Turpentineing Practices in the United States
by
William L. Robson
A Thesis
Presented to the Faculty
of the
School of Forestry
Oregon State College

In Partial Fulfillment
of the Requirements for the Degree
Bachelor of Science
June 1938

Approved:

_________________________
Professor of Forestry
Acknowledgement

The writer is indebted to Eloise Gerry and to Captain I. F. Eldredge for advice and information pertaining to the subject of turpentining.
Mr. William L. Robson,
1604 North Polk Street,
Corvallis, Oregon.

Dear Sir:

Your letter of October 15 is received.

Enclosed is a copy of the Naval Stores Handbook with a large bibliography and some other reprints which may also be helpful. The Naval Stores Yearbooks (1937-38, $3.00 a year) and the Weekly Naval Stores Review ($5.00 a year) both published by Thomas Gamble, Review Printing Company, Savannah, Georgia, give some of the best current information on the industry.

With respect to your question concerning the condition of the timber when cut after turpentining, I refer to the section on degrade and also that on insects in the Naval Stores Handbook. Well turpentined trees, if the faces remain unburned, show little or no degrade except the actual wood cut away in chipping. Sometimes, if the chipping is deep and the weather dry, pitch-soaking may appear in varying degrees in the segment bounded by radii from the sides of the face. (See sketch below.) For some purposes, such as for export piling, this is held to be an advantage, not a degrade.
Mr. W. L. R.

Our industry in the United States is not satisfied with the yields obtained from the French type of face, yields, within limits, being roughly proportional to width of face.

If we can be of further service, let us hear from you at any time. This is a very picturesque and important industry in the South, and, if well managed, can be very successfully conducted in conjunction with the remarkable increases now taking place in the production of pulp and paper in the South.

I suggest that you write to Capt. I. F. Eldredge, Southern Forest Experiment Station, 400 Union Building, 837 Gravier Street, New Orleans, Louisiana, for reprints of the preliminary information, as issued, that is being obtained by "The Forest Survey" on the naval stores industry and on southern pines and their utilization. I should appreciate receiving a copy of your thesis if available.

With best wishes for your success.

Very truly yours,

ARTHUR KOEHLER, In Charge,
Section of Silvicultural Relations.

Enclosures:
Reprints, bulletins, and mimeographs.
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Introduction

The turpentine industry of the United States has had a steady growth since about 1610 with the exception of a period of about 10 years (1860-1870) (1). This industry at present represents an annual output of nearly $50,000,000 worth of products obtained from nearly 100,000,000 longleaf and slash pine trees (2). No other industry is of such basic importance to the nation as is this naval stores industry. One of the most outstanding facts of an industry so important to our country is that until recently there has been practically no change in methods since its establishment. It has been only in the last few years that the cup method of turpentining has been used. The wasteful box method is still being used by private owners over which the government as yet has no control. There are many farmers interested in naval stores production in the Southeastern States, for they have some land on which they can grow nothing but a forest crop. It is mostly these farmers who have to be educated in the modern and efficient ways of naval stores practices.

In order to make the industry a permanent one instead of a rapidly diminishing one, provision must be made to insure a continuous crop of trees. It has been suggested that there is a possibility of Western Pines being a source of
Figure 1.—Approximate percentage of world's production of turpentine, 1930-31, by countries (214).

**Figure 1**

![Figure 1](image)

**Figure 2**

**Figure 2** — Tools: 

a, Double bevel, straight-edge broadax used for removing the bark in preparing a place to seat the cup and also for making the incision to hold the apron; 
b, gutter chisel, or Pringle ax, having the same use as the broadax (a) for making apron incisions; 
c, maul used for driving the broadax into the tree to cut incisions for aprons; 
d, hogal used for removing the rough bark at the butt of the tree and frequently for cutting the first streak; 
e, hack for cutting streaks on low faces; 
f, puller for cutting streaks on high faces; 
g, shove-down scraper for removing scrape from low faces; 
h, double-edged pull-down and shove-down scraper for use on high or low faces; 
i, apron or gutter puller for use in pulling aprons preparatory to resetting; 
j, dip iron for removing gum from the cups.
naval stores. Experiments were made in Arizona, California and Colorado to determine the amount of crude oleoresin which could be secured from the pines in these states by the methods employed in the turpentining of longleaf yellow pine in the Southeast. H. S. Betts, Assistant District Forester, seems to think that turpentine operations will be commenced in the West in the near future on a large scale (3). His reasons for this are: that the cost of securing turpentine rights in the Southeast is constantly rising and that turpentine stumpage could be leased at lower rates in the West; also that there will be the "cutting out" of a two or three thousand mile haul from the Gulf States to the West. Some people disagree with H. S. Betts for the following reasons: The problem of labor in the West is very important. Mexicans constitute a large part of the laboring class in Arizona, but they are entirely unfamiliar with turpentine work. Negro turpentine hands could be brought in from the Southeast, but their transportation would be costly. Also the importation from the Southeast is not desired by the Westerners. Although negro hands could teach the Mexican, Indian and a few white laboring class the methods of turpentining, the results are uncertain. Because of the shorter season in the West and the comparative severity of the winters, it would be necessary to discontinue operations entirely for a few months during the winter. It would be necessary to reorganize the operating force each spring, which would bring many difficulties.
Present Turpentining Practices

In the western part of the southern pine belt the great bulk of longleaf and slash pine stands are in the hands of lumber companies which rarely permit their timber to be chipped for naval stores for more than two or three years before it is cut. The greatest percentage of their timber holdings are virgin timber. The owner of this timber requires by contract that the turpentine operator pay for all the trees that die as a result of turpentining. The result is that the loss of timber is light in spite of the fact that timber such as is represented by virgin stands is susceptible to injury in these processes, for the turpentine operator takes considerable care in chipping and other steps of the operation.

Conditions are very different, however, in the eastern part of the southern pine belt where the greater part of the turpentine woods is second-growth. It is the common practice now to chip front faces for four years or more and then to back face the same trees for an equal period. A very small percentage of the merchantable timber, particularly second-growth, is held by lumber companies, and the cutting of logs, crossties and other products is generally a process of salvage after turpentining is complete (4).

Enormous loss of second-growth slash and longleaf pines in the eastern territory, particularly Georgia and Florida, results from the destructive turpentining methods commonly used. The box method of turpentining, which was formerly used and was considered very destructive, is now equaled if
not exceeded by the abuse of the cup and gutter system. Gutters are driven unnecessarily deep into trees, chipping is often one or one and one-quarter inches, and faces are run together eliminating the bark bars. These practices, which not only lower the vitality of every tree by impeding the circulation of sap within it, also weaken the small trees mechanically. When the vitality of a tree is lowered, a "dry-facing" condition results. This condition along with excessive scraping of the longleaf faces at the end of the season allows both boring insects and rot to enter the trees.

**Necessary Modifications of Turpentine Practices**

In the majority of the turpentine orchards a large number of trees "dry-face" before the end of a normal chipping period and cease to yield gum. A great many of the trees die. In the second-growth stands, a large proportion of the surviving trees are so riddled by borers and consumed by rot that they may not increase at all in useable volume. The competition of these trees remaining on the ground for light and food prevents young growth from coming in. Many of the trees are in such a weakened condition that they are unable to produce seed for natural reproduction. Many of the turpentinened trees are broken by the wind before they are able to reach crosstie, sawlog or pole size. In both the second-growth and virgin stands the ordinary methods of naval stores production are the primary cause of a serious lowering in the rate of forest production.
Some of the most necessary modifications of the present day turpentining practices are as follows, regardless of method used.

1. Putting one face only on trees not large enough for profitable cutting after turpentining is finished.

2. Absolute elimination of boxes.

3. Avoid deep cuts in setting and particularly in raising tins.

4. The width of face should be limited to not over one-third the girth or circumference of the tree.

5. The strips of bark between the faces should be at least four inches in width.

6. The depth of streak should be restricted to, at most, 0.75 inch in longleaf and 0.5 inch in slash.

7. Great care should be taken in scraping to avoid exposure of dry wood.

8. Low chipping should be enforced.

All of these modifications of ordinary turpentining practice involve no costs that are not fully offset by increased yields either in current or later working periods. These methods would nearly eliminate dryfacing and the death of turpentined trees except those that would die of natural causes. Growth of the trees will continue after chipping ceases provided, of course, that there are no fires in the abandoned orchard which will be ready to work again after a
rest. However, the rate of growth will be lowered to some extent.

Theoretically it should be possible to chip trees for many years before they are cut. Early studies of the use of French faces in turpentining practices show that these faces could be worked for a longer period than the conventional American face (5). Furthermore these studies indicate that the actual per acre yield of naval store products over an equal period of years would be greater from the French faces than from the American faces. It was estimated at the time of these early studies that under the French system of facing, a stand could be worked from thirty to forty years. However these experiments and their results will be discussed later.

Practically it is unlikely that in the future, management of longleaf and slash pine lands for full production of quality of the wood grown on them can be dismissed from consideration. Even under the best turpentining practice some rot and insect damage will occur if trees are not cut for quite a few years after their first cupping. Pitch-soaking, blue-staining and other defects will develop in the butt logs.

All streaks should be narrow, that is, the chipping should proceed slowly up the tree. Experiments on both virgin and second-growth timber show that faces that are raised more than twelve to sixteen inches by thirty-two streaks, yield no more gum over a four-year period than low faces. The advantage of the low-face is that there is less wood exposed, to degrade as a result of chipping. Results of recent
Figure 3

ACTIVE NAVAL STORES BELT
SHOWING THE NUMBER AND APPROXIMATE LOCATION
OF TURPENTINE PROCESSORS. - SEASON 1934-35.

*** PROCESSORS INSIDE ACTIVE BELT.
*** KNOWN PROCESSORS OUTSIDE ACTIVE BELT.
experiments on lower chipping are given under the section on Operating Methods.

Trees less than ten inches in diameter should not be turpentined. Ten inch trees on fairly good sites will in fourteen years of chipping reach merchantable size for ties, piles, poles or saw-logs. These trees should also be seed-producing size. Although seed production from these trees will probably be less than from unturpentined trees, it should be enough to maintain a stand fully stocked at all times.

Selective Turpentining

By the term selective turpentining is meant the selection and turpentining of only a part of the trees in the stand rather than all the trees in a stand of sufficient size to hold a cup. Besides this a style of chipping is applied that is suitable to the tree.

One of the advantages is the opportunity to avoid the working of unprofitable faces. This avoidance resembles the removal of slow-growing trees and the leaving of the vigorous in selective cutting. Also healthy faces may be unprofitable if they are on trees of too small a size or too slow a growth. The influence of the diameter of the tree on yield of naval stores may be seen from Table I.

