diameter of 12 inches in forty-four years, whereas the Shortleaf requires over sixty years. Although the "Heart" Pine, or Shortleaf, commands a slightly higher price than the "Bull" Pine, or Loblolly, the difference is only just about enough to pay for sorting it out. The Loblolly is therefore by far the more valuable tree of the two, and should be favored in every possible way. The more there is of it in the reproduction the better will it be for the future forest, because the crop will become merchantable in a much shorter time, and consequently the returns will be higher.

Unfortunately, the number of Loblolly seed trees is comparatively small on the pine ridges, and an increase in the percentage of Loblolly can be obtained only by letting as many as possible of these trees stand. In practice it will be possible to spare a tree above merchantable diameter here and there, and this should by all means be done, for every Loblolly left standing will very appreciably help along the representation of this species in the new growth. The number of Shortleaf Pine below 12 inches in diameter left after the cutting will be nearly sufficient to produce all the seed necessary for a reproduction of this species, but in some localities it will be advisable also to save a few above this 12-inch limit.

To increase the pine stand by protection against fire is entirely practicable, and will produce valuable results. It has been shown that, in the young growth, hardwoods have a decided advantage over pine where the ground is swept by repeated fires, and it is beyond doubt that if fire be kept out the percentage of pine in the young growth will be largely increased.

During the first five or six years after lumbering, if fire is kept out, the reproduction will usually appear to be composed almost entirely

FIG. 1.—LOBLOLLY POLES UNDER MATURE LOBLOLLY ON A PINE FLAT.

FIG. 2.—HARDWOOD UNDERGROWTH UNDER MATURE PINE ON A PINE FLAT.

of hardwoods; a few years later, however, a vigorous growth of young pine will be seen pushing up, and from this time on both the Shortleaf and the Loblolly will overtop the hardwoods and develop rapidly to maturity. If left to nature and protected from fire, pine is bound to be the dominant species. The locality is natural pine land, and in the past the percentage of this species was probably much greater than it is at present.

Even if such a thing were possible, it should, however, never be the object of management to exterminate the hardwoods. When present to a limited extent they serve a very useful purpose by forcing the young pine to grow up straight and free from branches, and they are also exceedingly valuable for the protection they afford the soil. As a pure pine forest approaches maturity it thins out very rapidly and the soil tends to deteriorate, as the crowns of the pine afford insufficient shelter against the action of sun, wind, and rain. If a growth of hardwoods is present under the pine the soil is much benefited, both from the shade afforded and from the humus which will gradually collect. Hardwoods, then, are a secondary but very useful factor in the forest growth. The ideal condition is that they should not be present in such numbers as to interfere with the best development of the pine, but should be sufficiently represented to afford protection to the soil and force the pine to produce clear, straight boles. In other words, they should serve as a nurse for the pine in youth and should form a second story under it as the forest grows older.

If care is taken to protect the tract from fire there is every reason to expect that after lumbering in a pine ridge forest an excellent reproduction of pine will develop, and that this reproduction will, in years to come, produce a stand of mature timber superior to that of the present day.

The stand of merchantable pine on the pine ridge type is shown below.

TABLE NO. 7.—*Average stand of merchantable pine per acre on the pine ridge type, for Shortleaf and Loblolly, and the two species combined, for trees over 12 inches in diameter breasthigh.*

[Average of 1,516 acres.]

Species.	Merchantable contents.
	Board feet.
Shortleaf Pine	3,819
Loblolly Pine	2,126
Total	5,945

PINE FLAT.

On the low, almost perfectly flat lands the forest growth is in many respects very similar to that of the pine ridge type. The soils are of the same general character, but contain a larger amount of clay and are somewhat moister. Over considerable areas on these flats, and especially in the open spaces, there is a dense and often quite high growth of grass, and the usual ground cover of leaves, weeds, ferns, and huckleberries is common throughout. As on the ridges, the humus layer is exceedingly thin or entirely absent. The representation of the various species is shown by the following table:

TABLE NO. 8.—*Average number of trees per acre, percentage in mixture, and average diameters for the most important species, for trees 12 inches and over in diameter breasthigh.*

PINE FLAT.

[Average of 229 acres.]

Species.	Average number of trees per acre.	Percentage of each species.	Average diameter breast-high.
			Inches.
Loblolly Pine	10.35	33.91	19.9
Shortleaf Pine	6.21	20.35	18.7
White Oak	5.68	18.61	18.9
Post Oak	3.04	9.96	16.4
Gum	2.68	8.78	15.0
Spanish Oak	1.08	3.54	17.8
Black Oak	.65	2.13	16.0
Hickory	.63	2.06	14.7
Other species	.20	.66	13.6
All species	30.52	100.00	18.4
All species except pine	13.96	45.74	17.1
Pine	16.56	54.26	19.5

It is seen from this table that the Loblolly Pine is the most common tree on the pine flats. Where the conditions are well suited to it it is decidedly the dominant species of this type. Although Shortleaf Pine is also well represented, it is not so much at home as on the ridges; and the fresher the soil the more Shortleaf Pine gives way to the Loblolly. White Oak, Post Oak, and Gum are fairly numerous, while Hickory is very scarce. Of special interest is the proportion of pine to the hardwoods. In constitutes but little more than half the forest.

The general appearance of a pine flat forest is similar to that of the ridges, yet it differs in several particulars. As on the ridges, the pines stand high above the crowns of the hardwoods, the latter forming, as before, a kind of underwood; but instead of occurring by single trees or in small groups, the pines of the flats have a decided tendency to grow in large groups, occupying at times a quarter of an acre or

more. Scattered through these groups by single trees, or forming open groups and clumps by themselves, are oaks, gums, and other hardwoods, while both pine and hardwood reproduction is fairly abundant throughout. This reproduction is generally in the form of thickets from five to ten years of age, which prefer as a rule the more open spaces. While the reproduction of the pine ridges is usually a mixture of pine and hardwoods, on the flats the young growth occurs to a large extent in pure groups; that is, the thickets are either composed entirely of young pine or entirely of hardwoods.

The future of this type of forest, after lumbering and the removal of all merchantable pine above 12 inches in diameter, will be very similar to that of the pine ridge type, with the exception that the pine reproduction will not be hindered to such an extent by the hardwoods, as the latter are less numerous in the reproduction of the flats. If a few Loblollies over 12 inches in diameter are left standing on each acre as seed trees, the reproduction of the pine will be sufficiently cared for, and after cutting has admitted the light, seedlings of pine and hardwoods will rapidly develop. This reproduction, on account of slight variations in the nature of the soil and the characteristic grouping of the old trees, will tend to form itself into groups of pine and groups of hardwood, the latter composed almost entirely of oak.

Here again the all-important question is that of fire. What the future forest will be depends to a great extent upon the protection afforded. In this case, as on the ridge land, in spite of lumbering, fire, and the struggle with hardwoods, pine is bound to be the ruling species in the end, for the locality is natural pine land. It is simply a choice between fire protection, with a valuable future stand of pine, and no protection, with an inferior stand.

From the 229 valuation surveys taken on pine flats the average stand of merchantable pine per acre was found to be as follows:

TABLE NO. 9.—*Average stand of merchantable pine per acre on the pine flat type, for Shortleaf and Loblolly Pine and the two species combined, for trees over 12 inches in diameter breasthigh.*

Species.	Merchantable contents.
	Board feet.
Loblolly Pine	4,474
Shortleaf Pine	2,172
Total	6,646

HARDWOOD BOTTOM.

Lying in narrow belts on either side of the creeks and larger streams are the hardwood bottoms. They vary in width from a quarter of a mile along the smaller water courses to over 2 miles along

Saline River, and occupy the lowest levels on the tract. At any considerable rise in the streams they are flooded, and during the rainy season (in late winter and spring) they often remain under several feet of water for weeks at a time. Slight differences in level occur throughout these bottoms, and in the depressions or sloughs standing water is always present. (Pl. VI, fig. 1.)

The soil is very deep, rich sandy loam. Its condition varies greatly with the season, because during a part of the year it is subjected to constant inundations, and then again is left dry and exposed to the action of sun and wind. In the fall the surface of the soil is exceedingly hard and "caky." Owing to frequent inundation, the leaf mold is washed away and the soil left bare. A peculiarity of these bottom lands is the dense growth of cane (*Arundinaria tecta*), which forms by far the greater part of the ground cover. This cane varies in height from 2 to 10 feet, and often grows so densely that it is hard to walk through. Grass and weeds are present to some extent.

The forest is of an entirely different character from that of the pine ridge and pine flat types. It is composed almost entirely of broadleaf species, and the trees show a very different habit of growth from the hardwoods of the pine lands. The locality is distinctly hardwood land, as ridges and flats are pine lands. From the following table the composition of the forest is evident:

TABLE No. 10.—*Average number of trees per acre, percentage in mixture, and average diameters for the most important species, for trees 12 inches and over in diameter breasthigh.*

HARDWOOD BOTTOM.

[Average of 155 acres.]

