

Journal of Work at The Harvard Forest 1940

August 19
 Geography is cut by north-south ridges and valleys. The soil on the tops of these ridges is more productive and better drained than that in the valleys. It may have been for this reason that the colonial settlements were all made along the ridge tops. Previous to the coming of the white man Indians practiced light controlled burning around their villages, usually once in the spring and once in the fall. This was done to clear out underbrush around the camp or village and make it safe for the women and children to travel there, it also made it more difficult for enemies to approach unobserved. These villages were often in the valleys near water.

settlement Petersham was first settled in 1733, the lands being split into parcels and awarded by lot. These lands were given as rewards for service in the French and Indian War. The first settlers didn't live on the land but commuted from the southern settlements,

to do the farm work and clearing. Huts and log shantys served as shelter during their short stays on the land. The logs, brush, and tree skesh from clearing the fields were burned to get them out of the way, while stumps were either grubbed out or left to rot.

Old Growth

The old growth forests of this region are approximately three hundred years old and more or less even aged. The old forests were a mixture of hardwoods, pine and Hemlock. Many people believe that the ancient forests were pure pine, perhaps influenced to this decision by the stands of old field pine found today. Pine was found on the lighter soils along ridge tops but the bulk of the forest were hardwood, red and white oak, beech, maple, etc mixed with hemlock and some scattered pines.

Climax

This old growth does not represent a climatic climax because of the many interferences which occurred. A hurricane was recorded in Plymouth in 1635 and others in 1815 & '20, Indian fires, and lightning fires all helped to upset the climax forest, so that only an approach was made to it.

Pitch pine

In colonial times pitch pine was found as a native tree, as it is today,

growing on the lighter soils. It was much used and known locally as Dana Yellow Pine.

Industry

Petersham and the surrounding country was a dairy center. A cheese factory flourished in town and the farmers maintained more or less extensive dairy herds. Much land was cleared for pasture as can be seen today by the abundance of old field pine. The Dexter lot today contains this pine about 75 years old.

Ht. of cult.

From 1830-50 was the period of greatest cultivation of the soil in this section. About $\frac{2}{3}$ of the land was cleared for cultivation or pasture land. Petersham had a population approximately three times its present number. After 1850 the abandonment of farms began and kept on gradually until almost the present time. Some fields and pastures were abandoned as early as 1810. The growth of farm lands in the West, Civil War, building of the transcontinental R.R., and the discovery of gold in California are some of the factors which helped to drain the population of New England farms.

abandonment
of farms

Field Pine

These abandoned fields and pastures seeded

in with white pine, the stocking was usually fairly good when it is compared with the stocking of more recently abandoned fields. The better stocking may be attributed to the presence of wolf trees left for shade and protection for cattle and to the trees which sprang up along fences and walls, all of which proved good seed. Today these sources of seed are often lacking. Slab City, 4 is an example of a pasture which was abandoned about 1850 and has come into old field pine. On some of the more moist sites, when seed was available, hardwoods seeded into the abandoned lands and took over the site.

A section of Slab City, 10 was examined which lies on the eastern side of the Barre road. This section is on a moderate slope with a western exposure at a relatively low elevation and fairly well protected and cool. The soil is soft and springy underfoot with a thick mat of ~~red~~ raw organic matter covering the mineral soil. Evidently the land had never been cleared and today supports a growth of large hemlocks with a few scattered pines and hardwoods. The ages range

S.C. 4

Hardwoods

S.C. 10

up to 200 years. There are 40-50 year old stumps of large white pines which were logged off the area releasing the hemlocks. There are also present in the stand a few old beeches, some hard maple, yellow birch, white ash, and black birch. There is very little underbrush and only a small amount of hemlock reproduction.

Break up

at some time there must have been a break up of the original forest to allow the establishment of the present hemlock and the logged off pine. This theory is borne out by the presence of charcoal in the duff in a few protected spots, indicating an ancient fire.

climatic
climax

If a few more hardwoods were to come into this stand, with its protection from fire and other injurious agencies it would be the climatic climax of that site. In thinking of types of forest growth one should think in terms of sites and not regions. The factors affecting the forest type vary too much throughout a region to establish one type for the whole area. These climax types should be used as guide for the forester in growing trees. Mature should

be aided and not misguided to grow trees in the best possible way. The present value of wood doesn't warrant the use of artificial types as they are too expensive. Wood in order to be grown economically must be done in the cheapest possible manner, and this must be done by letting nature guide forestry practices.

Clear cutting and abandonment tends to encourage the growth of the heat loving, light seeded species of hardwood, while conservative cutting will encourage the light tolerant species.

5C.10.

Another section of slab city 10 on the opposite side of the road was examined. This site was cool and protected with a stream thru its center, and had never been cleared. The old growth trees had all been blown down but were mainly Hemlock, hardwoods and a few pine. The hemlock had responded to two releases from suppression, undoubtedly when the old pines were removed. This site contained a good deal more hardwood than did the other old growth, perhaps because of the moister conditions.