Table I:

Calculated yield of turpentine in barrels of spirits per crop for second-growth long-leaf and slash pines of various diameters at Starke, Florida, 1935.
The rate at which a tree has been recently growing appears to have a very marked affect on gum yield. This rate is best expressed in the last inch of growth measured from the bark toward the center of the tree. In selective turpentining it should be possible to take advantage of this knowledge by suit- ing the style of chipping to the tree. At the same time that thrifty trees capable of yielding heavily during the period of chipping that has been recommended are being carefully worked, slow-growing and failing individuals may be turpentined to death. This is done by working with a wide face or by plac- ing an excessive amount of faces per tree, with the object of

| Diameter of Tree at Breast-height | Yield from Longleaf Pine | Yield from Slash Pine
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Inches</td>
<td>Barrels</td>
<td>Barrels</td>
</tr>
<tr>
<td>6</td>
<td>15.3</td>
<td>20.3</td>
</tr>
<tr>
<td>7</td>
<td>22.2</td>
<td>26.2</td>
</tr>
<tr>
<td>8</td>
<td>29.4</td>
<td>32.2</td>
</tr>
<tr>
<td>9</td>
<td>36.2</td>
<td>38.4</td>
</tr>
<tr>
<td>10</td>
<td>43.1</td>
<td>44.4</td>
</tr>
</tbody>
</table>

Table I

1 Vigorous trees only. Second-year work, one face per tree (trees over ten and one-half inches cupped fifteen years previously) chipped one-half by one-half inch, thirty-three streaks.

2 Vigorous trees only. First year work, one face per tree, chipped one-half by one-half inch, thirty-three streaks.
getting all the gum possible in three or four years and ex-
hausting the trees in the process. Their death will favor
the growth of the thrifty trees and give room for the repro-
duction to start. Of course a thorough knowledge of growth
rates in the particular stand concerned is necessary to draw
the line between thrifty and unthrifty trees.

Costs

If the operator buys his lease at so much per thousand
faces, there is no increase in costs as a result of selective
turpentining. However he has to work at least ten or twelve
faces per acre, and he has to see that his general expense
and depreciation per crop are not raised by lessening the
volume of gum coming currently to his still. On the other
hand operators who have paid a lump sum for the turpentining
privileges on a given tract for a short period will lose
money when he fails to hang a cup on any tree capable of
yielding a net profit.

The careful selection of the trees to be worked will
involve a cash outlay for the landowner whether he works his
own timber or leases it. The cost will be about the same as
for marking trees in selective cutting (twenty-five to fifty
cents per acre). This expense will make the marking unneces-
sary, for it is the chipped trees which are removed when cut-
ting begins.

Thinning by Turpentining to Death

Well-stocked stands of timber are as essential to profit
EXTREME VARIATIONS IN THE RATE OF GROWTH AND DENSITY OF THE WOOD OF SOUTHERN PINES ARE SHOWN BY THE ABOVE DISKS.

The rate of growth and quality of wood may be controlled to a large extent by the proper spacing of the trees.
in naval stores management as in timber management (6). Such stands can be developed only through the intelligent application of silviculture. Complete stocking is only one factor that affects the earnings in the naval stores industry. First of all high gum production is dependent upon the thrift and rapid growth of the trees. Individual trees, to obtain these characteristics, must have ample space for development. In order to do this readily, thinnings may have to be done when the stands are so young they do not produce material of merchantable size.

The same process described for working poorer trees in mature stands under selective turpentining may be used to thin young stands of longleaf or slash pines in advance of turpentining the main crop of trees. The fact that yield of gum increases with increased width of growth rings will influence the spacing of trees in thinning longleaf or slash pines. (4). Trees given plenty of room will have few rings to the last inch of growth and will yield more naval stores than trees growing at the best rate for high-quality wood production. The early returns obtainable from gum appear to justify some sacrifice in the quality of the wood. Thinnings will therefore be heavier in stands to be turpentined than in those which are not to be turpentined. Since the saw log constitutes only one-third of the value of the crop (naval stores two-thirds), it would seem practical to sacrifice a little quality for rapid growth, although the use of turpentine methods that will conserve the lumber value is worthy of consideration (3).
A Few Things to Remember

There are instances in which losses have been changed into profits by observance of good naval stores practices. Naval stores operators and timber owners should allow for this in their calculations (7). A few years may carry a tree from the doubtful into the highly profitable class. Naval stores operators and timber owners should at all times consider the continuance of their business and the revenue to be obtained from their wooded tracts. The French raise timber and produce naval stores continuously from the same tracts of land, having thus a permanent and satisfactory business. We have better facilities than they possess, and no reason appears why we do not do the same (7).

Naval stores are an essential commodity, and the lumber that may be obtained from turpentine trees is rapidly increasing in value. It is asked how the farmer owning timber can protect himself when he leases it. The answer to this question is that he should obtain a contract.

The timber is usually leased from the owners from periods of three to five years. The price of the lease varies with the size and quality of timber, cost of labor, prices received for turpentine and resin, distance from shipping point and a number of other factors. The average price for leasing in 1929 and 1930 was two and one-half to three cents per face per year (8). This amounts to $2,500 to $3,000 for ten crops each year. In 1926, when naval stores prices were high, seven cents per face per year was not an exceptional price,
NAVAL STORES LEASE

THIS NAVAL STORES LEASE, made and entered into this the day of ____________, A.D., 19____, between ____________________________________________, County __________________________, hereinafter called the Owner, and ____________________________________________, County __________________________, hereinafter called the Producer.

WITNESSETH, That the Owner, for and in consideration of the rents and royalties hereinafter mentioned, does hereby grant, bargain, lease, let and convey unto the Producer the exclusive right to work, for naval stores and turpentine purposes, by the cup system only, in accordance with the restrictions and provisions hereinafter enumerated, the longleaf and slash pine timber, hereinafter described, now standing and growing upon the lands of the Owner, in __________________________ Count. __________________________, Florida, and more particularly described as follows, to-wit:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Excepting, however, from this lease, all trees upon the above described lands, as have been reserved and designated by the Owner, and all trees as are unfit for turpentining, because of defects, abnormality or inaccessibility.

That the Owner hereby fully warrants the title to said timber and will defend the same against the claims of all persons whomsoever.

That the Owner warrants that there are no mortgages, liens, tax liens or other encumberances upon the above described lands, except as follows, to-wit:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

That for and in consideration of the rights and privileges herein granted, the Producer agrees to pay unto the Owner the following sums at the times and in the manner following, to-wit:

(Cross out the two methods of payment not used)
Woods Practices

Details of woods work, hanging cups, chipping, et cetera, can be obtained from the Lake City office of the Southern Forest Experiment Station. Any unusual woods problem may be taken up with the trained foresters at that station.

Equipment and Still Practices

Information on cup, gutter, and apron materials, design of turpentine stills, proper stilling methods, gluing barrels, and other points of manufacture is available at the Lake City office of the Bureau of Chemistry and Soils, U. S. Department of Agriculture, or at the new Naval Stores Station near Olustee.

Cooperative Agent

By a joint agreement between the Bureau of Chemistry and Soils and the Florida Forest Service, a naval stores technologist with offices at Lake City was appointed in August, 1932, to carry to the operators and timber owners in Florida improved naval stores practice in the woods and at the still. For the first year activities are confined to eleven eastern counties, but visits to other sections are made on request.
FORM I.

The sum of ________ cents per face for the full term of this lease, the amount to be determined by actual count when cups are installed. Said payment to be made in the following manner, to-wit:

$________ on or before the ___ day of __________, 19___.
$________ on or before the 1st day of June, 19___.
$________ on or before the 1st day of June, 19___.

FORM II.

The following sums per face, payable on or before the ___ day of __________, each year during the term of this lease, the number of faces to be determined by actual count when the cups are installed, to-wit:

__________ cents per face for the first year.
__________ cents per face for the second year.
__________ cents per face for the third year.
__________ cents per face for the fourth year,
and each year thereafter.

The above enumerated sums per face to be effective during said years, provided the average unit price of turpentine and rosin does not exceed __________ dollars per unit, but should the unit price of turpentine and rosin exceed the aforesaid average unit price during any or all of said years then and in that event, the Producer shall pay to the Owner an additional __________ cents per face for each __________ dollars advance in price over and above the aforesaid average unit price, such additional sum to be payable on the ___ day of __________, the following year. It is hereby agreed that a unit of turpentine and rosin consists of fifty gallons of spirits of turpentine and three and one-third round barrels of rosin of approximately five hundred pounds gross weight each. It is further agreed that the price per unit shall be determined by taking the average daily strong and firm Savannah markets of all grades of rosin and turpentine for the twelve-month period ending on the ___ day of __________ of each year.

FORM III.

That the Producer, at the time of sale, shall pay to the Owner __________ per centum of the net returns received from the sale of all products. Said net returns to be determined by deducting all freight, loading, handling, grading, inspection, storage and commission charges from the gross returns.
for the sale of the products. Should the average net returns per unit per year exceed $\text{dollars per unit, hereinafter called the basic price, then an additional per centum of the net returns shall be paid unto the Owner for each $\text{dollars advance in price per unit over and above the basic price, said additional amount to be due and payable on the day of the following year after sale.}\\

That the unit price per year shall be determined by taking the average net returns from all turpentine and rosin sold hereunder during that year, expressed in terms of unit value, that is, a unit of turpentine and rosin to consist of fifty gallons of turpentine and three and one-third round barrels of rosin of approximately five hundred pounds gross weight each.

All products shall be sold and/or contracted for to the best advantage of the Owner and the Producer, but should they fail to agree as to the advisability of selling and/or contracting such products, either party may at his option, take over his proportionate share of such products.

The Producer shall insure and be held liable to the Owner for the Owner's interest in all products in the process of distillation or held or stored at the still or in the yard, excepting such products as have been taken over by the Owner.

All rosin and spirits of turpentine shall be inspected by a Federal or authorized State Inspector before sale.

The Producer shall make arrangements with his factor or purchaser to furnish the Owner with a full statement, at the time of sale, showing in detail the amount of products sold, the amount received from the sale thereof and the items of expense deducted from the gross returns.