Species.	Average number of trees per acre.	Percentage of each species.	Average diameter breast-high.
			Inches.
Gum	7.59	26.86	20.9
Hickory	5.81	20.55	18.9
Cow Oak	4.45	15.72	24.6
White Oak	3.47	12.27	20.7
Holly	2.05	7.25	14.6
Ash	1.30	4.60	18.2
Loblolly Pine	.71	2.52	19.5
Basswood	.62	2.19	17.7
Shortleaf Pine	.55	1.95	18.4
Post Oak	.22	.78	16.1
Other species	1.50	5.31	18.4
All species	28.27	100.00	19.9
All species except pine	27.01	95.53	20.0

The gums, including both Sweet Gum and Black Gum, comprise about a fourth of the total stand, while the hickories (principally Shagbarks, with a very few Pignuts and Bitternuts) are next in number. Cow Oak, White Oak, and Holly are all fairly well repre-

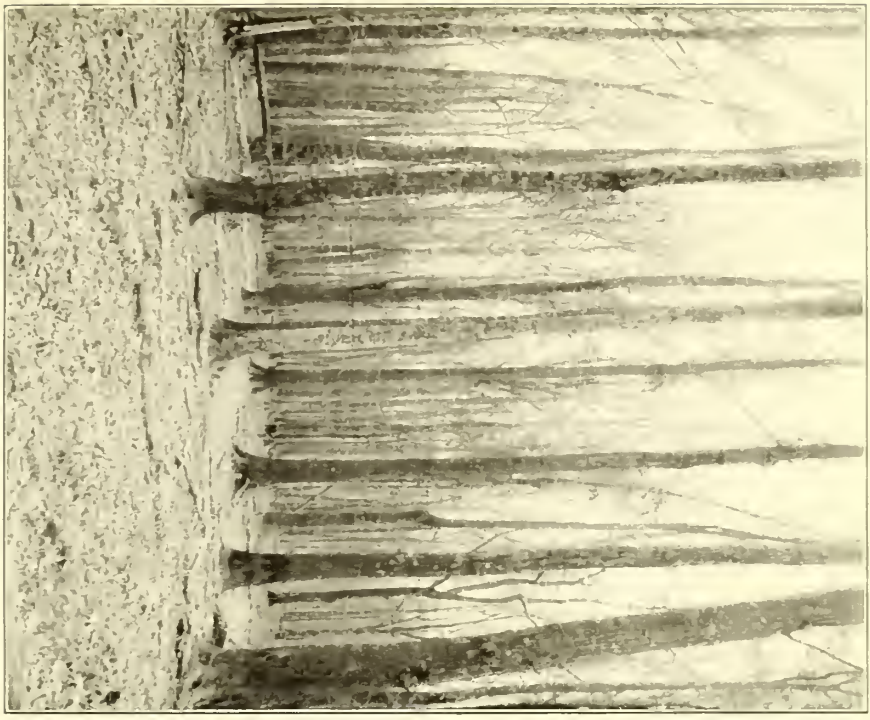

FIG. 1.—SWEET GUM AND WILLOW OAK IN A HARDWOOD BOTTOM.

FIG. 2.—COW OAK AND WHITE OAK.

FIG. 1.—A SLOUGH IN THE HARDWOOD BOTTOMS. COW OAK AND WILLOW OAK.

FIG. 2.—A HARDWOOD BOTTOM.

sented. In a typical hardwood bottom no pine is present, but along the borders of this type, where the soil is not quite so moist, a few pines occasionally creep in. This forest of broadleaf species is remarkable for its luxuriant growth and large timber.

Although the gums and hickories are the most important in point of numbers, the Cow Oaks and White Oaks will probably prove the most important commercially. The forest as a whole has the appearance of a nearly even-aged mature stand. The large, spreading crowns of the oaks slightly overtop those of the other species. Rising to nearly the same height are the gums, hickories, and ashes; and all these species are very evenly distributed over the entire bottom. Basswood is somewhat smaller in size, while the Holly and Hornbeam form a kind of scattering underwood to the main stand. The forest as a whole is dense, and but little light penetrates through the heavy crowns.

The most notable feature of this type of forest is the general absence of young growth. With the exception of scattering specimens of Sweet Gum, Holly, and Hornbeam saplings, reproduction of any description is lacking. The following facts account for such a state of things:

(1) Throughout a large part of the forest the ground is kept too dark for reproduction of any but the most tolerant species.

(2) Wherever sufficient light occurs for the germination of seedlings, these rarely succeed, because—

(*a*) The very dense growth of cane makes it almost impossible for a seedling to develop; and

(*b*) In case a seedling struggles on in spite of the cane, it rarely survives the frequent and severe floods which are sure to occur each year.

It is difficult to foretell just what the result of lumbering in the hardwood bottoms will be. In all probability no natural reproduction of the desired species can be hoped for, because of the dense cane and grass and the inundations. As soon as light is admitted by the cuttings the growth of cane and grass will be greatly stimulated. No figures can be given in this report in regard to the rate of growth of the hardwoods, as circumstances were such that it was deemed best to confine such work to the pines. If the diameter limit is kept fairly high in cutting these hardwoods (say at 20 inches), there is every reason to believe that a good second crop will be ready for the axe when the pine lands are cut over the second time. The chances of a sustained yield in future years are, however, doubtful.

The hardwood bottoms are not subject to forest fires, on account of the moistness of the ground and the sentiment of the local population. The dense growth of cane furnishes a most excellent supply of fodder for cattle, and every winter the bottoms are full of stock from the neighboring villages. In case a fire breaks out an alarm is soon given and it is quickly extinguished.

Here is a very pretty example of how interest affects the fire question. In the bottom lands the people are directly interested in protecting the grazing, and consequently the sentiment is strong against allowing fires to run in them. On the other hand, they have no particle of interest in future timber supplies or understanding of the damage which fire causes to the forest. As a consequence, there is absolutely no sentiment against fire in pine lands.

SILVICULTURAL NOTES.

BRIEF DESCRIPTIONS OF THE MOST IMPORTANT SPECIES.[a]

Shortleaf Pine (*Pinus echinata* Mill.).

Situation.—The Shortleaf Pine occurs most extensively on the relatively higher, very gently rolling pine ridge land. On the flats of the lower levels it generally gives way to the Loblolly. It reaches its best development on the side slopes rather than on the flat tops or in the bottoms, probably on account of the better drainage.

Soil.—A fairly light, dry sandy loam is the soil upon which this species grows to best advantage. On the low levels and in the slight depressions where the soil is moist, or even fresh, it can not compete with the Loblolly. Sometimes a little dip with a difference in level of only a few feet will bring about a change of species. The Shortleaf Pine is not exacting in regard to the mineral composition of the soil, and can flourish upon comparatively poor lands. Its chief requirement is that the soil be deep, porous, and well drained.

Tolerance and reproduction.—Direct sunlight with no shade whatever is the condition of light best suited to this species throughout its whole life. During extreme youth, however, it is capable of living under an open or very broken canopy of hardwood foliage.

Shortleaf Pine begins to produce seed when 25 or 30 years old, and occasional cone-bearing specimens but 15 or 20 years of age were met with. After the thirtieth year, at any rate, an abundant supply of seed is produced every two or three years, and under favorable conditions the reproduction of this species is marvelous.

Upon old, abandoned fields surrounded by or situated near to seed-bearing pines ideal conditions are met with. Such localities furnish the two essentials for excellent reproduction—an abundance of light and protection against fire. Seeds blow in from the neighboring trees, and at first a scattering growth of seedlings appears. This gradually becomes more closed and regular, until after eight or ten years a very dense thicket is found, which rapidly develops into a young pole

[a] These silvicultural descriptions apply simply to the particular locality for which the working plan was made, and are not to be regarded as holding good for any species over its whole range of distribution.

forest. By a natural process of pruning, the lower branches die and fall off, while the weaker trees are suppressed in the struggle for existence. Such reproduction can be seen on almost any old field, and if protected from fire it will produce a heavy and valuable stand of mature timber.

In this connection the areas known as "hurricane breaks" are of interest. Between thirty and forty years ago a tornado completely destroyed the forest in a narrow strip about half a mile wide and 4 or 5 miles long. This entire area is now grown up with a pole forest of Shortleaf and Loblolly Pine, in which hardwoods occur but rarely. The pine seed evidently blew in from the surrounding forest.

With open ground and plenty of light there is, then, no difficulty in obtaining an excellent reproduction of Shortleaf Pine. The difficulty occurs when reproduction is required under a certain amount of shade from both broadleaf and coniferous trees, upon ground where the young pine must fight for existence with a growth of oak, gum, hickory, and other hardwoods, and struggle along against the ravages of repeated fires. After the first eight or ten years, the period during which this species is capable of existing under the broken shade of broadleaf reproduction, the chances are that, unless the plant has succeeded in forcing its leading shoot up through the broadleaf growth surrounding it, it will give up the struggle and yield the ground to the hardwoods. Fortunately a large percentage of the pine seedlings usually succeed in outgrowing and overtopping the hardwoods at this important point, and from then on develop rapidly to maturity. Reproduction is also difficult on ground covered by a dense growth of grass, although a light growth seems to have no great influence.

If a good reproduction of Shortleaf Pine is wished for, protection against fire is absolutely necessary.

After lumbering under present methods, with the simple addition of a system of fire protection and the leaving of an occasional Shortleaf Pine above the diameter limit to furnish seed for reproduction, the new growth of this species should be excellent. It will appear at first as scattering seedlings under the young growth of hardwoods, and will slowly push up above the latter. As time goes on it will gradually become more dense and tend to form itself into groups. Groups will be formed because in some places the pine will have an easier time of it against the hardwoods than in others. Consequently there will be groups of hardwoods where these are too well established to be replaced by pine, and groups of pine where the latter wins.

One point in connection with the reproduction of Shortleaf Pine can not be too strongly emphasized. While there is no doubt that a young growth much superior to that which will follow the usual method of lumbering could be obtained if a number of merchantable Shortleaf Pine trees were left standing on each acre and a large quantity of the

hardwoods were cut, it is a most fortunate circumstance that even after ordinary lumbering the pine will eventually predominate, for the simple reason that the locality is one naturally suited to it.

Only those silvicultural operations are allowable which are justified by future returns. In this particular case there is no doubt that the very slight expense caused by leaving an occasional seed tree and maintaining a system of fire protection is well justified by the increase in value which will result to the future stand. Anything beyond this would involve a present expense without the certainty of an improvement in the forest which would pay for it.