Ref.

H. J. Lutz: Trends & silvicultural significance of Upland

- Forest Successions in Southern New England
 Merrill & Hawley: Hemlock: Its Place in the
 Silviculture of the Southern New England Forest
 Frothingham: Eastern Hemlock U.S.D.A.
 R.T. Fisher: New-England Forests: Biological Factors
 S.W. Brouley: The Original Forest Types of Southern
 New England: Evol. Manag. 5: 61-89
 Raup: Arnold Arboretum Bul. '38
 Clepper: Hemlock, The State Tree of Penn.

S.C. 3

a section of slab city 3 was examined in the afternoon. This was a section of blown down old growth on a steep side hill with a south eastern exposure. Here was found a greater preponderance of hardwoods, large white oaks (167 yrs old), beech, paper birch, red maple, white pine, and hemlock. Chestnut also made up a part of the old stand. One hemlock was found to be 107 to 180 yrs old. This area was probably never cut over as the springy layer of raw organic matter, and large trees would indicate. Possibly it was reserved as a woodlot and culled for the better trees from time to time as the ancient stumps seem to indicate. This forest comes close to the climatic climax with a mixture of hardwoods and conifers.

Here again the charcoal in protected spots indicates an ancient burn.

August 20

The morning was spent inspecting the Adams-Fay Lot, for detailed reference to the treatment of this area see "The Growth of Hemlock Before and After Release from Suppression" by R. Marshall, especially pages 13 and 14

area 1

Area one: This area was cut in 1893-37 rather lightly leaving a stand of hemlock with an admixture of white pine. Some hardwoods were present but the soil is too light to favor them. The heavy organic mat over the soil prohibited white pine reproduction but with the complete exposure this is starting to break us so that hardwoods, red maple, black birch, and some spruce are starting to come in.

organic mat.

The original stand of hemlock built up a heavy organic mat which greatly effects the reproduction

area 2

Area two: This area was almost pure hemlock of two divisions, one from the red case of 1893-45 and the other from the understory released in 1894 by group selection cutting of pine.

area 3

Area three: This area was cut more heavily

and more white pine was present. There was a fairly uniform mixture of white pine, hemlock, and hardwoods. The soil is now coming to life after complete exposure and shelterwood cutting and white pine seedlings are present in abundance. Black birch, red maple, and beech were also present.

area 4

Area four: This area was heavily cut and came in to almost pure white pine with an under story of hemlock. Few hardwoods came into this stand. At present the organic mat is almost gone as the area was logged on the strip method and white pine reproduction is coming in. The clear cut strips now contain cherry, birch, some maple as temporary cover, with a heavy growth of brambles below. Quite possibly the hardwoods will shade out the brambles which will give way to coniferous reproduction.

climax

Physiographic

In this part of the country we have ~~three~~ ^{four} physiographic climax types. The spruce-tamarack bog type as seen near the Adams-Fay lot, the Red Maple swamp type which has some drainage to distinguish it from a bog, the Red Maple swail type a side hill

water seep area, and the pitch pine - sand plain type.

Indicator
plants.

Certain plants can be used as indicators of site quality, ^{and soil} at least on the extreme types, wet and dry. These plants are of little use in the great middle area as there is so little differentiation between many of the intermediate soils that the indicators grow on all and there are so many temporary types. Sphagnum moss, gold thread, sitcher plants, etc indicate bog conditions.

(a) treatment

More than the name of a soil must be considered as the treatment of a soil can build up or tear it down and greatly change its productivity. Periodic cuttings that break the canopy encourage the heat loving hardwoods and discourage the hemlock. In many of the old growth forests the soils may not be as productive as that of a second growth. Much of the nutrient materials are locked up in the organic matter and is not available until there is some break up of the forest cover as a fire.

5C.1.

In the afternoon Slab City, was visited and found to be old field white pine about seventy years old, tall, straight,

and with relatively small branches, indicating a denser stand at some former time. This area was probably once pasturage and although the pine is of poor quality it is very good for field pine. Old stumps indicate that pine was cut from this area at some previous time. The volume today is from 25-30 M per acre and may have run as high as 50-60 M before the cutting.

Hardwoods come in

Hardwoods usually start to enter this type of stand when it is from 40-50 years old and the canopy has thinned to admit more light. They have started on this area, white oak, pinnut hickory, black birch, and maple. If cut this area would probably reach a white oak-pinnut hickory climax, and as the soil is fairly good some paper birch, aspen, gray birch, and pin cherry would come in as temporary cover.

old field pine

another area of old field pine on the road toward Quabbin Reservoir was examined and found to be from 40-50 years old and pretty well blown down. a large open area was filled with a dense stand of popple with a slight mixture of white ash and red maple.

w.t. ash

The ash in the open had been frosted back

once already but seemed to have escaped this year. Under the remaining stand, especially on the lighted edges there was a good deal of ash reproduction which was doing very well with little frost damage.