In order to obtain the best yield and grades and to eliminate waste the Producer agrees as far as practical to:

Cup and streak all trees on or before the 1st day of February, A. D. 19; use rustless or rust-free cups and tins; use chip paddles which will cover cups and tins; place at least thirty-two streaks per year on all faces at one week or longer intervals; dip all gum at least every four streaks; raise cups at the end of each of the first four working seasons; distill the crude gum according to the methods of the United States Bureau of Chemistry and Soils as contained in "Directions for Running a Turpentine Still," dated April 1, 1927, "How to Charge and How to Discharge a Turpentine Still," dated March 5, 1924, and
April, 1924, respectively; insure the still from fire; cover the separator barrel and spirit tub; glue the spirit barrels by method contained in Bureau of Chemistry and Soils' leaflet “Gluing Turpentine Barrels,” dated July 15, 1931, or ship the spirits of turpentine in tank cars or drums in such a way as to eliminate waste and discoloration; and strain rosin properly.

That the timber, embraced by this lease, shall be worked in accordance with the following restrictions and provisions, to-wit:

1. This Naval Stores Lease shall be for the full term of working seasons, beginning as soon as this agreement is executed and delivered, and ending at midnight, on the 31st day of December, A. D. 19....

2. All cups shall be installed not later than the 31st day of March, next after the date hereof.

3. All round trees nine inches in diameter and above shall be cupped with one face, provided however, that with the written consent of the Owner, trees measuring fifteen inches or more in diameter may be cupped with two faces. No trees measuring less than nine inches in diameter may be worked. All diameter measurements shall be taken four feet six inches above the ground.

4. One cup shall be installed on all trees previously worked that measure twelve inches or more in diameter four feet six inches above the ground, provided that no trees previously worked with more than one face or that measure less than twelve inches in diameter, as aforesaid, may be worked.

5. When two faces are placed upon any tree, they shall be located so that the width of one of the bark bars is not greater than eight inches.

6. Bark bars not less than four inches wide shall be left between faces.

7. The faces shall be chipped for the first year not to exceed sixteen inches in height from the shoulder of the first streak to the shoulder of the last streak of the season. The faces chipped or pulled yearly thereafter shall not exceed fourteen inches in height for each season.

8. Measured in the deepest place, the depth of the streak shall not exceed five-eighths inch in the wood of slash pine or three-fourths inch in the wood of longleaf pine.

9. The width of the face shall not exceed one-third of the circumference of the tree, and in no case shall the width of the face exceed twelve inches, measure from shoulder to shoulder.

10. No wood shall be exposed below the gutters or aprons at the time the cups are installed, however, it is permissable to chop into burls and
swellings to properly set the cups. All cups shall be installed as close to the ground as practicable and the first streak shall be cut as close to the gutters or aprons as possible.

11. Incisions in the wood for installing tins or raising in jump peaks shall not exceed one-half inch in radial depth. No incision or streak in the face for the purpose of raising tins shall exceed one-fourth inch in radial depth. Whenever tins or cups are raised, removed or abandoned, all tins, tacks and nails above a stump height, of fourteen inches from the ground, shall forthwith be pulled and removed, but not chopped out, by the Producer.

12. Should the Producer cup or fail to cup any tree or trees in violation of the above sections three and four, he shall pay unto the Owner, as and for full liquidated damages caused by said violation, _______ cents per face cupped or that should have been cupped, provided, however, he shall have been notified in writing by the Owner, within sixty days from and after the date of the said violation or from and after the 31st day of March, A. D. 19________, whichever is the later date. That upon being notified as aforesaid the Producer shall forthwith remove all cups installed in violation of sections three and four hereof, and his failure to so remove said cups shall constitute a breach of this contract, and the Owner shall have the right to remove said cups at the expense of the Producer.

13. Should the Producer violate any of the restrictions and provisions herein contained, the Owner shall notify him in writing, within sixty days after such violation has occurred, and if said violation is not ceased and any defective work corrected within twenty days from and after receipt of such notice, the Producer shall pay the Owner, as and for liquidated damages, as follows:

   (a) For all faces that exceed the heights specified in section seven of this contract, _______ of a cent for each inch in excess of the specified heights.

   (b) For trees split or windthrown during the life of this agreement in violation of the above section eleven, _______ dollars per thousand feet board measure full scale computed by Doyle rule.

   (c) For violation of all restrictions and provisions, other than those mentioned in sections eleven, twelve, thirteen a, and thirteen b, hereof _______ cents for each face worked in violation of these restrictions and provisions.

14. Should the Producer fail or refuse to pay unto the Owner the liquidated damages herein provided for, within ten days from and after the same becomes due and payable, the Owner shall have a lien upon the equipment of the Producer used upon the lands above described, therefor, and may at
his option prohibit further work, under this lease, until such damages are paid in full.

That it is hereby further agreed by and between the parties hereto, that:

(a) The Owner reserves unto himself the right to list any or all of the lands embraced in this lease with the Florida Board of Forestry, for forest fire control. In case the said lands or any part thereof be so listed, the Producer hereby consents to such listing and agrees to cooperate with the Owner and the said Board in said control; to plow, rake and burn such fire lines as may be designated by the said Board or its agents for proper fire control; to aid and assist the said Board in preventing and suppressing forest fires on said lands; to require his servants, agents, employees, and all other parties under his control to cooperate in said forest fire control, and to aid and assist in preventing and suppressing fires.

(b) That in case the Owner lists the lands with the Florida Board of Forestry as aforesaid, and thereafter fails to carry out the terms of said protection agreement, then the Producer may carry out the terms of said agreement, in behalf of the Owner, and thereafter deduct the amount of the cost and expenses of so carrying out said agreement from any and all sums then due or to become due from himself to the said Owner, under the terms of this lease, and should there be no sums due or to become due as aforesaid, then said amount of costs and expenses shall be a lien upon the lands embraced in said protective agreement.

(c) That the Producer, his heirs and assigns, shall have the free and unrestricted right to enter upon, occupy, use and enjoy said lands for the purpose herein granted during the continuance of this lease. It is further agreed that the Producer shall have a period of sixty days from and after the expiration of this lease, within which to remove and take away, or otherwise dispose of, all cups, gutter irons, and other equipment belonging to him, provided he has carried out the terms of this agreement.

(d) That the Producer shall be allowed to use dead and down timber from the aforesaid lands as fuel wood for his still and fire wood for his hands and laborers but not for removal or sale.

(e) That the Producer shall have such free and unrestricted right of ingress, egress, and regress, upon the lands of the Owner as may be necessary for the purpose of working the timber, hereinabove described, for turpentine and naval stores purposes.

(f) That the Owner shall have access, to the lands above described, for any and all purposes not inconsistent with the terms and provisions of this lease, provided, however, that such use by the Owner does not interfere with the operations of the Producer. In the event of any such interference, the Owner shall be liable to the Producer for all injury and damage to his
cups, tins, cupped trees and products, caused by the Owner's operations on said lands.

(g) Should the timber embraced by the terms of this lease be damaged by fire, insects, drought, act of God or vis major so that, in the judgment of either party, further work would be impractical, impossible or injurious to the timber, the parties hereto shall mutually agree as to what modification or suspension of work is necessary for the proper protection of the timber and the interests of the parties hereto, provided, however, that if said parties are unable to effect mutual agreement then such question shall be submitted to a committee of three arbitrators, one to be chosen by the Owner, one by the Producer, and the third by the two so chosen, and the decision of said board of arbitrators shall be binding and final upon the parties hereto as to all questions arbitrated.

(h) That the Owner shall pay the taxes upon the lands embraced in this lease before the same become delinquent and should the Owner allow the lands to become delinquent then, and in that event, the Producer, in order to protect himself from having his operations stopped, on account of the non-payment of taxes, shall have the right to pay such taxes and to deduct the amount of such payments from any payments due or to become due from said Producer to the Owner under the terms of this agreement, and in case there be no payments due from the Producer to the Owner aforesaid, the Producer is hereby given a lien upon the lands of the Owner to the extent of the taxes so paid.

(i) Neither party hereto shall be held liable, if prevented from the performance of his covenants and obligations hereunder by an Act of God or major contingencies beyond his or their control.

(j) The terms "Owner" and "Producer" when used herein shall be taken as extending to and embracing the heirs, personal representatives, successors and assigns of the parties hereto.

(k) The rights and privileges, under the terms of this lease, accruing to the parties hereto shall be assignable and transferable and when assigned or transferred the rights and obligations hereunder shall devolve upon the assignee or transferee.

If any of the sums, herein referred to as compensation for this lease, be not promptly and fully paid within ______ days next after they become, severally, due and payable, the aggregate sum of unpaid compensation for this lease shall, at the option of the Owner, become due and payable forthwith, and if not fully paid within ten days, after notice by the Owner that he has elected to exercise his aforesaid option, this lease shall become terminated in toto and the Owner shall have the right of reentry.
IN WITNESS WHEREOF, The parties hereto have hereunto set their hands and seals the day and year first above written.

(SEAL) (SEAL)

Signed, Sealed and Delivered
in the presence of:

ACKNOWLEDGEMENT FOR PERSONS OTHER THAN MARRIED WOMEN

STATE OF ____________________________
COUNTY OF ____________________________

On this day, before me, a notary public, personally appeared ____________________________, to me well known and known to be one of the persons who executed the above and foregoing Turpentine Lease, who acknowledged before me that he executed the same freely and voluntarily for the uses and purposes therein expressed.

Witness my hand and official seal this the ______ day of ________ A. D. 19________.

_________________________________________
Notary Public.

ACKNOWLEDGEMENT FOR HUSBAND AND WIFE

STATE OF ____________________________
COUNTY OF ____________________________

On this day, before me, a notary public, personally appeared ____________________________, and ____________________________, his wife, to me well known and known to be the persons described in and who executed the above and foregoing Turpentine Lease, who acknowledged before me that they executed the said instrument freely and voluntarily for the uses and purposes therein expressed, and,

The said ____________________________, wife of the said ____________________________, upon an examination taken before me and by me, separate and apart from her said husband, further acknowledged that she executed the said Turpentine Lease freely and voluntarily and without any compulsion, constraint, apprehension or fear of or from her husband.
Witness my hand and official seal this the______ day of______________,
A. D. 19_______.

________________________________________
Notary Public.

ACKNOWLEDGEMENT
BY CORPORATION

STATE OF__________________________.
COUNTY OF_______________________.

On this day, before me, a notary public, personally appeared_________
________________________________________ and _______________________,
to me well known and known to be the persons who executed the above and
foregoing Turpentine Lease as President and Secretary, respectively, of
______________________________________, a corporation, who acknowledged
before me that they are the President and Secretary, respectively, of the
aforesaid corporation; that they executed the said Turpentine Lease, in be-
half of the said corporation, freely and voluntarily for the uses and pur-
poses therein expressed; that they caused the common seal of the said
corporation to be affixed to the said instrument; that the seal affixed to
the said instrument is the common and corporate seal of the said corporation.