Occurrence.—In the present composition of the forest the Shortleaf Pine occurs most frequently by single specimens, although found at times in small groups. It is almost invariably associated with the hardwoods, seldom forming pure stands. In the future forest the occurrence of this species should be more and more by groups, and by groups constantly increasing in size. Such will be the case if fire is kept out.

Development.—Under ordinary forest conditions this species produces a long and straight cylindrical bole, having at times a clear length of nearly 60 feet. The crown is irregular in shape, approaching the form of a truncated cone, and the stem has a tendency to fork near the top of the crown. The height of merchantable trees varies from 70 to 120 feet. Trees over 40 inches in diameter breasthigh are very rarely met with.

The accompanying diagrams illustrate the growth of the Shortleaf Pine. They are simply graphic presentations of the figures obtained from the stem analyses.

Relation of diameter to height.—This curve shows the relation between the diameter and the height growth of Shortleaf and Loblolly Pine, since the two species exhibit no marked difference in this respect. As can be seen from the curve, the height increases very rapidly with diameters up to 5 or 6 inches. The rate then diminishes in a very uniform manner until the largest diameters are reached. (See fig. 4.)

Relation of age to diameter.—The relation between age and diameter breasthigh is here shown for both Shortleaf and Loblolly Pine.

The diameter of the Shortleaf increases very regularly for the first hundred years, after which the rate of increase begins gradually to fall off. For the first hundred years the average time required to grow 1 inch in diameter is five and one-half years. It will be seen from the curve that if 12 inches be taken as the cutting limit, Shortleaf Pine first becomes merchantable after sixty-two years. (See fig. 5.)

Relation of age to height.—The height growth for both Shortleaf and Loblolly Pine is represented in this diagram. For Shortleaf the height growth is exceedingly uniform and quite rapid for the first twenty years, after which period the rate gradually diminishes. For

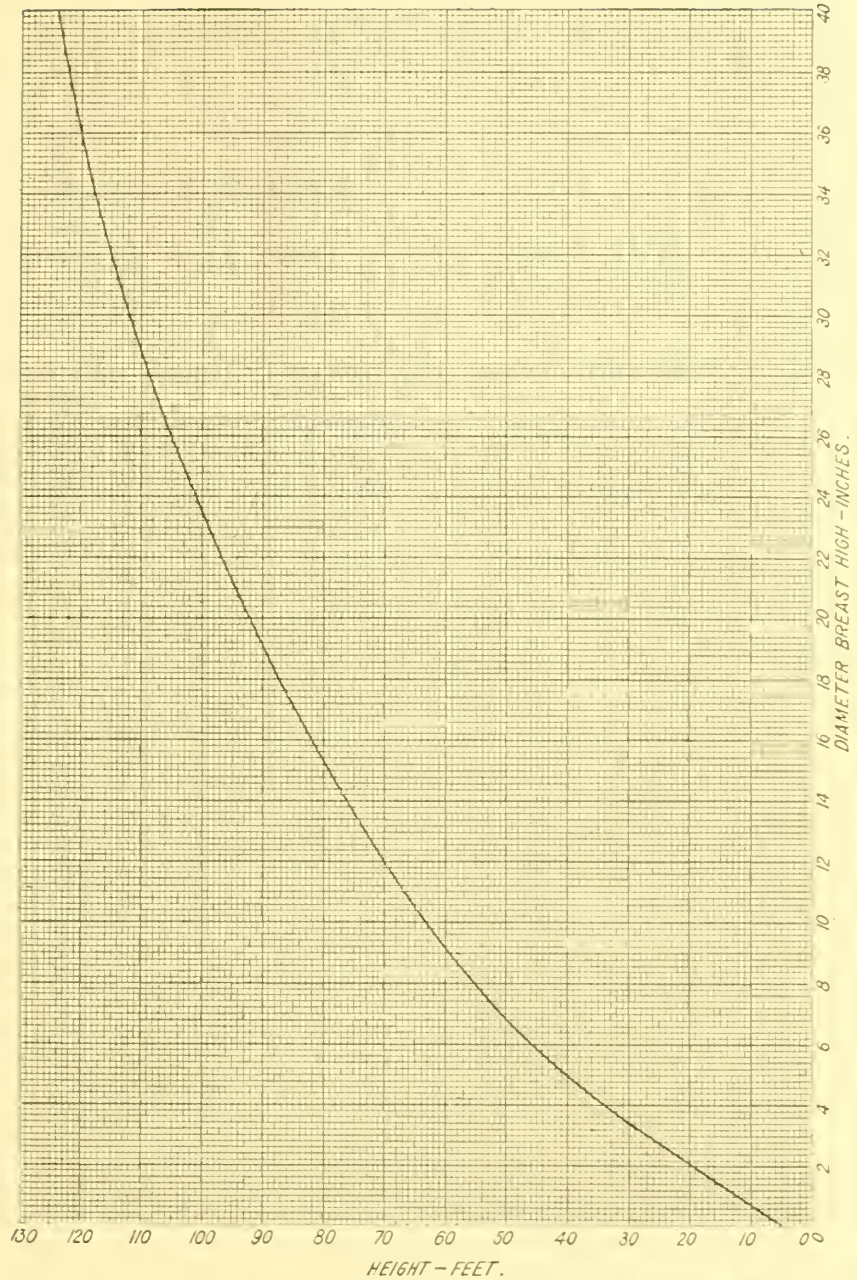

FIG. 4.—Diagram showing the height growth of Shortleaf and Loblolly Pine on the basis of diameter breasthigh.

the first one hundred years the yearly average growth in height is 0.83 foot, and for the first twenty years 1.5 feet. (See fig. 6.)

Relation of age to merchantable contents.—The curve here given

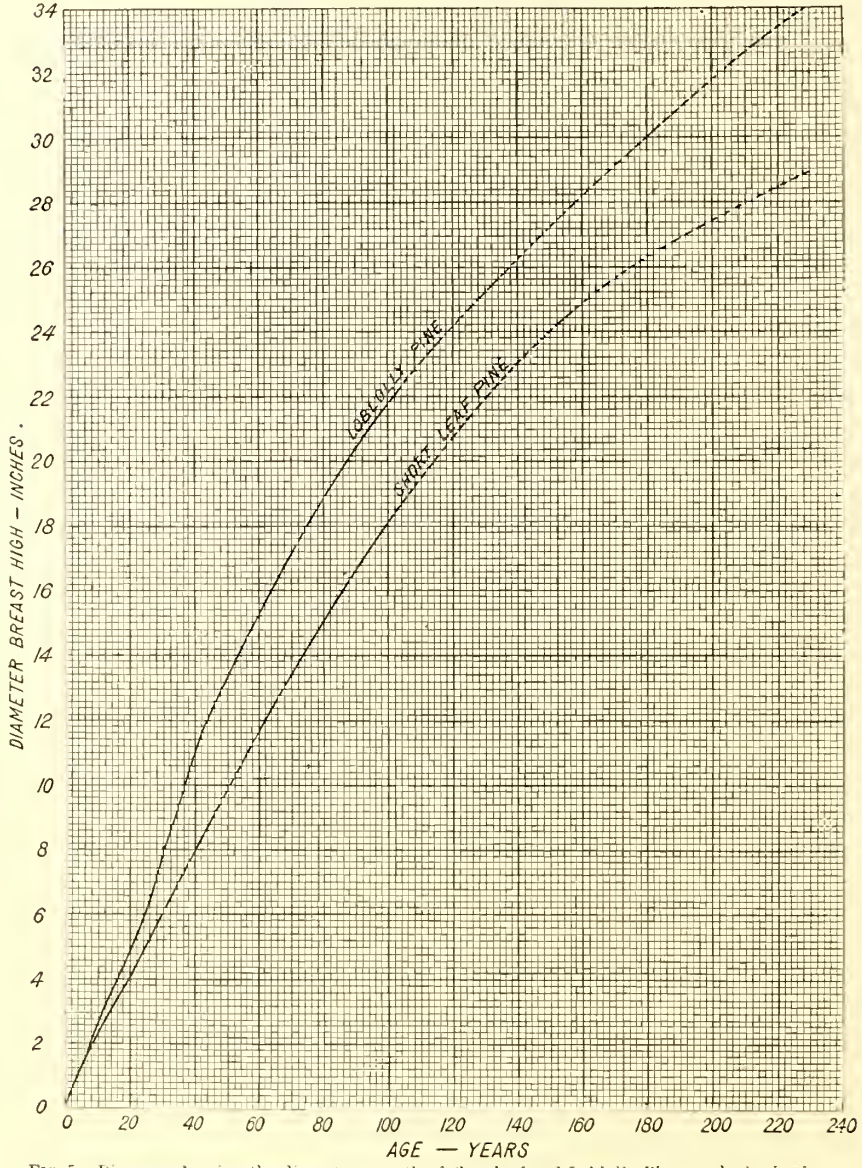

FIG. 5.—Diagram showing the diameter growth of Shortleaf and Loblolly Pine on the basis of age.

shows the volume growth in board feet for Shortleaf and Loblolly Pine, the contents being calculated according to Doyle's Rule.

Between 80 and 140 years of age the Shortleaf Pine increases very uniformly in merchantable contents, after which age the rate of

increase begins to fall off. The merchantable contents of Shortleaf Pine under 80 years of age is somewhat uncertain, as the diameters become too small for accurate calculations. Between the ages of 60 and 100 years the average yearly increase in merchantable contents amounts to 6.25 board feet, and between 60 and 200 years to 7.71 board feet. (See fig. 7.)

Relation between diameter, total height, merchantable length,[a] *crown length, and clear length.*[b] (See fig. 8.)—The principal point of interest connected with this diagram is the rapid increase in the length of merchantable timber obtained from trees of 15 to 24 or 25 inches in diameter, and the small additional length obtained from trees of greater

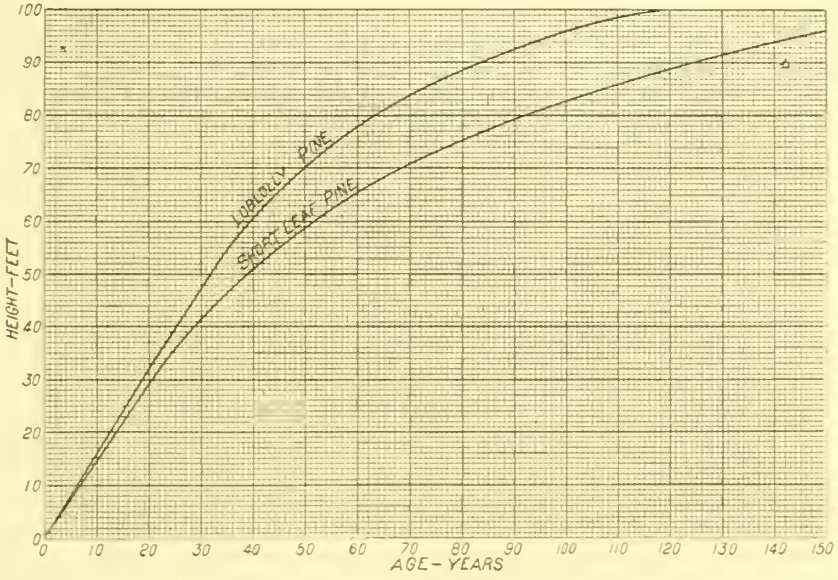

FIG. 6.—Diagram showing the height growth of Shortleaf and Loblolly Pine on the basis of age.

diameters. The merchantable length is greatest in proportion to the total height when the tree has a diameter of 20 inches. In this case a little more than one-half of the total height is merchantable.

By comparing the curves for clear length and for merchantable length it will be seen that for trees below 19 inches in diameter the merchantable length is less than the clear length, while above that diameter the reverse is true. In other words, in trees over 19 inches in diameter breasthigh (21 inches on the stump) the logs are cut up into the crowns, the distance to which the cut extends into the crown increasing as the diameter of the tree increases.

[a] Merchantable length is the total length of merchantable timber; in other words, the sum of the log lengths.

[b] Clear length is the distance from the ground to the point where the branches of the crown begin.

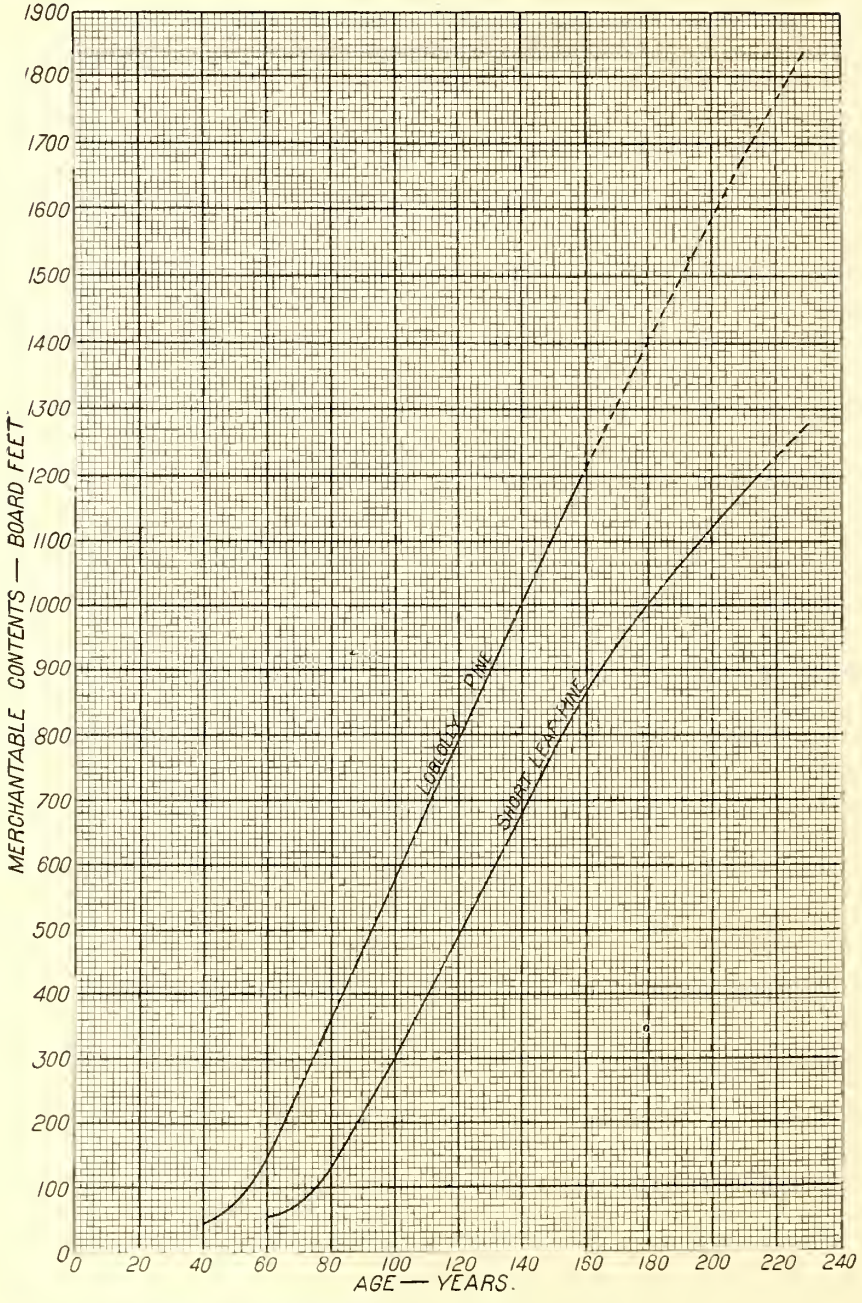

FIG. 7.—Diagram showing the merchantable contents in board feet of Shortleaf and Loblolly Pine on the basis of age. (Contents by Doyle's Rule.)

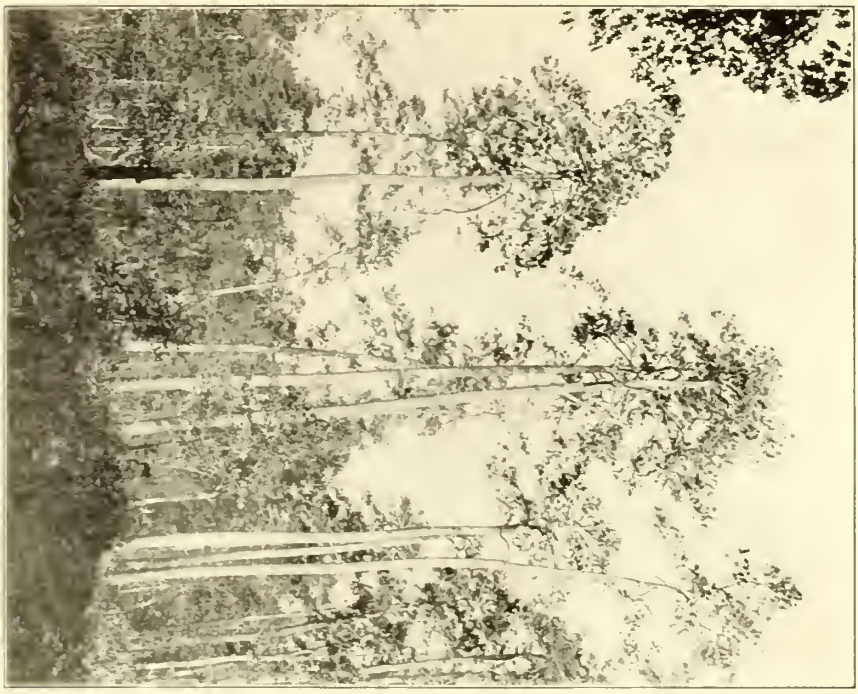

FIG. 1.—LOBLOLLY PINE.

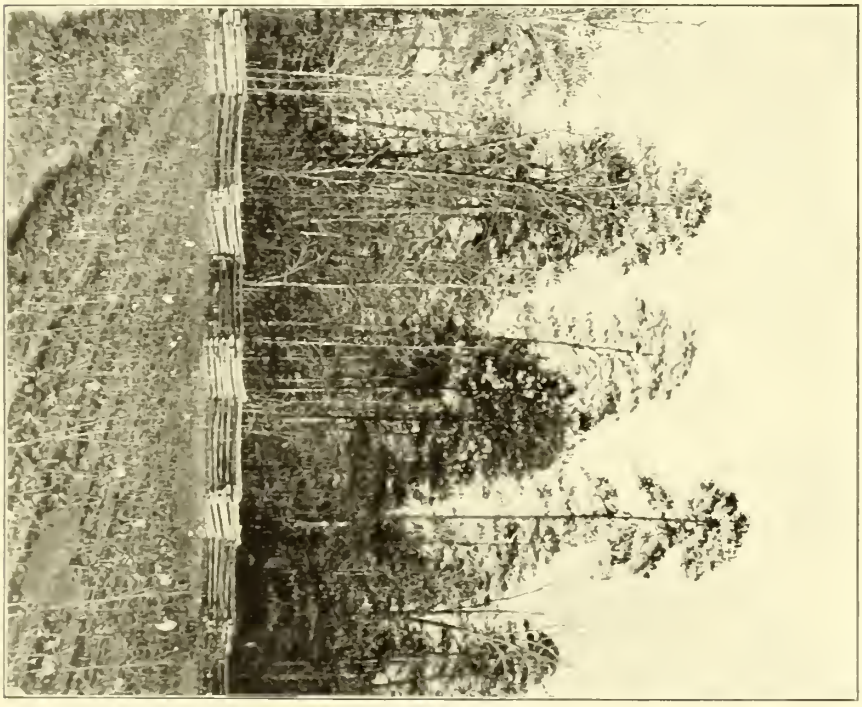

FIG. 2.—SHORTLEAF PINE.