Witness my hand and official seal this the______ day of______________,
A. D. 19_______.

________________________________________
Notary Public.
but in 1932 many leases were made at two cents per face per year.

Large owners frequently lease their timber on a percentage basis. In such cases the operation pays from fifteen to thirty percent of the gross sale value of the turpentine and resin produced, the payment varying according to the producing capacity of the timber, the grades of resin, and the various factors which influence lease values that were mentioned previously. Although the percentage basis is fair to both the owner and the operator, it can be used successfully only if the owner supplies the operator with all, or at least a great percentage, of his gum. It will be difficult to keep accurate records if several individuals are concerned.

Although it is less desirable, a form of lease is used for the owner of a small block of timber. These leases provide three different bases of payment, based on commercial lease forms in common use but embodying restrictions and specifications which safeguard the timber owner's interest without imposing any hardships on the operator. There is a tendency on the part of modern operators to acquire title to their timber lands rather than to lease them. This policy is commendable for it leads to a better class of work, since the operators are personally interested in the highest ultimate product from the land on which they are working.

Comparison of Yields of our Methods with Those of the French

The French raise timber and produce naval stores
continuously from the same tracts of land, having thus a permanent and more satisfactory business. As was mentioned before, there appears to be no reason why we can not do the same as the French, for we have better facilities in this country. Studies have been made of the French system in turpentining as compared to our methods.

American and French Faces

The difference between the American face and the French face is in the width of face and the method of chipping. The width of a French face is from two to four inches whereas the width of an American face may be from six to fourteen inches. An American face is chipped with a streak approximately one-half inch high by one-half inch deep across the top from the sides inward and downward to a peak. A French face is arched at the top. After a French face is chipped, the freshened surface is five to seven inches long. The deepest point is at the bottom of the freshened surface and center of the face, and gradually tapers to a feather edge outward and upward to the top.

These very different types of faces are the result of the conditions under which American and French turpentining industries started. The Americans were turpentining only their virgin timber; there was no need for long-time operations, for sawmills were right on the heels of the turpentine stills. During the Civil War the naval stores supply to France ceased. France, having no vast areas of virgin
Figure 6

Figure 7

Figure 20.—Two views of chipping tool used in cutting French faces by the Southern Forest Experiment Station.
pine, found it necessary to develop a system of turpentining in harmony with the growing of wood products. They have succeeded, for their turpentine orchards are managed for long sustained production. The American operator finds that, now, he too is confronted with a lack of virgin pine. It is necessary that he look for a method that will permit the growing of trees to sawlog size. Probably he can not adopt the French system in its entirety because of a different economic conditions, but some modification is certainly possible. The following experiments were made with this thought in mind.

Early Experiments as to the Value of French Faces as Compared to Our Own System

Great and irreparable damage is being done to the second-growth longleaf pine in parts of the South by destructive turpentining methods. The results of experiments carried on for six years in the Florida National Forest indicate that the second-growth longleaf pine can be worked profitably under the French system of turpentining and that for the permanent welfare of the naval stores industry of the South, operators in second-growth forests would do well to adopt the governing principles of the French system.

The naval stores industry of the Southern states dates back to colonial times. Since 1820 American production of naval stores has led the world. So pronounced, however, is the depletion of the timber upon which our naval stores industry depends that the industry is commonly regarded as
a dying one. Steps should be taken in the immediate future to work conservatively the remaining supply of virgin timber and to adopt a method of turpentining the second-growth timber that will insure a profitable yield over a long period of years while it is maturing. If we do not do this, the gum and naval stores industry in the South will be forced to seek new fields for its supply of timber. In contrast to this situation is the industry in France where the output of naval stores has been growing steadily for more than eighty years and where it is still increasing yearly in amount and value. The answer to this is that in France both private owners and the government have a system of turpentining that is based upon the scientific development of the idea that a pine tree can be profitably worked for turpentine over the major portion of the time it is growing to saw-timber size.

The French can profitably work a forest area for turpentine during a period from thirty to fifty years, with short intervals of rest, without materially reducing the saw-timber value of the trees. We Americans have a very short-lived operation. By far the greater amount of timber is being worked not more than five or six years before it is cut for saw timber.

The object of the experiment tried in Florida was three fold. It was desired to ascertain

1. By actual operation over a period of years what flow of gum, as compared with that under
the regular government method, would result from the French method.

2. What effect the French system would have upon the trees.

3. By a practical commercial operation on a small scale, to determine whether or not the French method could be applied profitably by a typical naval stores operation with an average plant and the ordinary grade of turpentine labor using French tools.

One of the turpentine companies cooperated with the Forest Service of Florida. The company furnished the labor and directed the labor in the putting up of the cups, chipping the faces, dipping and hauling the gum, and raking the trees. A forest officer inspected the work each week during the season and weighed and recorded the dip and scrape. The age, size, and quality of the timber is practically the same in the four drifts. Figure 8 shows the layout of the drifts in the township.
Drift No. 1 was cropped and chipped according to the regular government method. Trees below ten inches in diameter were not cupped. Only one cup was placed on trees ten to sixteen inches in diameter; only two cups on trees seventeen to twenty-four inches in diameter, and not more than three cups were placed on any tree. The McCoy metal cup and horizontal apron was used. The cup was placed as near the ground as possible, the first streak being chipped at the time the apron was installed and was placed within three inches of the apron. Cups were placed on the two-cup trees in such a manner that an eight inch bar of uncut wood was left between faces. The chipping and pulling was done with No. 0 hacks and pullers; the depth and height of streak did not exceed one-half inch.

Drift No. 2 differed from the regular government method in that smaller trees were cupped and the faces were narrower. Trees below a diameter of eight inches were not cupped. Not more than one cup was placed on trees eight to twelve inches in diameter; not more than two cups on trees thirteen to seventeen inches in diameter, and not more than three cups on any tree. On two-cup trees the cups were placed on opposite sides of the tree, and on three-cup trees they were equidistant around the tree. All of the conditions of cupping and chipping were the same as the government method except that the faces were only six inches wide.

Drift No. 3 was cupped and chipped exactly as the French method specifies. Trees below eight inches in diameter were
not cupped. Not more than one cup was placed on trees eight to twelve inches in diameter; not more than two cups on trees thirteen to seventeen inches in diameter, and not more than three cups on any tree. On two-cup trees the cups were placed on opposite sides, and on three-cup trees were placed equidistant around the tree. All the tools used were the specified French tools. The first operation in cupping was to thin the bark for the first season's work. A groove-like face three and one-half inches wide and seven inches up the tree was then chipped, a circular gutter inserted, and a Herty clay cup hung under the gutter. In regular chipping the streak was one-half inch deep in the center, tapering to a feather edge.

Drift No. 4 was cupped and chipped somewhat according to the French system, but with wider faces. The cups were placed according to the same diameter limits given above. French tools were used. Instead of the three and one-half inch width face used by the French, faces were six, eight, and ten inches wide. Also the first faces were chipped ten inches high to start with and a horizontal cup and apron were used. This method was abandoned at the end of the fourth year because of the difficulty in chipping the high wide faces with the French tools.

During the life of the experiment labor was scarce and unstable. Thus new chippers had to be trained. It took considerable time for the men to become adept with French tools. Three West Indian hurricanes occurred during the
life of the experiment and caused a considerable reduction in yield.

Analysis of Results

Table II shows the number of faces that can be worked on a given area under the four methods.

<table>
<thead>
<tr>
<th></th>
<th>DRIFT No.1</th>
<th>DRIFT No.2</th>
<th>DRIFT No.3</th>
<th>DRIFT No.4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Government Method</td>
<td>Narrow-face</td>
<td>French Method</td>
<td>Wide-face</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Modification of</td>
<td></td>
<td>Modification of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Government Method</td>
<td></td>
<td>French Method</td>
</tr>
<tr>
<td>Area in drifts (acres)</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td>160</td>
</tr>
<tr>
<td>Number of trees cupped</td>
<td>2180</td>
<td>3622</td>
<td>5341</td>
<td>5640</td>
</tr>
<tr>
<td>Average number of faces per tree (inches)</td>
<td>1.2</td>
<td>1.5</td>
<td>1.2</td>
<td>1.1</td>
</tr>
<tr>
<td>Average width of faces</td>
<td>9</td>
<td>6</td>
<td>3.4</td>
<td>8</td>
</tr>
<tr>
<td>Height of trees at end of sixth year (inches)</td>
<td>79</td>
<td>80</td>
<td>104</td>
<td>0</td>
</tr>
<tr>
<td>Total number of streaks per face</td>
<td>172</td>
<td>168</td>
<td>166</td>
<td>107</td>
</tr>
<tr>
<td>Number of cups placed</td>
<td>2395</td>
<td>4675</td>
<td>6385</td>
<td>4024</td>
</tr>
<tr>
<td>Number of seasons worked</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Actual total yield</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pounds of dip</td>
<td>87,745</td>
<td>120,657</td>
<td>117,980</td>
<td>74,356</td>
</tr>
<tr>
<td>Pounds of scrape</td>
<td>20,670</td>
<td>29,620</td>
<td>40,630</td>
<td>20,460</td>
</tr>
<tr>
<td>Total</td>
<td>108,415</td>
<td>150,277</td>
<td>158,610</td>
<td>94,715</td>
</tr>
</tbody>
</table>

Table II

1 Abandoned at end of fourth year

From the table it can be seen that the percentage of scrape from Drift No. 3 French method was larger than from
Drifts No. 1 and No. 2. This was due to the fact that the faces were higher over which the gum had to flow to reach the cup.

On the basis of yield per acre the French system shows better results with an increase of fifty-two percent in production over the government system. The reason for this is that trees of smaller diameters can be worked without damage and with profit, thus increasing considerably the number of working faces. In contrast to the government drift, the French drift can be worked over several additional periods, each being as productive, or more so, than the first, and during all this time the smaller trees will maintain their growth.

The most important lesson that we have learned from the French method is that the chipping surface should not be increased to obtain a greater yield, for this is certain to be only temporary and will involve early exhaustion of the tree. The French system is better adapted to young second-growth timber, and on such an operation death caused from chipping would be practically eliminated. Because of the narrowness and smooth feather-like edge of the French face, the process of healing-over takes place very rapidly. The yield per face under the French system shows a considerably lower production than under the regular government method, but on the acre basis the yield of the French system is higher. However, if the labor was familiar with the method and could do the chipping regularly, it is believed
that the French system would compare more favorably with the
government system as far as yield per face is concerned.
The experiments conducted in Florida indicate that our
second-growth longleaf pine can be profitably worked by the
French system. American operators should adopt this method
for the sake of the permanent welfare of the naval store
industry.