FIG. 1.—REPRODUCTION OF LOBLOLLY PINE IN AN OPENING.

FIG. 2.—HARDWOOD REPRODUCTION UNDER LOBLOLLY.

LOBLOLLY PINE (*Pinus taeda* Linn.).

Situation.—Loblolly Pine is found at its best on the pine flats. It also occurs on the ridges, but seldom reaches its full development there.

Soil.—Soils which are favorable to the Shortleaf Pine are also most suitable to the Loblolly, with the one exception that the latter requires

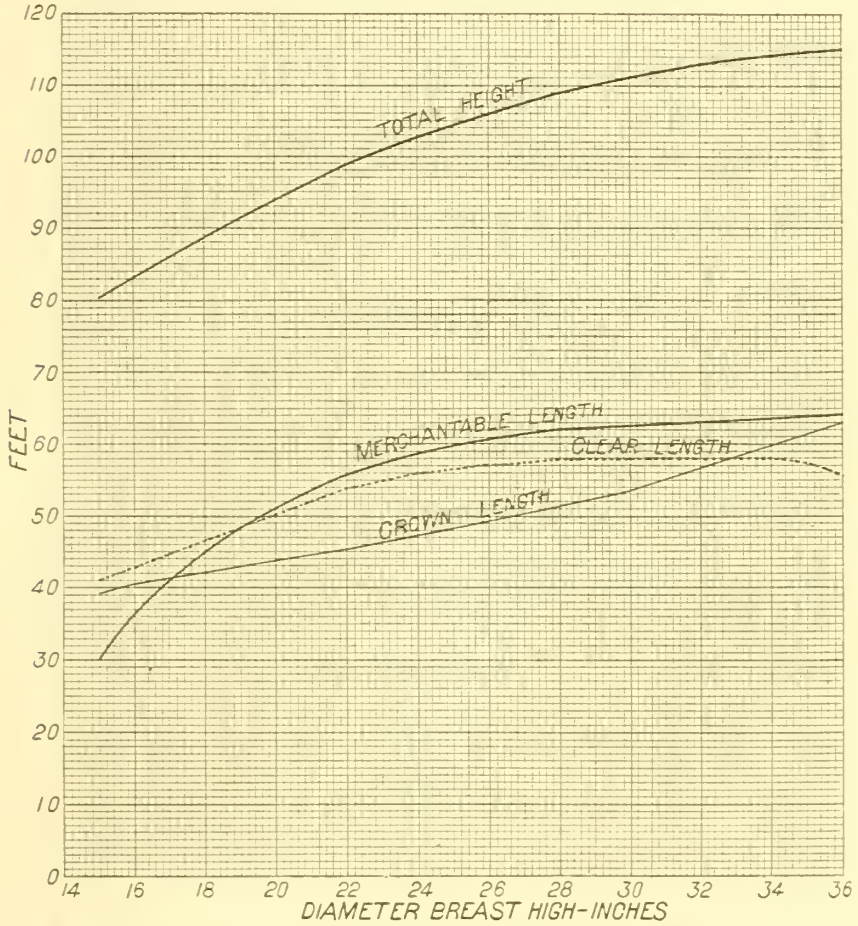

FIG. 8.—Diagram showing the relation between the total height, merchantable length, crown length, and clear length for Shortleaf Pine on the basis of diameter breasthigh.

a little more moisture. The Loblolly prefers a fresh soil, and it can flourish even in a fairly moist one. Occasional specimens are found on the higher levels of the bottom lands. Any prolonged exposure to standing water is, however, quite fatal to its growth.

Tolerance and reproduction.—In its demand for light, the Loblolly is very similar to the Shortleaf Pine, with the important exception

that under certain conditions it can tolerate a greater amount of shade during youth; where the soil conditions are favorable, Loblolly seedlings will come up under an amount of shade from the hardwoods which Shortleaf seedlings would not be able to withstand. Nevertheless, the Loblolly, like the Shortleaf, develops to best advantage under direct, open sunlight.

When 25 or 30 years of age this species begins to produce seed abundantly, and, when conditions are favorable, the reproduction is equal if not superior to that of the Shortleaf. Here, again, the young growth flourishes best in old fields, and the thickets and pole forests of Loblolly on such ground are similar in every respect to those described for Shortleaf Pine. The question as to whether Loblolly or Shortleaf will predominate on old fields depends largely on which species the locality is best adapted to. When conditions of soil are equally favorable to both species the Loblolly will generally win on account of its faster growth. But on very poor, dry ridge land the Shortleaf has the best of it. Very rarely indeed do the two species grow up into a forest where each is equally represented; one or the other will generally predominate largely in the end.

In the forest the best reproduction of Loblolly Pine is on the pine flats, because on them the mature trees are much more numerous. Here the young growth is usually found in large or small groups, always making for the open spaces, where there are any. The reproduction is in general much better than that of Shortleaf, on account of the greater tolerance of the Loblolly, and because of the smaller percentage of hardwoods in mixture where the reproduction of this species occurs. As might be expected from its greater tolerance, Loblolly gradually gains the upper hand over Shortleaf where the former has an equal chance. It must be remembered, however, that the number of seed-bearing Shortleaf Pine is far greater than that of the Loblolly, and hence the latter species is at a great disadvantage. Nevertheless, the percentage of Loblolly is gradually increasing.

Occurrence.—Loblolly occurs mostly in large groups, although occurrence by single trees is not at all uncommon. These large groups often have the appearance of miniature pure forests, as the percentage of hardwoods in mixture is small. If fire is kept out, the forest of the future should consist of much larger groups, and it can even be expected that over considerable areas the Loblolly will completely supplant the hardwoods and form very valuable stands of pure pine.

Development.—Under favorable conditions this species produces a long, straight bole, free from branches to a height of 50 or 60 feet from the ground, and has a thin and irregular crown. Its percentage of sapwood is greater than that of the latter species, as the table following shows.

TABLE No. 11.—*Per cent of sapwood in the merchantable contents of Shortleaf and Loblolly Pine, for diameters from 24 to 32 inches, breasthigh.*

Diameter breasthigh.	Shortleaf.	Loblolly.
Inches.	*Per cent.*	*Per cent.*
24	55.4	76.0
25	53.4	72.5
26	51.4	68.9
27	49.9	65.2
28	48.7	61.3
29	47.7	57.3
30	47.0	53.1
31	46.3	48.9
32	45.8	44.5

The growth of the Loblolly Pine can best be understood by a study of the curves of the various diagrams. Most of these will be found in the figures already given for Shortleaf Pine. The curves for both species are shown on the same diagram, that the two may be more readily compared.

Relation of age to diameter.—(See fig. 5.) The curve for Loblolly Pine here shows a much more rapid growth than that of the Shortleaf. For the first one hundred years the average time required to grow 1 inch is four and one-half years. If the cutting limit be placed at 12 inches, it will be seen that Loblolly reaches a merchantable size when 44 years old, or eighteen years earlier than the Shortleaf.

Relation of age to height.—(See fig. 6.) The height growth for Loblolly is rapid and very uniform for nearly forty years. After this age the rate gradually diminishes. For the first one hundred years the yearly average growth in height is 1.04 feet. As can be seen from the two curves, there is very little difference in the height growth of the two species for the first twenty years.

Relation of age to merchantable contents.—(See fig. 7.) The volume curve here given for Loblolly Pine is seen to be very nearly a straight line. The rate of increase in merchantable contents is remarkably uniform. The upper portion of this line is dotted, because so very few Loblollies over 160 years of age were analyzed that the results can not be accepted as conclusive. It is probable that in practice the actual contents of the older trees would be somewhat less than is here shown. Between the ages of 44 (when the Loblolly reaches a diameter of 12 inches) and 100 years, the average yearly increase in merchantable contents is 9.28 board feet per tree.

Relation between diameter, total height, merchantable length, crown length, and clear length.—(See fig. 9.) In trees from 15 to 30 inches in diameter the merchantable length increases quite regularly as the diameter becomes larger, but in trees above 30 inches the length of

merchantable timber increases but slightly. In proportion to the total height the greatest merchantable length is obtained from trees about 20 inches in diameter, and, as with the Shortleaf, this amounts to only one-half the total height of the tree. The merchantable length is less than the clear length in trees below 20 inches in diameter, but in large trees the reverse is true.

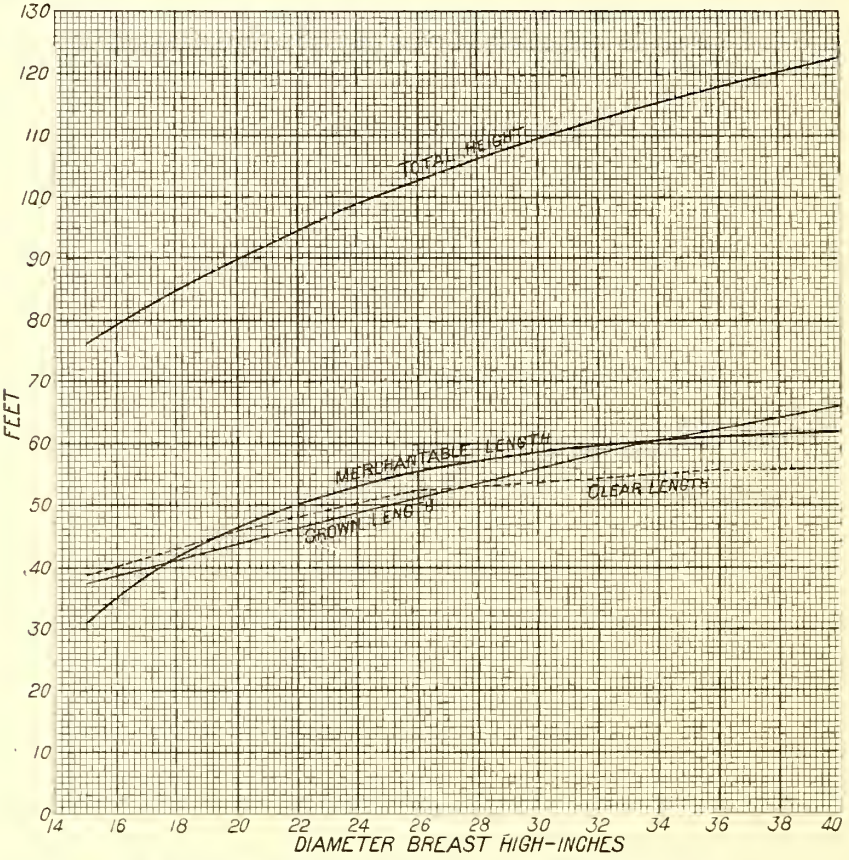

FIG. 9.—Diagram showing the relation between the total height, merchantable length, crown length, and clear length for Loblolly Pine on the basis of diameter breasthigh.