More Recent Studies in French Face Experiments

The minute details of this more recent experiment will
not be given in this paper. It is sufficient to say that
the experiments were carried on much the same as in the
earlier experiments. The yield from American faces was com-
pared to that of the French faces. The labor, however, in
the second experiment was a little more skillful in handling
the French tools. This experiment, which started in 1929,
has not progressed far enough to determine the rate of face
healing. Theoretically the French face will be grown over
in seven years, while the American face would have closed
to the extent of only three and one-half inches (9). These
theories were indicated by the observations made.

In the basis of these preliminary tests it is believed
that the French system of turpentining has much to recommend
it to operators working in second-growth timber. Of course
more experimental work will certainly be done on the basis
of the success already obtained. In the experiments con-
ducted it has been demonstrated that French faces can be
Fig. 1.—The regular American face. (U. S. Forest Service photo No. 226689.)

Fig. 2.—Two 3.5-inch French faces arranged to drain into one cup on a slash pine tree 9 inch, d. b. h. Faces have just been chipped giving the outline of the streak a clearer definition. (U. S. Forest Service photo No. 234956.)
chipped at a rate that compares favorably with American faces, and enough work has been done in hanging cups and gutters to indicate the feasibility as well as the practicability of the French-face method.

Most of the success of the French method is due to the narrow face. Not only will two or more faces on a tree heal faster, but the yield is greater per share unit of surface compared to the wider American face. Some of the turpentiners have stated that narrow faces can be made with the regular American hack to accomplish the same thing. It is not practicable to do so, for experience with the so-called split face, which is the regular American face separated in the middle by a bark bar, has shown that the chippers have trouble in keeping their chippers from chipping through the bark bar in their free hand stroke of the hack from outside shoulder to bark bar.

The summarization of the results of the experiment as given by V. L. Harper (9) are:

1. The French face is much narrower than the traditional American face. In chipping a French face a surface freshened is from five to seven inches long and is as wide as the face, whereas the American face has a streak about one-half inch high and one-half inch deep cut across the top of the face. The faces lengthen or progress up the tree at approximately the same rate.
2. The two main reasons why previous trials with the French face in this country were unsuccessful are: (1) difficulty in getting the work done with the French tools (2) the small yield from such a narrow face.

3. On young longleaf pine five-inch French faces yielded twenty-two percent more gum than five-inch American faces for the first year. For the second year the French exceeded the American by sixteen percent.

4. Three well-matched, young slash pine groups of fifty trees each were selected and two groups were turpentine with French faces and the other group was turpentine with the regular American face. The total amount of wounding was the same for all three groups. Results for the first year of working showed one group of French face to be yielding twenty-three percent more turpentine than the American faces. The other French-face group yielded twenty-five percent more than the American face group.

5. Another experiment with slash pine showed that the gum yield per French face increased with the size of the tree.

6. One French face per tree does not yield enough to pay for its working under present cost of production.
7. The regular French hack proved too slow for chipping French faces. A new tool, similar in principle to the American hack, was developed and proved satisfactory. Two French faces can be chipped in approximately the same time as one American face.

8. The time required to heal a tree turpentined with French faces is shorter than the time required for the wider American face. Two French faces separated by a bar have four healing surfaces, while the American face has only two.

Variables Which Influence Yield

There are a number of variables which influence the yield of gum from living pine trees. These influencing variables that have not been previously discussed are site factors (weather, soil, and drainage) and fire frequency.

Weather

The effect of weather, particularly temperature, on the yield of gum is reflected in the increased production of naval stores during the summer and its practical cessation during the winter (2). The various weather factors such as temperature, sunlight, humidity, wind movement, and rainfall not only influence immediate yields, but also control the rate at which the tree can obtain food materials.
which in turn determines the rate of growth and affects the yield of gum.

The average daily temperature is the most important weather factor affecting gum production. Temperature and the length of time the streak is allowed to run are the two factors which, within limits, determine the amount of gum that will be obtained by cutting a streak of uniform dimensions on a given tree. If a streak runs for one or two days only, temperature is of paramount importance. The yield of a streak which is allowed to run four weeks during cool winter days is about the same as the yield obtained during the same length of time in the summer, because the streak ceases to yield after a few days when temperatures are high.

The weekly yield in midseason is apt to be fifty percent higher than the yield at either the beginning or the end of the season. From forty to seventy percent of the total yield for the week flows during the first twenty-four hours after chipping. The yields slow down each night and morning for several days following chipping and rises again as the temperature rises.

Although droughts seriously influence the life processes of trees, generally the trees recover after normal moisture relations are established. Sometimes such conditions may cause the death of large numbers of trees. However, dry spells during the producing season are ordinarily accompanied by excessively high temperatures, and very good gum yields may be obtained up to the time when the trees actually start
to die.

Too much rain in the spring may delay the warming of the soil, which causes a reduction in the early yields. Rains may also flood the ground around trees for so long a period as to produce conditions sufficiently abnormal and unfavorable to cause the death of trees.

Wind velocity and relative humidity, both of which influence evaporation and temperature, affect gum yields to a lesser degree.

Drainage

Although turpentine trees are influenced by drainage conditions as much as other crops, there is no measure of the effect of drainage or lack of drainage on gum yields. Generally it is known that trees on well-drained land grow much faster than those on poorly drained land, and it has been shown that yields of gum are greater in fast-growing trees. Although slash pine trees growing in shallow ponds seem to be able to adapt themselves to this condition so that they often give excellent gum yields, it has been observed that trees growing in such ponds are more apt to dry-face during droughts than trees that grow in drier situations.

Soils

Although soils have a possible bearing on gum yields, insufficient data are available, as yet, to state positively
which soils produce the best turpentine timber. Investigations are now being carried on in the South to determine the relation of turpentine yield to the type of soil. Drainage and stand density are much more important factors than soil in regards to yield.

Relation of Fire to Yields of Gum

No general statement on forest fire can be made that is generally applicable to all parts of the southern pine region and no single set of recommendations can fit all conditions. Uncontrolled fire cannot be tolerated where forestry is to be practiced successfully (2).

Little information is available on the direct effects of forest fires on the yields of oleoresin and none, so far as is known, is available on the effects of fires on the cell structures and the responses inside the tree (10).

Pine seedlings should be protected from fire during their earliest development. This fact should not be altered by the knowledge that longleaf pine seedlings frequently survive repeated burning during their early years. To enable very young slash pine to survive requires absolute fire protection. Fire is considered as an essential control to the brown spot needle disease which severely attacks longleaf pine seedlings during their early years while the foliage is within eighteen inches of the ground. Evidence indicates that the beneficial effects of a fire may vary somewhat with local conditions, and that fire may often do
Eigl-re 54.—Effect of fire on growth as shown by last 4 years' growth at the tops of two longleaf pines. Tree on left grew on land protected from fire. Note height and well-developed buds. Tree on right survived repeated fires but was retarded in development and reduced in wood formation.

**Figure 10**
as much harm as good to the young trees. In the winter the
buds of the trees are dormant, and in longleaf pine they are
so effectively protected that trees survive fire of a se-
verity that would kill them in the summer (2).

These trees so often survive and put out new foliage
that the actual damage done to growing pine trees is not
usually realized. The rate of growth of the trees is defi-
nitely influenced by the condition of the soil which results
from fire. The soil under the unburned litter is more
mellow, permeable, and friable and contains more fungi and
channels of insects than the compact, impermeable soil not
covered with litter that is found on burned areas. The
growth of timber is favored by porous soil conditions.

A study was made of the results of turpentinining of
longleaf pine which had been defoliated by fire in compari-
son with the yield of longleaf pine which had not been
defoliated, but had been subjected to a ground fire. The
loss of about fifty percent or more of the yield of oleo-
resin from the first working is largely traceable to the
fire. A far greater loss, if total returns from the pro-
ducts of these trees is to be considered, is in potential
oleoresin and wood forming power. A reduction of growth in
all dimensions persisted for at least three years in the
scorched trees.

The examination with the microscope of the scorched
and denuded longleaf pine gave evidence of the vigor of
this species in recovering from fire, as shown by its
ability to build wood cells and to respond with high yields of oleoresin even when severely wounded by commercial turpentining (10). Another example of the vigor of the scorched trees is that during the second and third years after the fire, the scorched trees that survived yielded, tree for tree, practically as much oleoresin as unscorched trees.

Protection from Fire

Each winter when the gathering of scrape is finished and most of the straw or leaf fall is over, some form of protection must be used to prevent the burning of the highly inflammable turpentine faces with the accompanying loss of cups and tins (8).

The old method of raking and burning is still common practice although in some cases, since organized fire protection has been gaining ground in the South, the practice of raking and burning has been given up by some operators who now conduct their turpentining in the unburned woods and believe that they obtain more and clearer gum as a result. The method of raking and burning consists of raking the grass, straw, chips, and brush away from the turpentined trees for a distance of two or two and one-half feet. As soon as this material is raked away from the trees, the whole tract is burned usually at a time when the ground is damp and at a time when the operator figures that the fire will do the least damage to turpentine trees. Even though
Fig 11. Before and after burning. Burning has damaged cup and tins and scorched the face. Scorched leaves the tree open to damage by the turpentine borer and may result in a blow down two or three years later.
great care is used with fire, some faces are burned and cups and tins are destroyed. Faces are sometimes burned in spite of the raking done around turpentine trees. The future working of the area is destroyed if the young growth restocking the blank spaces is damaged. The blackening and charring of the bark above freshly hung cups and the scorching of high pulling faces causes a reduction in the grades of resin with a consequent reduction in the sale price.

At present, over thirty-five turpentine operators in Florida are cooperating with the State Forester in protecting 227,670 acres of turpentine woods from fire (8). Fire lines are plowed, guards and organized crews are equipped for fire fighting, and lookout towers are erected. Operators have reported an increase of gum yields of from ten to twenty percent from timber which has been protected from two to four years. It is so essential for the expansion and betterment of the naval store industry that other states are now following the example of Florida in providing a good protection system.

Operating Methods in Relation to Yields

Part Played by Wounded Wood

Evidence has been presented that the internal structure of the wood formed about a turpentined face will produce an increase in yields during the second, third, or fourth years of turpentining. When a streak is cut not only is resin production stimulated, but the formation of new resin ducts
Figure 60.—A gang disk plow which has been found highly efficient for use in constructing firebreaks.