PRACTICAL VALUE OF THE LOBLOLLY PINE AS COMPARED WITH THE SHORTLEAF PINE.

In case conservative lumbering is undertaken upon the tract of the Sawyer & Austin Lumber Company, it will be possible to increase the percentage of the most valuable species in the forest of the future. As already said, there is no doubt whatever that an increase in the stand of pine and a decrease in that of hardwoods would very materially increase the value of the forest. More than this, there are notable differences between the two species of pine, and such differences should also be taken into consideration, and the species which gives promise

of affording the largest returns in the future should be favored in every way possible.

The only advantage which the Shortleaf possesses over the Loblolly Pine is that at the present time Shortleaf Pine lumber commands a slightly higher price than Loblolly, owing principally to the greater amount of sapwood in the Loblolly. On the other hand, the Loblolly has the following great advantages over the Shortleaf:

(1) The reproduction is easier to obtain, because Loblolly endures more shade during extreme youth and so has a better chance in the struggle with the hardwoods.

(2) The rate of growth of Loblolly is much more rapid than that of Shortleaf; hence it produces a given amount of timber in a much shorter time.

(3) Wherever Loblolly becomes firmly established the forest growth tends to be more dense and more nearly a pure pine forest than with Shortleaf. The stand per acre is therefore greater.

These advantages of the Loblolly outweigh the slight superiority in the wood of the Shortleaf, and it would be advisable, therefore, to favor the former species in every possible way. This can be done by using care in the selection of trees to be left standing for seed purposes. Wherever feasible, Loblolly should be left in preference to Shortleaf. Great care is necessary, however, in selecting the trees to be left, as much depends upon the nature of the locality. In some situations the Shortleaf would develop to much better advantage than the Loblolly. In such cases Loblolly should not be favored.

Cow Oak (*Quercus michauxii* Nutt.).

Situation.—This species occurs only in the hardwood bottom type. In these bottom lands the important point is whether the various species occupy the lower or the higher levels, the moist or wet, or the relatively dryer soils. Cow Oak always occurs on the slight elevations and invariably shuns the depressions, showing that it is not suited to an excess of moisture in the soil.

Soil.—No variation exists in the composition of the soil of these bottom lands, and all the species flourish alike on the deep, fresh or moist compact loam.

Tolerance and reproduction.—In common with the other oaks, the Cow Oak is very intolerant of shade and requires full light for development during its entire life. Reproduction of this species is exceedingly scanty, and not likely to be increased by lumbering, for in spite of the favorable conditions of light which would be created it is improbable that the seedlings could withstand the dense growth of cane and the frequent floods.

Occurrence.—Cow Oak is one of the most common as well as the most valuable species of the bottoms, and occurs by single trees evenly

distributed throughout the type. Very few young trees are present; almost the entire stand is composed of veterans.

Development.—The Cow Oaks of these bottoms have massive cylindrical boles, rising 60 or 70 feet before branching. They bulge out considerably at the base, and as a rule incline to be squarish or angular in form. Small clumps of twigs commonly sprout out at short intervals over the whole length of the stem.

The crown is large and massive, consisting generally of two or three heavy main forks, and extends slightly above the surrounding forest canopy, occupying a large amount of space when well developed. It must always have plenty of light and room.

White Oak (*Quercus alba* Linn.).

The White Oaks of the bottom lands are similar in every way to the Cow Oaks described above. When growing on the pine lands this species is inferior in character and of much smaller proportions. It seeks out the best soils, reproduces readily, and is intolerant of shade.

Sweet Gum (*Liquidambar styraciflua* Linn).

Situation.—This species occurs both on the elevations and in the depressions of the bottom lands, and is able to grow in places where standing water is present during most of the year. It is also common throughout the pine lands, but the growth is here very scrubby in comparison with the splendid development attained in the bottoms.

Tolerance and reproduction.—Sweet Gum can tolerate a good deal of shade, and the reproduction grows well under the shelter of oak, ash, hickory, etc. It seems also to flourish equally well in the open. This is the only species of the bottoms with a fair amount of young growth present. Its reproduction occurs everywhere, although in a thin and scattered form.

Occurrence.—Sweet Gum occurs by single trees; occasionally also a pure pole forest of limited extent is met with.

Development.—The bole is inclined to be somewhat crooked and enlarged at the butt, and is fairly cylindrical and free from branches for 50 or 60 feet from the ground. The crown is large and somewhat more dense than that of the Cow Oak.

White Ash (*Fraxinus americana* Linn.).

Situation.—Like the Sweet Gum, the White Ash flourishes in the hollows of the bottoms where water collects, seeming to prefer such locations to the drier elevations; it is found even in the sloughs, where water is almost always present, at least to the depth of a few inches. White Ash occurs to a very limited extent on the pine lands.

Tolerance and reproduction.—White Ash can succeed under a good deal of shade, but young growth is very scarce.

Occurrence.—Always by single trees.

Development.—The bole is massive and cylindrical, and the crown large, spreading, and irregular in shape. It attains about the same proportions as the Sweet Gum.

SHAGBARK HICKORY (*Hicoria ovata* Britton).

Situation.—This species prefers the higher levels in the bottom lands, and is never found in standing water. It occurs also on the pine lands, but its development here is very poor in comparison with the fine proportions it reaches in the bottoms.

Tolerance and reproduction.—Young growth is very scarce; what there is seems to tolerate a certain amount of shade.

Occurrence.—Always by single trees.

Development.—The crown is large and dome shaped, and the bole long, slender, and somewhat tapering; a clear length of 40 to 50 feet is quite common.

HOLLY (*Ilex opaca* Ait.).

Situation.—The Holly seems to be at home alike on the slight elevations and in the depressions of the bottoms, although always shunning any considerable amount of standing water. It occurs but rarely on the pine lands.

Tolerance and reproduction.—This species is very tolerant of shade. It will come up under dense foliage and very slowly force its way through the crowns of all species overtopping it. The reproduction is scattering throughout.

Occurrence.—Always by single trees.

Development.—The Holly is small in comparison with the other species, seldom attaining a height of over 30 or 40 feet or a diameter of over 24 inches. Its bole is tapering and covered almost to the ground by its dense, conical-shaped crown.

HORNBEAM (*Carpinus caroliniana* Walt.).

With the Holly, this species forms a kind of underwood to the large oaks, gums, etc., although it is generally so stunted as to resemble a bush rather than a tree. In regard to situation, tolerance, and occurrence it resembles the Holly, but in mode of growth it is very irregular, usually forming a crooked, short bole and a very broken and open crown.

PART II.

FOREST MANAGEMENT.

INTRODUCTION.

Under ordinary lumbering the forest is treated as if its value lay only in the merchantable timber which it contains. Under practical forestry immature trees have a value because they form the basis for future crops. Practical forestry, through a slight expense in the care of young growth and in the protection of the forest from fire, insures the production of a permanent supply of timber. Ordinary lumbering in saving this expense sacrifices largely or wholly the productive capacity of the lumbered area.

The advantage of practical forestry as a business investment depends naturally upon whether it offers better returns than those to be had from ordinary lumbering. Since practical forestry reduces present profits slightly, in order that the forest may produce a steady supply of timber, its financial success rests upon the safety and value of the future crops which it fosters. For example, uncontrollable danger of fire makes forestry unadvisable, since the care given to the production of a second crop may be nullified by injury to the young forest. Again, a low profit on lumbering may render the probable value of future crops of timber insufficient to justify the attempt to foster them.

The tract of the Sawyer & Austin Lumber Company presents conditions which render the application of practical forestry a thoroughly sound business measure. The forest contains an excellent stand of merchantable timber which can be lumbered inexpensively and for which there is a steady and profitable market. The protection of the forest from fire is practicable at small cost and will render the reproduction of the pine a simple and certain matter. The stand of immature trees of certain sizes is somewhat deficient as the result of forest fires in the past. This deficiency, however, is not large enough to impair future yields seriously, and will be largely remedied under conservative management.

TIMBER YIELDS.

The following table shows, approximately, the present stand of merchantable timber per acre upon the tract of the Sawyer & Austin Lumber Company and the future yields to be expected from the lumbered areas. The measurements of the stand and of its rate of growth

upon which this table is based, were carefully made, and it is believed the table is a fair estimate of what may be expected. It is exceedingly probable that it underestimates rather than overestimates, since not only were the most conservative figures used throughout, but no allowance has been made for the improved conditions for forest growth which will result under the application of conservative lumbering.

The table also shows the yield per acre of merchantable pine which may be expected after twenty, thirty, and forty years, cutting to the diameter limits of 12, 14, 16, 18, and 20 inches breasthigh, and also the time required before a yield equal to the present merchantable stand may again be obtained.

TABLE NO. 12.—*Present and future yields of pine per acre, and time necessary before the present yield may again be obtained.*

Cutting-limit, diameter breasthigh.	Present cut.	Cut after 20 years.	Cut after 30 years.	Cut after 40 years.	Present cut again obtained.
Inches.	*Board feet.*	*Board feet.*	*Board feet.*	*Board feet.*	*Years.*
12	6,067	1,047	2,467	5,270	42
14	5,845	957	2,408	5,278	41
16	5,597	1,225	2,678	5,212	41
18	5,130	1,309	2,612	4,678	42
20	4,561	1,381	2,333	4,174	42

It will be noticed that in general the cut after twenty years increases as the diameter limit is raised; that at thirty years the cut increases to the 16-inch limit, and then falls away again, and that at forty years it decreases as the diameter limit increases.

The time required before equal cuts can again be obtained is irregular and needs explanation. Ordinarily, raising the diameter limit decreases the time. But the table shows that the time is here the same whether the diameter limit is 12 or 20 inches—forty-two years in each case. This is due partly to the fact that the growth of the pine of small diameters, especially that of the Loblolly, is very rapid. In forty-two years Loblolly, with a present diameter of 12 inches, and Shortleaf, with a present diameter of 14 inches, will have passed the 20-inch limit, and Loblolly of 2 inches and Shortleaf of 5 inches will have passed the 12-inch limit. A second reason for the disproportionate length of the period required to produce a second crop equal to the first at a 20-inch diameter limit is the fact that the forest is "abnormal," the number of trees between 14 and 20 inches being especially small, as is shown by fig. 1, the probable result of the severer fires due to the accumulated rubbish when fires first became frequent. These are just the trees which would have to furnish the next equal crop cutting to a diameter limit of 20 inches.

EFFECT OF FIRE PROTECTION UPON FUTURE YIELDS.

An important conclusion follows. The fires which have repeatedly swept the tract have reduced the proportion of pine trees under 22 inches now standing. If the forest were normal—that is, if all age classes were present in sufficient amounts to maintain the present stand of mature timber in years to come—equal cuts could be obtained in much shorter periods than are now necessary, and probably twenty-five years would produce a second crop equal to the first. In that case a total area of 170,000 acres would suffice for a sustained yield equal to the present annual consumption instead of the much larger area now required.

SUSTAINED ANNUAL YIELD OF THE FOREST.

The sustained annual yield which can be obtained from the forest is given in the following table. It shows the annual merchantable cut of pine per acre, the area to be lumbered annually, the total annual cut, and the time required for a second cut equal to the first, for the diameter limits of 12, 14, 16, 18, and 20 inches.

TABLE NO. 13.—*Sustained annual yield of merchantable pine in board feet, area to be lumbered annually, and time required to cut over tract.*

Cutting limit, diameter breasthigh.	Area to be lumbered annually.	Annual cut per acre.	Total annual cut.	Time required to cut over tract.
Inches.	*Acres.*	*Board feet.*	*Board feet.*	*Years.*
12	2,380	6,067	14,439,460	42
14	2,439	5,845	14,255,955	41
16	2,439	5,597	13,651,083	41
18	2,380	5,130	12,209,400	42
20	2,380	4,561	10,855,180	42

SUSTAINED ANNUAL YIELD IN RELATION TO THE PRESENT CAPACITY OF THE MILL.

The Sawyer & Austin Lumber Company own and operate a mill with an annual capacity of 40,000,000 board feet. The present tract of 100,000 acres, cutting to a diameter limit of 12 inches, can supply continuously about 14,500,000 feet per year. The following table shows, approximately, the forest area which would be necessary to produce a sustained annual yield of 40,000,000 board feet per year. It estimates for the several diameter limits the annual cut per acre, the area to be lumbered annually, the time required to cut over the present tract, and that required for a second cut equal to the first.

TABLE NO. 14.—*Area necessary for a sustained annual yield of 40,000,000 feet per annum.*

Cutting limit, diameter breasthigh.	Annual cut per acre.	Area to be lumbered annually.	Time required to cut over present tract.	Time required before second cut equal to first can be obtained.	Total area necessary for sustained annual yield.
Inches.	*Board feet.*	*Acres.*	*Years.*	*Years.*	*Acres.*
12	6,067	6,593	15	42	276,906
14	5,845	6,844	14½	41	280,604
16	5,597	7,147	14	41	293,027
18	5,130	7,797	13	42	327,474
20	4,561	8,770	11½	42	368,340

Cutting to 12 inches, therefore, a sustained annual yield equal to the capacity of the mill can be obtained by the addition of about 170,000 acres of forest land similar in character to that of the present tract.

INTEREST RETURNS ON CUT-OVER LANDS.

It is obvious that calculations of future financial returns from conservative lumbering can not be infallible, because changes in the value of land or of timber may entirely alter the premises upon which these calculations are based. However, when compiled from adequate and conservative data, estimates of future money returns are of reasonable safety and of no small practical value.

The table below relates simply to land which has been cut over, and shows the annual interest, represented by future cuts, on the capital invested in the land. At the present time cut-over lands can be bought at an average price of 50 cents per acre, but, in order to be conservative, calculations are made with such lands valued at $1 and $1.50. Taxes are taken at 3 cents per acre per annum, and the cost of protection against fire at 2 cents per acre per annum, making a yearly expense of 5 cents per acre per annum. Pine stumpage is now worth $1.50 per thousand board feet, and the returns from future cuts were accordingly figured for stumpage values of $1.50 and $2. As a matter of fact, the probability is that after thirty or forty years the value of pine stumpage will be considerably above $2 and the interest returns shown by future cuts greatly increased in consequence.

TABLE No. 15.—*Annual interest represented by future cuts on the capital invested in cut-over lands.*

STUMPAGE VALUE, $1.50 PER THOUSAND BOARD FEET.

Cutting limit, diameter breast-high.	After 20 years.		After 30 years.		After 40 years.		When equal cut occurs.		Equal cut again obtained.
	$1 per acre.	$1.50 per acre.	$1 per acre.	$1.50 per acre.	$1 per acre.	$1.50 per acre.	$1 per acre.	$1.50 per acre.	
Inches.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Years.*
12	3.9	3.1	4.9	4.1	6.6	5.6	7.0	6.0	42
14	3.6	2.9	4.8	4.0	6.6	5.7	7.0	6.0	41
16	4.6	3.7	5.4	4.5	6.5	5.6	6.7	5.8	41
18	4.9	3.9	5.2	4.4	5.8	5.0	5.9	5.1	42
20	5.2	4.1	4.7	3.9	5.2	4.5	5.3	4.5	42

STUMPAGE VALUE, $2 PER THOUSAND BOARD FEET.

12	5.2	4.2	6.6	5.5	8.8	7.5	9.3	8.0	42
14	4.8	3.8	6.4	5.4	8.8	7.5	9.3	8.0	41
16	6.1	4.9	7.1	6.0	8.7	7.4	9.0	7.7	41
18	6.5	5.2	7.0	5.8	7.8	6.7	7.9	6.8	42
20	6.9	5.5	6.2	5.2	7.0	6.0	7.0	6.0	42

CONCLUSIONS.

The study made by the Bureau of Forestry establishes the fact that the application of practical forestry to the tract of the Sawyer & Austin Lumber Company would be a sound business measure. It shows furthermore that in the cheapness of logging, the value of the product, the quick growth and the ready reproduction of the timber trees, and the practicability of inexpensive and effective measures against fire, the opportunity is a markedly favorable one.

The yield to be expected from cut-over lands shows a high return from the capital invested in them. Cutting to the advised diameter limit of 12 inches breasthigh, or about 14 inches on the stump, with stumpage reckoned at $2 per 1,000 board feet, and the value of cut-over land at $1 per acre, the average annual interest represented by the future crop on cut-over lands is, for a period of forty years, nearly 9 per cent. In other words, after the Sawyer & Austin Lumber Company have lumbered their present tract at the rate of 14,500,000 feet per year, the lands which have been cut over will be producing timber which, at a conservative estimate, represents an income of 8.8 per cent on the capital invested in them.

It has been shown that, in order to assure a sustained annual yield equal to the capacity of the mill, the addition of 170,000 acres to the present tract is necessary. With this addition, or its equivalent in stumpage, the Sawyer & Austin Lumber Company can cut continuously 40,000,000 board feet per year. If this addition is not made, it is clearly unadvisable for the company to lumber its tract upon the principle of a sustained annual yield, since this would fall short by about 25,500,000 board feet of the annual capacity of its mill.

FIG. 1.—PINE TOPS AFTER A GROUND FIRE.

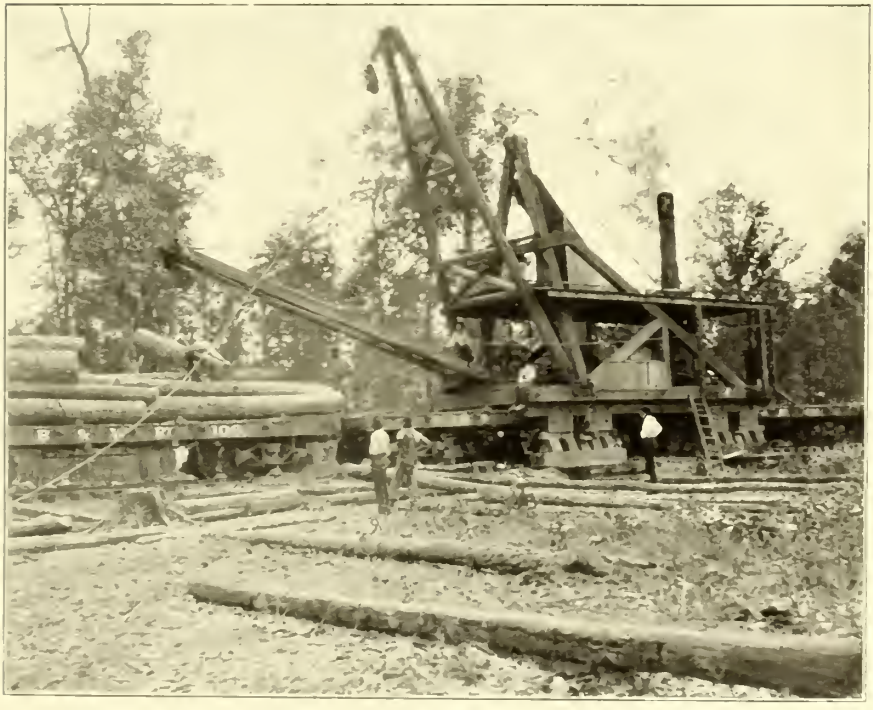

FIG. 2.—THE STEAM SKIDDER.