Figure 12

Figure 53.—Effect of fire on young longleaf pine: A, Twelve-year-old trees on land burned annually; B, trees of the same age protected for 5 years from fire.

Figure 13
takes place as well (11). This takes place upward from the streak. Just above the streak the ducts are very plentiful. Farther up the tree they lessen in number, but are still more than normally abundant. One streak is all that is necessary to start this extra duct formation which lasts through the year. Occasionally some effect has been found to extend over the second season. Of course the process can be renewed. Just above the streak the wood ring of any year is very thin, while up the tree its thickness gains progressively. Sometimes as early as the fourth year of normal working the whole depth of the streak has been found to be within this new wood rich in resin ducts.

By means of suitable management this habit of the pine tree may be utilized to secure an increased return in gum for the labor the naval stores operators put into their business. Inquiry was made among the members of the industry to see if various tests and experiments resulted in a gain in yield. The results all indicated that favorable yields resulted from the advanced streak.

At the present time it can not be predicted how an idea like this may work out or be worked out, if it were to be continued. Experimenters think that its utilization might be worked out in the future by allowing timber to stand unworked for a year or more with one streak cut. The time for resting should be during periods of low price. This resting will allow the building up of rich wood. Only trial will test out the practicability and value of these ideas.
Height of Streak

The idea of removing only a thin chip each time the wound is freshened is by no means new. Thin chipping was recommended in 1851 by Debow, and a partially successful effort to determine its advantages was made in 1911 by Herty (12). The introduction of lower chipping on a commercial scale did not occur until after the first sale of government turpentine leases in Florida in 1910. Although the common practice was to remove three-fourths to one inch, the leases stipulated that not more than one-half inch of new wood was to be taken from the upper side of each streak. A No. 0 or smaller chipping tool was required. Under the lease stipulations not more than sixteen inches increase in height each season was allowed. The enforcement of these regulations have been so thorough that it is not uncommon to find a full season's chipping that produced faces only thirteen and one-half inches in height. The practical work done has positively demonstrated the fact that with only ordinary labor, but with smaller tools, thinner chips can be cut. The point of interest is that the yields far surpassed those obtained by the surrounding operators who used the old-fashioned, high and deep chipping together with the cutting of wide faces. A large number of trees were killed as a result of these old-fashioned methods.

The Forest Products Laboratory made an attempt to gain evidence on the effects of still further reducing the height of chipping. The results of this experiment showed distinct
A FACE, HALF OF WHICH HAS BEEN SCRAPED.

Note large mass of scrape at left, such as frequently breaks away from the face and falls upon the ground, where it may be trampled and wasted. The scraped side of face shows that some of the wood is actually cut away by removing the ridges between the streaks. Careful operators arrange to cut a streak or two after a face is scraped so that fresh gum may flow over the face, thus coating it as with varnish to assist in lessening the drying of the exposed surface.

Figure 14
improvements upon the higher chipping of one-half inch to three-quarter inch. During the five-year test (1923-1927) on a National Forest in Florida, as high a yield of oleoresin was obtained from the low faces as from faces more than twice as high. This almost doubles the potential yield per face as well as the leasing value of the timber (12). Another factor to be considered is that the low faces gave yields of higher quality because there was a greater proportion of dip and not so much scrape that is usually collected from higher faces. Another possible advantage of the lower face would be the lessened degrade of butt lumber because of excessive pitch soaking or because of drying of the exposed surface accompanied by attacks of insects and fungi.

A study of the wood and bark of the test trees with a microscope showed that the low-chipped trees had wider rings of annual growth, better developed summer wood, and much more abundant oleoresin-giving tissues just above the faces. The fact that low chipping reduces the waste of productive wood and in addition maintains the potential oleoresin and wood producing powers of the tree is very significant in the turpentining of second-growth timber where rapid healing following chipping, especially of the French split-face, will hasten the next working of the trees for oleoresin. In applying low chipping the use of two French faces with a four inch bar of bark between them, in place of one American face, gives further promise of high
yields, excellent tree health, and the most rapid healing known.

Depth of Streak

Even though very deep chipping may give high yields for a few years, it will lessen later producing power. Sometimes deep chipping results in the damage or even the destruction of the timber. It stands to reason that trees with narrow sapwood must be chipped with shallower streaks than trees with wide sapwood. From experience it is generally recognized that longleaf pine timber is not so susceptible to damage from deep chipping as slash pine. Deep chipping results in a progressive increase of dry face, which is likely to be attacked by boring insects and later by wood-rotting fungi still further reducing the strength and vigor of the trees and the value of their butt lumber as well as rendering them liable to windbreak.

From the above reasons it can be readily seen that the streak five-tenths of an inch deep is an excellent standard depth for chipping since it produces as much gum as deeper chipping with less damage to the timber (2). From experience it has been found that old-growth timber and small-tapped slash pine trees in crowded stands should be chipped with even shallower streaks to avoid undue injury; also longleaf pine with large crowns in open stands may be chipped to a depth of 0.75 inch without injuring the tree.
Number of Faces

Overcupping small trees will result in a decided loss in yield. An operator experimented with this situation by overcupping several ten inch trees. He placed two faces on each of these ten inch trees. He also placed only one face per tree on a number of other ten inch trees in the same crop and in close proximity of the two-faced trees. Records from these two groups of trees showed clearly the present waste and future loss which resulted in the care of the two-faced trees. Although the two-faced trees started by doubling the yield at the beginning of the first year of working, the gum yield by autumn that year was only thirty percent more than that of the one-faced trees. By autumn of the second year the gum yields from the two-faced trees was actually less than that from the corresponding one-faced trees yet the cost of operations was nearly twice as great.

One of the major results of this experiment was to show that the growth, both in diameter and height, of the two-faced trees was checked to a much greater extent than in the one-faced trees.

Frequency of Chipping

Theoretically a second streak should not be cut on a tree until the gum has ceased to flow from the preceding ones. The time cannot be determined exactly, for it is influenced by the season and the temperature. The time varies from three to four days for longleaf in the summer to three or four weeks in the winter for slash pine.
Longleaf pines produce eighty-three percent of the total gum yield for a week during the first twenty-four hours following chipping during the hottest weather. The corresponding figure for slash pine is about sixty-four percent. In cold weather only about twenty-three percent of the yield for a week is produced by longleaf pines on the first day and nine percent on the seventh day. For slash pines the figures are about fifteen percent for the first day and about eight percent for the seventh. Slash pine also shows a tendency to flow a longer period than longleaf. Table III shows the daily yield of gum from slash and longleaf pine for a week in which the mean air temperature was seventy-six degrees Fahrenheit.

<table>
<thead>
<tr>
<th>DAY</th>
<th>Slash Pine Percent</th>
<th>Longleaf Pine Percent</th>
<th>DAY</th>
<th>Slash Pine Percent</th>
<th>Longleaf Pine Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>52.8</td>
<td>74.1</td>
<td>Fifth</td>
<td>4.9</td>
<td>2.2</td>
</tr>
<tr>
<td>Second</td>
<td>19.5</td>
<td>12.1</td>
<td>Sixth</td>
<td>4.0</td>
<td>1.9</td>
</tr>
<tr>
<td>Third</td>
<td>9.1</td>
<td>14.8</td>
<td>Seventh</td>
<td>3.4</td>
<td>1.7</td>
</tr>
<tr>
<td>Forth</td>
<td>6.3</td>
<td>3.2</td>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table III

It is the usual practice to cut a streak once a week from March to November and either once in three or four weeks from November to March or not at all. Once in a while trees are cut twice a week in midsummer. This practice takes advantage of the physiological response of the tree.
to weather conditions. It seems that moderate double chipping (twice a week) has not appeared to affect vigorous young trees to any great extent.

**Effect of Turpentinining on Growth and on the Internal Structure of Trees**

**Effect of Working on Growth of Trees**

Stem analysis is really a simple thing once one understands it. It is based on the fact that trees grow by putting on a layer of new wood yearly under the bark, the successive rings clearly separated from one another. A tree will have as many rings at its base as it is years old. The top section, which is produced within the last year, will have one ring only. If several cuts are made along a stem, the material in hand is capable of producing the history of its height growth.

An experiment was conducted by examining cuts from a tree that had never been worked for turpentine and cuts from a tree worked with one face. The corresponding cuts of each tree were at **two**, ten, twenty, thirty feet, etc. from the ground. In the lower disk of the turpentinined tree a cross section of the face itself appears with the wood of the tree cut away. The rings of the working years are also seen outside of the earlier ones (11). The rings of the disks referred to appear to be of normal width, which is true to the usual facts. However, the case is different with the upper disks. In these disks, the belt
DIAMETER 5.2 INCHES
3 GROUPS OF 5 RINGS EACH
+ 1 RING IN CENTER-TOTAL 16
AVERAGE THICKNESS OF:
OUTER 5-RING-BELT... .44 INCH
NEXT 5-RING-BELT... .83 INCH
INNER 5-RING-BELT... .03 INCHES
LEAVING .6 INCH AT CENTER.

DIAMETER 7.1 INCHES
4 GROUPS OF 5 RINGS EACH
+ 4 INSIDE
AVERAGE THICKNESS OF:
OUTER 5-RING-BELT... .35 INCH
SECOND 5-RING-BELT... .59 INCH
THIRD 5-RING-BELT... .61 INCH
FOURTH 5-RING-BELT... .91 INCH
LEAVING 1.7 INCH DIAMETER FOR 4 CENTRAL RINGS

WIDEST DIAMETER 8.5 INCHES ACROSS.
VERTICAL DIAMETER 8.0 INCHES
5 GROUPS OF 5 RINGS EACH
+ 3 RINGS IN CENTER
AVERAGE THICKNESS OF:
OUTER PARTIAL BELT... .61 INCH
FIRST COMPLETE BELT... .61 INCH
THIRD 5-RING-BELT... .85 INCH
FOURTH 5-RING-BELT... .96 INCH
FIFTH 5-RING-BELT... .96 INCH
LEAVING 1 INCH FOR THE 3 CENTRAL RINGS

DIAMETER GROWTH IN LONGLEAF PINE WORKED FOR NAVAL STORES FIVE YEARS BEFORE CUTTING. THREE DISCS ARE ILLUSTRATED, 2, 10 AND 30 FEET FROM THE GROUND. THERE ARE 28, 24 AND 16 RINGS IN THESE SUCCESSIVE DISCS, AND IN EACH DISC 5-RING GROUPS BEGINNING WITH THE BARK ARE REPRESENTED. DIAMETER GROWTH OF THIS TREE SHRUNK 80 PER CENT BY THE WORKING.