The quantity of timber taken annually from the tract has no bearing upon the main question before the company: Whether the application of conservative lumbering is justified by the value reasonably to be expected for a future crop of timber from the lumbered area. Under the very small added expense incident to the application of the rules for forest management which follow, the productive capacity of the cut-over lands will be preserved and they will supply a second crop of merchantable timber, which represents an exceedingly good rate of interest upon the capital invested in them. Whether the second crop is grown in order to be cut by the Sawyer & Austin Lumber Company, or whether the cut-over lands be sold after the merchantable stand is removed, has no bearing upon the advisability of conservative lumbering in the present case. The increased value of the cut-over lands in either event renders the application of practical forestry in the lumbering now going on a safe and advantageous business measure.

RULES OF MANAGEMENT.

CUTTING LIMIT FOR PINE.

The cutting limit for pine should be placed at 14 inches on the stump (12 inches breasthigh). This is advisable for the following reasons:

(1) The largest cut at the present time will be obtained.

(2) An equal cut can be harvested after the same number of years required in case a higher cutting limit were used.

(3) As a result, a sustained annual yield equal to the capacity of the mill can be obtained by the addition of a much smaller forest area than that required by a higher diameter limit.

(4) With a cutting limit of 12 inches, logging operations will be more concentrated and hence more profitable than if the limit were higher.

(5) A cutting limit below 12 inches would be inadvisable both financially and silviculturally.

SEED TREES.

When the first cutting is made a small number of Loblolly and Shortleaf Pine trees above 12 inches in diameter breasthigh should be left standing. These trees should be selected and marked beforehand by a trained forester. The Bureau of Forestry cooperates with the Sawyer & Austin Lumber Company in these markings. It is probable that after they have once been well started by an agent of the Bureau, and a competent man in the employ of the company has had opportunity to become thoroughly acquainted with the manner in which they are made, they can be carried out successfully thereafter under his supervision alone. The number of trees to be left should be determined by the nature of the locality. In all cases the Loblolly is to be favored, unless the locality be distinctly unfavorable to this species. The leaving of such trees for seed purposes will not involve any appreciable loss to the company.

CUTTING LIMIT FOR THE HARDWOODS OF THE BOTTOM LANDS.

In the hardwood bottoms the cutting limit should be placed at 20 inches. Although no study of the rate of growth in these bottoms was made, it seems probable from the composition of the stand that if such a cutting limit be adopted a second cut can be obtained when the pine lands are lumbered again.

Every opportunity should be taken advantage of to cut and utilize the hardwoods of the pine lands, even at a very small profit.

HEIGHT OF STUMPS.

Stumps should not be cut higher than 18 inches, and all trees below 18 inches on the stump should be cut 12 inches from the ground.

At the present time stumps are being cut at an average height of 18 inches from the ground, and this rule appears to be fairly satisfactory. No trees below 18 inches in diameter on the stump are now cut, but probably no difficulty would be met with in getting the sawyers to cut the small trees (below 18 inches) at 12 inches from the ground.

Logs should also be cut as high up into the crowns as conditions will allow.

PROTECTION AGAINST FIRE.

The principal difficulty in the way of adopting a good system of fire protection is the broken character of the company's holdings. If the tract were in one solid block the matter would be much simplified. Cut up as it is at present by farms and private wood lots, the sources of danger from fire are greatly multiplied, because fires purposely set on these holdings are never watched or controlled, and as a general thing quickly spread.

The forest would prosper most if the whole tract could be protected from fire. On account of the difficulties just mentioned, however, such a course would in all probability be impracticable at the present time. The most urgent need at present is a thorough system of protection for the cut-over lands. This is entirely practicable and should by all means be adopted. After the opening of the forest the young growth will quickly develop on these lumbered areas, and it is of the greatest importance that it be given every possible chance for rapid growth and that the reproduction of the pine be effectively protected in every way. The tops of felled trees are a source of great danger and should be burned as soon as they are dry enough to burn readily, at a time when the forest floor is damp and there is no danger of the fire spreading. It is probable that the cheapest and most effective way of disposing of the tops will be to skid them into piles and then to burn as many together as can conveniently be skidded to one point.

Fire protection would cost about $500 per year for the first few years. This would pay the salary of one man, who should have entire charge of burning the tops and at the same time act as a fire guard

and patrol the cut-over land. By such a system the area under fire protection would increase from year to year, until finally protection would be extended to the whole tract. As soon as the lumbered area becomes too large for one guard to control, another man should be added. In case a fire breaks out which the guard can not control by himself, he should have authority to hire what help may be necessary, and, if such a fire occurs in the vicinity of lumbering operations, the logging force should be turned out to fight it.

Roads are excellent fire lines, and form very good bases from which to work against fire, as well as checking any light ground fire in whose course they lie. The abandoned railroad spurs are valuable for the same purpose, and should be kept clear of all litter. If this is done the damage from fire will be very materially decreased.

Great care should be taken to keep in good order the spark arresters of the locomotives and skidder.

The main point to be urged is a thorough system of fire protection for the cut-over lands. At the present rate of cutting some 6,500 acres will be lumbered annually. If a start is now made by protecting the area cut over during the past year, the initial expense will be small, and, if the attempt proves successful, another 6,500 acres can be added the next year, and the protected area thus gradually increased. It is reasonable to expect that as time goes on experience will tend toward a reduction in expenses, and also that as the sentiment of the inhabitants improves, forest fires will become less numerous.

CARE IN FELLING.

It is fully realized that it is almost impossible to secure care in felling the trees, owing to the character of the labor force employed. Moreover, the small amount of young growth already present fortunately makes regulations regarding this of little importance. If the ground were covered by a valuable reproduction of pine and the labor force were of a different type, rules would be required.

INSPECTION.

An agent of the Bureau of Forestry should inspect each year the area lumbered during the preceding year, and at the same time mark the seed trees to be left standing in the next cutting area. He should report fully as to the manner in which the rules for lumbering have been carried out and describe in detail any damage caused by fire in the preceding year. This will involve an expense to the company of about $200 a year.

SUMMARY OF RULES FOR LUMBERING.

(1) The cutting limit for pine to be 14 inches on the stump, and for hardwoods 20 inches.

(2) A certain number of pine trees over 14 inches on the stump to be marked and left standing for seed purposes.

(3) Hardwoods on pine lands to be cut whenever practicable.

(4) All pine 18 inches and over in diameter on the stump to be sawn not higher than 18 inches from the ground, and that below 18 inches in diameter on the stump at 12 inches from the ground.

(5) Care to be used in the felling to do as little damage as practicable to valuable young growth.

LIST OF TREES FOUND.

Shortleaf Pine	*Pinus echinata* Mill.
Loblolly Pine	*Pinus taeda* Linn.
Bald Cypress	*Taxodium distichum* (Linn.) Rich.
Butternut	*Juglans cinerea* Linn.
Black Walnut	*Juglans nigra* Linn.
Bitternut Hickory	*Hicoria minima* (Marsh.) Britton.
Shagbark Hickory	*Hicoria ovata* (Mill.) Britton.
Pignut Hickory	*Hicoria glabra* (Mill.) Britton.
Hornbeam	*Ostrya virginiana* (Mill.) Koch.
Hornbeam	*Carpinus caroliniana* Walt.
Beech	*Fagus atropunicea* (Marsh.) Sudworth
Chinquapin	*Castanea pumila* (Linn.) Mill.
White Oak	*Quercus alba* Linn.
Post Oak	*Quercus minor* (Marsh.) Sargent.
Overcup Oak	*Quercus lyrata* Walt.
Cow Oak	*Quercus michauxii* Nutt.
Red Oak	*Quercus rubra* Linn.
Yellow (or Black) Oak	*Quercus velutina* Lam.
Spanish Oak	*Quercus digitata* (Marsh.) Sudworth.
Black Jack	*Quercus marilandica* Muenchh.
Water Oak	*Quercus nigra* Linn.
Willow Oak	*Quercus phellos* Linn.
White Elm	*Ulmus americana* Linn.
Red Mulberry	*Morus rubra* Linn.
Papaw	*Asimina triloba* (Linn.) Dunal.
Sassafras	*Sassafras sassafras* (Linn.) Karst.
Sweet Gum	*Liquidambar styraciflua* Linn.
Sycamore	*Platanus occidentalis* Linn.
Honey Locust	*Gleditsia triacanthos* Linn.
Locust	*Robinia pseudacacia* Linn.
American Holly	*Ilex opaca* Ait.
Deciduous Holly	*Ilex decidua* Walt.
Silver Maple	*Acer saccharinum* Linn.
Red Maple	*Acer rubrum* Linn.
Boxelder	*Acer negundo* Linn.
Basswood (Linn.)	*Tilia americana* Linn.
Dogwood	*Cornus florida* Linn.
Black Gum	*Nyssa sylvatica* Marsh.
White Ash	*Fraxinus americana* Linn.

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