Figure 15
HEIGHT FEET

FIG. 1 NORMAL HEIGHT GROWTH AND THAT OF BLED TREES-LONGLEAF PINE AT WAYNESVILLE, GA. COMPOSITE OF A NUMBER OF TREES. TIMBER WORKED 1920-1924 - RESTED 1925-1927 - CUT EARLY 1928

Figure 16
of wood representing the last working years is seen to be thin in comparison with similar belts of rings in the older wood. The amount by which working a tree has checked growth is found by measuring the width of these different ring groups and compare the figures with one another.

One of the most important observations made by this experiment is that working timber for naval stores as we conduct the operation constitutes such a drain upon it that its growth rate is lessened materially. At present it is an open question as to whether this will hold true if present tools and better operating methods are used.

Two faces on timber a foot in diameter has been found to cut the growth down about half, sometimes more. On the average one face and good average chipping will reduce the growth of timber about twenty-five percent. Although the growth of some trees is reduced by only five percent or not at all, others are heavily cut down. This study has not yet thoroughly covered the question as to whether the timber, after working ceases, will resume its natural growth rate or remain at the lowered rate induced by working. Although a few trees do start up with increased growth when turpentine has been stopped, others seem to drop even farther down. The outcome of this study indicates in a general way that the lowered growth rate usually persists (11).

The Effect of Turpentine on the Internal Structure of the Tree
THE NUMBER OF RESIN PASSAGES DECREASES WITH INCREASE IN DISTANCE ABOVE THE FACE.

Figure 17
After a tree has been turpented notable changes occur in the new wood formed especially in the amount and distribution of the resinous tissues in the region above and close to the sides of the face. Since each year's growth is practically complete at the end of the current growing season, the structure of the wood formed during the previous years is not altered. There is a general tendency for an increase in resiniferous tissue production following wounding. This is often accompanied by a narrowing of the annual ring and a reduction in the amount of summer wood formed directly over the face. The increased activity of the resin passages already present in the vicinity of the streak has led to the practice of using the advance or hauling streak when installing a new operation (2). The decrease in the number of resin passages in relation to the increase in distance above the face is apparent from the illustration of the three blocks cut at varying distance above the face.

As was before stated, there is a distinct reduction in the width of the rings formed directly above the face after turpentinaing has begun under the methods used at present. The amount and density of the summer wood is usually reduced, although in a very conservative working of trees with narrow annual rings there may be little or no reduction (15). The narrowing of the annual ring may extend forty or fifty feet above the face in heavily worked trees.
During turpentining the resin content of the wood does not seem to be altered to any great extent in the area above the face where it may be somewhat higher than normal because some of the gum may soak into the tissues.

Eloise Gerry of the Forest Products Laboratory stated that well-turpentined trees, if the faces remained unburned, show little or no degrade except the actual wood cut away in chipping. It was also stated that if the chipping is deep and the weather dry, pitch-soaking may appear in varying degrees in the segment bounded by radii from the sides of the face. For some purposes, such as export piling, this is held to be an advantage not a degrade (14). Such soaking, especially as a result of deep chipping, sometimes occurs in the sapwood behind the chipped face if this area becomes unduly dry as a result of deep chipping or of wood fires.

Insects That Attack the Southern Pine

These forests are unusually free from insect pests, but destructive methods of turpentining, especially deep chipping and overcupsing of trees of small diameter, have resulted in an enormous increase of a flat-head borer known as the turpentine borer (Euprestis apricans). The adult beetle lays its eggs only on trees where the wood has been exposed by a scar or wound and is especially abundant on turpentine faces when they are burned or dry and checked (15). The grubs which develop from the eggs
Figure 62.—A flat-head borer, known as the turpentine borer (Fomatia africana Herbst.). A, The beetle which lays the eggs; B, the larvae which develop from the eggs and cut tunnels in the wood of the trunk behind the face; C, cross section of turpentina butt showing turpentine-borer galleries filled with powdered wood.
laid in these cracks mine extensively through the inner wood, often completely riddling it. One infestation may result in this process continuing for three years or more. As soon as the tree becomes sufficiently hollowed with galleries, it is weakened and subject to windthrow.

If conservative practices in turpentining are adapted, attacks from this insect can probably be entirely prevented. Narrow faces and shallow chipping are two practices that must be carefully watched. Another important practice is to tack the gutters on the face rather than insert them in an incision made in the chipped face with an axe. The exposed face should at all times be protected by a thin protective covering of gum. This necessitates special care in scraping so that large chips of wood will not be needlessly removed thus deepening the scar and exposing the unprotected surface to drying (2). Above all things fire protection must be maintained for all chipped faces while they are being worked and during periods of rest.

Forest Management for the Turpentine Pines

In my opinion the naval stores belt shows a better opportunity for sustained yield than any other region in the United States. In many regions forest management plans must extend over one hundred to one hundred and fifty years or more, while in the naval stores region, it is possible to establish and harvest a stand within the active period of the life of the owner. What is of more interest to this
southern industry is that such stands will be capable of maintaining and even increasing the past volume of naval-stores production, as well as supplying such commodities as firewood, poles, piling, pulpwood, railroad ties, timber and lumber. To obtain the greatest net financial return per acre per year on a sustained yield basis is the objective of a management plan.

The eastern part of the longleaf pine region, namely in Alabama, Georgia, and Florida, is being managed now and will be managed for some years to come primarily for the production of naval stores. All other uses are secondary. It is believed that in a very few years the management of the forests in the South will be such that the production of naval stores and wood products, mainly pulpwood, will be of equal value.

There are several reasons why naval stores timber of the South should be managed so that the production of pulpwood is of equal importance to that of naval store production (16). One reason is that we should create a permanent domestic pulp and paper industry which can meet our entire needs founded on home grown timber. In the long run this will insure cheaper products to the ultimate consumer than can be obtained from foreign countries. The possible stoppage of foreign pulp and paper supplies would be very objectional to our industries. Another advantage of managing the naval-stores belt in coordination with the pulp industry is that more employment will be supplied to
the people of the South in the paper mills.

As one can readily see, there is a very marked difference in the management of forests which are designated primarily for the production of naval stores as against those destined primarily for saw timber. The forests for naval stores require different treatment from earliest infancy to the time that turpentining is stopped. The management and silviculture must be designed to produce the greatest quantity of naval stores per acre at the lowest cost in the shortest possible time and with the greatest degree of stability, and all with the minimum damage to remaining wood products value (14). These objectives will effect silviculture, management, protection facilities, and utilization. The grouping of industries here will not be the same as those in the forests of the same species managed for wood products. Regardless of the system of management, certain necessary steps must be taken.

**Survey and Inventory of the Property**

The first step necessary for systematic management is to make a survey and inventory of the timber resources. Some of the factors that should be known are the number of trees by species, by age and by diameter classes. The rate of diameter growth should be established for trees by species and by diameter classes. The number of trees being worked, with the height of faces, should be determined together with the number of trees still standing upon which
turpentine has been completed (2). It is necessary that a map be made showing the location of boundary lines, roads, highways, railroads, streams, swamps, barren areas, location and area of crops — active, idle and abandoned — forest types, and areas of young growth.

The owner, having a practical knowledge of the needs, possibilities, and limitations of the turpentine and logging business, can, from the above information, appraise the possibilities of the situation and make plans for systematic management designed to give the greatest possible returns per acre. Since some areas are too small and do not have a favorable distribution of age classes in their timber stands, some timber is of such poor quality as to present a poor chance, and some are impossible because of financial burdens already fastened on them, not all ownerships are suited for immediate ownership.

Length of Rotation

The second feature of importance in formulating a working plan is determining of the time required to grow to useable size for final products the type of tree desired. If stands are to be managed primarily for naval-stores production, they require different treatment from that which would be given them if they were being grown primarily for the production of the best saw timber or for pulpwood. My opinion is that in the near future compromises will be made to permit a profitable production of woodpulp as well
as naval stores.

**Size of Holding**

If a profitable production of sustained or continuous yields is to be insured, a holding of sufficient size must be obtained. In considering a large scale operation the number of trees turpentined annually should be such that continuous yields from workings of different ages should so supplement each other that new trees will be ready for chipping when the turpentining of older crops is finished, either during rest periods or because they have been worked as long as it is deemed profitable, and are to be converted into other products. The above mentioned procedure resembles to some extent that used by the French who began turpentining when their trees were from twenty-five to thirty years old.

![Diagram of French turpentine farm](image-url)
Figure 19 illustrates the principle of continuous operation. The operator worked the even aged stands in each of the units marked six to fourteen. The stand on one lot would be of different age from the stand on any other lot. The lots from one to five would be covered with trees too small for working, while lot of fifteen would contain trees which turpentining had been finished, and the mature trees are turned over to the loggers. Turpentining would be commenced every five years or so in the oldest unturpentined lot and discontinued in the oldest turpentined lot. The operator would be working nine out of fifteen lots or would have these stands enjoying a temporary rest between workings. During this time, five lots of young trees are growing in preparation for assuming their place in the turpentine group. One lot, on which there are several crops, would be cut and restocked each year. The number of crops worked on each lot might vary from two to one hundred or more depending on the area involved.

The Forest management plans, as worked out in France, are applied to even aged stands. At the present time, the direct application of the French management system would not be possible in the United States for an even-aged distribution of second-growth forests is very uncommon. However, some parts of the plan have been tried out in the South with very good results. The part of the plan tried is the working and reworking of trees over a period of
years, often through three successive workings.

Thinning Pine Stands

After a stand of timber is established and protected from fire, no feature of forest management is of greater importance than the making of proper thinnings from time to time. There is considerable difference of opinion as to when, how, and to what extent stands should be thinned. Alfred Akerman, who experimented in the thinning of slash pine, claimed that since it has been held that to make a satisfactory turpentine tree the crown should extend halfway down to the trunk, it is necessary to obtain this crown by thinning. In thinning the method should rest on the principle that "if a tree in a dense stand has managed to reach dominance and a good crown, it can with a little help maintain its dominance and good crown. The method that suits this is called the Chosen Tree Method. The advantages of the Chosen Tree Method are (17):

1. The Chosen Tree Method assumes some good turpentine trees at an early age.

2. The cutting, while centering around chosen trees, should also benefit some other dominant trees.

3. Some of the trees on the areas thinned by this method will be subjected to enough crowding to insure some good lumber trees being in the stand.
Figure 45.—Experimental turpentine plot at Starke, Fla.  a, Typical "tree of place"; b, representative tree of the type being turpentined prior to removal in the final thinning of the stand; c, piles of still wood obtained from thinnings.

Figure 20
4. Any mistakes that may be made in choosing trees to be cut around can be corrected in part at least when the stand is cupped for the first time during the first fifteen or twenty years. That is, the selection of trees to be bleed need not coincide exactly with the chosen trees, but may be made with reference to leaving the most desirable trees for the final stand regardless of whether they were in the uncut strips between chosen trees or were chosen trees.

5. Thinning by the Chosen Tree Method can be done at a low cost.

6. If the amount of material is taken as an index of fire risk, it may be said that the number of trees cut and left on the ground by the Chosen Tree thinning is about one-third of the number cut and left on the ground by one drastic cutting.

7. The Chosen Tree Method is easy to understand and apply. The ordinary woods hand can choose trees to be cut around as well as he can choose the ones to remain in one drastic cutting. After choosing his tree it is simple enough to cut all trees around it within the swing of a five foot stick, going a little beyond the five foot limit to cut a black pine, gum, or other undesirable.

The Forest Service is also making close studies of
various methods of thinning and is cooperating with others making studies of thinnings.

Taxation

Taxation, although not necessarily a subdivision of forest management, has a very decided effect upon turpentine operations. Various investigations now being made into the subject of taxation to determine a reasonable rate between revenue and taxation. Other studies are now being made to work out and recommend practical measures for handling and using forest lands which have been reverted to public ownership on account of delinquent taxes. Because the tax burden cannot be met from the current land income or forest income, there has been a great increase in tax delinquency. In 1933 one of the southern states held tax certificates on fifty percent of the taxable area of the state (area includes land actually reverted to state title plus that delinquent for one or two years taxes, but still subject to redemption) (2). In some counties it has been found that unimproved property including timberlands are assessed at forty-seven to forty-nine percent of its sale value, while improved farm lands are assessed at twenty-six to twenty-seven percent of their sale value. Even more drastic differences occur in the western part of the naval-stores region. While improved farm lands are nominally assessed at twenty-seven to thirty percent of actual sale values, cut-over timberlands are assessed at
ninety to one hundred and twenty-three percent of their sale value. This shows the heavy burden placed upon the owner of turpentine timber.

Working Turpentine Trees Under Sustained Yield

If the timber has been worked conservatively, it is of real value when turned over to the logger. The number of trees killed by turpentining in thrifty second-growth is very small. The only portion of a turpentined tree that is actually lost is the portion of the butt covered by the turpentine faces. Because of the one-quarter inch chipping rules this space will not be over six feet above the stump in eighteen years. At the present value of naval stores leases, the six feet of wood will have returned a stumpage value of thirty-two dollars per thousand board feet at the end of the eighteen years with only a minor effect on the value of the rest of the tree (14).

The forest manager finds no difficulty or expense in controlling the naval stores operation in an organized forest. Since the manager provides specifications for cup hanging, for chipping and pulling, and for removal of the cups and gutters, he must enforce them. The operator should be under contract, and there should be a penalty clause in the contract. The manager should see that field inspections should be made once a month or oftener, if possible. The most essential problem of forest management is fire protection. Protection from fire is a very
difficult problem in any pine stand, but more so in a stand worked for turpentine.

Yield of Other Products Under a Management Plan For Sustained Yield

The growing of slash and longleaf pine primarily for turpentine works in well enough with the production of saw timber, poles, piling, ties, stove bolts, and fuel, but the production of pulpwood as a by-product is one of the most important factors before the people of the Southern States today. The growing of these pines for turpentine in consideration with the pulp industry will have a very decided effect on the management of the forests. The last possible obstacle to successful forestry was removed when the large number of paper mills was established in the South.

The thinnings made in the stands will help pay for themselves besides helping to bridge over the twenty years between seeds and turpentine. After the trees have been turpentined, a market will be provided that will insure the profitable removal of abandoned trees as fast as they are turpentined.

The tapping of trees for naval stores does not reduce the final yield of wood products to an unreasonable extent and will provide a steady and satisfying income to the owner beginning at an early age and lasting until he can sell it for removal at a profit.
Conclusion

The Forest Situation in the Lower South

The United States Forest Service has been making an inventory of the growing stock of timber in the main forest regions throughout the United States during the last five years. The Southern Forest Survey has been under way since January, 1931. The five-fold object of this nation-wide survey is (1) to make an inventory of the present supply of timber and other forest products, (2) to ascertain the rate at which this supply is being increased through growth, (3) to determine the rate at which this supply is being diminished through industrial and local use, windfall, fire, and disease, (4) to determine the present requirement and the probable future trend in the requirement for timber and other forest products, and (5) to correlate these findings with existing and anticipated economic conditions in order that policies can be formulated for the effective use of land suitable for forest production (18).

Most of the field work of the Survey in the lower South was finished a little over a year ago, but the larger and much more time-consuming job of converting the field data into usable information for publication and its integration in a thorough-going economic study of the situation is still underway (19). One of the outstanding features of the findings of the survey of the land surface of the region is the large proportion of the land surface that is in
timber growth. Figure 22 shows a summary of land use in the lower South as found by the Forest Survey. The area surveyed was divided into survey units whose boundaries are shown. The circle in each of these units is of a size proportional to the land area of the unit in which it occurs. The black, gray, and white portion of each circle represents the forest, agriculture and other land uses, respectively, of the given unit. If the lower South is considered as a whole, forest growth in some stage occupies
fifty-nine percent of the land area, agriculture thirty-five percent, and other land uses about six percent of the land area.

If the four major regions into which the lower South has been divided for the purpose of description, the Naval Stores Region has by far the larger forest area. The other three regions are the Pine Hardwood East, the Pine Hardwood West, and the Delta Hardwood Regions. Figure 23 shows the four major regions of the forest area. Longleaf and slash pine types occupy two-thirds of the forest area. A point of interest to those concerned about the future of the turpentine and pulpwood industries is that the greater proportion of unstocked, clear-cut areas is found in the Naval Stores Region and the longleaf pine belt of the South-west where skidder logging and frequent fires account for a considerable area of denuded pine land, much of which has come back worthless scrub hardwoods.

Figure 24 gives a fair idea of the size class distribution in the pines, for it shows graphically the entire stand of sound pine trees in the Naval Stores and Pine Hardwoods West Regions, classified according to four-inch diameter groups. These two patterns represent the silhouette of a growing forest. There is a larger number of trees in the smaller diameter group. The interest of this chart lies in the fact that it shows that the necessary trees for an increasing yield are on the ground and can be realized if the proper measures are taken to reduce the
MAJOR FOREST TYPES
IN THE
SOUTHERN FOREST SURVEY TERRITORY

- Longleaf & Slash Pine
- Lob.-Shl.-Hardwoods
- Bottomland Hardwoods
- Upland Hardwoods

Prepared by Forest Survey
Southern Forest Experiment Station
New Orleans - La.

Figure 23
heavy mortality.

The Forest Survey has presented its findings on the distribution of sawmills, turpentine stills, and pulp mills in the southern survey territory. The pulpwood map shows a total of twenty-seven mills either established or well assured. When the new mills are finished, the pulp-producing capacity of the territory will have been increased nearly one hundred and twenty percent.

In connection with the new pulp mills in the Naval Stores Region is the matter of employment. Figure 25 shows the amount of employment given by the different forest industries in the Naval Stores and Pine-Hardwood.
West Regions during 1934. This figure does not include the new pulp mills. This picture will have a very different pattern by 1938 for pulp mill employment will rank much higher.

This developing of the paper pulp industry in the naval stores region will effect many parts of the United States. Until the South can build up and secure growing stock tributary to their mills, they must look to the forest region to the North and West for a part of their supplies. Also the location of additional large paper mills in the naval stores region at this time will undoubtedly threaten the future supply of lumber, poles, ties, and the turpentine
APPLOXIMATE LOCATION OF PULP MILLS IN THE SOUTH

1937

- PINE PULP MILLS
- HWDP PULP MILLS
- PINE & HWDP PULP MILLS

INDICATES BOUNDARY LINE OF TEXAS SURVEY UNIT NO. 1
industry. Their own future prospects might also be en-
dangered. The prospects of a successful expansion of pulp
and paper industry in the South are full of promise, but
certain precautions must be observed if this expansion is
to be permanent.

1. There should be no greater installation of
paper mills than the South can support from
timber not needed for established forest
using industries.

2. Insofar as economic circumstances will
permit, new pulp mills should be fairly well
distributed throughout the region and not
concentrated in restricted localities.

3. Each plant should be planned for permancy
and should utilize the timber in its terri-
tory on a sustained-yield basis with full
regard for the needs of other wood-using
industries, integrating the production of
pulpwood with other forest products of
greater value.

However, the South does not intend to repeat the
sorry cycle of cut out, get out, and suffer that happened
there in the past. Instead they are going to plan and
act with intelligence and restraint. The people of the
South believe in their new pulp and paper mills. There is
not the least doubt that they will fit the paper industry
in with the turpentine industry. With their long growing
APPROXIMATE LOCATION OF SAWMILLS
IN THE 32 SURVEY UNITS OF THE LOWER SOUTH

PREPARED BY FOREST SURVEY
SOUTHERN FOREST EXPERIMENT STATION
FROM DATA COLLECTED 1934-35

LEGEND
- PINE SAWMILLS
- HARDWOOD SAWMILLS
- CYPRESS SAWMILLS
- COMPARATIVE SIZE OF SAWMILLS
- 10-HOUR CAPACITY X BOARD FEET
- SPECIES
- NOT SHOWN

STATUTE MILES
25 50 75 100

FIGURE 8
season, fast-growing species, low taxes, and attractive working conditions, the South will expand rapidly and benefit not only the Southern states, but the rest of the United States as well.

According to the last issue of the Forest News Digest at the time this paper was written, E. L. Demmon, Director of the Southern Forest Experiment Station in New Orleans, thinks that too rapid development of the pulp industry in the South is threatened, as a result of the demonstration of the value of slash pine for making paper. Mr. Demmon advocates educating landowners, large and small, to better handling of the woodlands by securing maximum growth and income from sawlogs, poles, piling, naval stores, along with pulpwood (21). He also advocated educating the public to the point that they would establish pulp mills on a basis of the capacity of the forest to continually support them.

However, one of the editorials in the Jackson (Mississippi) News indicated that certain groups in the South think that Mr. Demmon is worrying too much about the possibility of the young timber of the South being quickly depleted by paper manufactures. In my opinion Mr. Demmon is fully justified in his statement that the pulp industry is developing too rapidly. Unless there is an assurance of a continuous supply of timber for this industry, no more pulp mills should be built in the South.
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