Aspen seed

Aspen seeds will remain viable in the duff for many years until the right conditions of moisture and heat cause germination. The organic mat had started to break up even in the two years of exposure.

Another stand was examined where the stocking was quite scanty and of two age classes, one about 30 and the other 50-60 years old. The ^{older} trees were poorly formed and bushy while the younger trees were straight and had much finer branches. Evidently abandonment had been gradual or partial so that the second group came in after complete abandonment 30 years ago. The organic mat was also only $1\frac{1}{2}$ -2" thick because of the more open conditions at the beginning of abandonment. Red maple, white oak are coming in at present very slowly. The moss beds found here provide excellent seed beds for white pine.

Another 40-50 year old stand was examined that had fairly good stocking. These trees were

much taller and straighter with finer branches than those of the previous area. a whip top is developing because of the close stocking and more light is being admitted and fern growth and other herbaceous plants are appearing on the forest floor. Hardwoods such as Black oak, black cherry, white ash, yellow birch, ^{and} black birch are just starting to come into the stand as well as hemlock reproduction.

S.C. 10

a stand way back in Slab City 10 beside the river was examined. This stand is on a terrace just above the river level and is flooded at times. The soil is very moist with a thin organic mat over a sand soil. The stand consists of almost pure pine about 70 years old with a very occasional hardwood. The pines are of good form, straight and tall with fine branches, indicating a denser stocking at some earlier date. Old stumps bear out this idea, as the present stocking is too open to grow such fine branches. There is very little weevil damage, probably because the trees grew slowly and didn't offer such succulent tops as did trees on better sites. Near the river

are found red maple, yellow birch, and some elm. The white pine reproduction in the more open spots is quite thick. The absence of hemlock is strange as the area is surrounded by this tree.

August 21

T.E. Jones Lot

This lot contains white pine of rather low stocking when compared to what old growth pine must have been. However this stocking is fairly good when compared to much of the old field pine of recent origin we have seen.

Branches

The soil hasn't as yet developed an organic mat an inch deep and there are no signs of leaching or podsol layer. The smallest branches appear to be with about two feet of the ground, while the largest one about 15-20' up. These longer branches develop when the tree makes its largest demands for food and before the canopy is closed.

weevils

When weevil damage occurs several branches are stimulated to take the lead but usually only one or two can get ahead. Weevil damage occurs at any time after the tree is three to four feet high and continues almost indefinitely.

The density of the stand governs the size of the side branches that develop, an inverse proportion.

Joints

The longest joints, or annual length growth, occurs in the upper half of the first log and carries on into the second log. After this there is a general slowing up of height growth.

No hardwoods were started as an understory in this stand, these will not come in until the stand is older and more open.

Fished Lot

The fished lot contained, before the hurricane, a very poorly stocked stand of 50-60 year old white pine. These trees had very poor form and many large branches, as well as being badly damaged by weevils, due to the scanty stocking. There were about forty or less, ^{large} hardwood stems per acre mixed with the pine as advance growth. There was a fair understory of advance growth hardwoods, red and white oak, white ash, red maple, black and paper birch, perhaps due to the more or less open character of the pine stand. One would not expect to find the light seeded species such as aspen, pin cherry, etc as advance growth under pine, they come in after the site is opened up.

Tom Swamp I

A section of former old field pine, now blown down, in the south east corner of Tom Swamp, I was examined. This contained a fifty year old pine stand which contained a considerable number of scattered white ash trees. These trees provided leaves for the chuff which are liked by worms and consequently considerable worm action was ^{formerly} found around these trees. This action of worms improves the soil greatly and helps to prevent the development of a thick organic matting. Worms prefer leaves of a high calcium content and will not touch oak leaves unless rotted about two years.

Worms

Repro.

at present this area contains abundant white birch reproduction mixed with white ash, gray birch, oak, and pin cherry. a good stand of paper birch should develop here.

Fishes

Mowing

The area known as the Fische Mowing contains a developing field pine stand from 15-20 years old. The stacking is quite thick and there is very little weevil damage, some was found about four feet from the ground. The organic mat has not reached an inch in thickness as yet and there are no signs of leaching. There is practically no ground cover

as yet, as the stand is quite dense and the canopy closed admitting very little light. In a few scattered spots white ash has come in below the stand and reached a height of two to three feet, but it seems more than likely that these trees will not survive. Some black birch and pin cherry are now included in the main stand, the latter will probably not last over 20-30 years.

Future plans

Thus far we have seen examples of old growth pine and hemlock and hardwood mixtures as well as old field pine types. In the future we will inspect red maple swail and swamp, Gray birch, oak-hickory, norther hardwoods and spruce, and the transition hardwood types.

Ref.

Forest types of Eastern U.S. - Soc. of Amer. Foresters
Development and Significance of Great Soil Groups of U.S. - Kellogg

The Original Forest Types of Southern New England - S. Bromley, 'Civil Monday Jun '35

Key species

Key species - Certain species of trees, when found growing on a site indicate a given site quality and are a key to the type to be expected. Pitch pine - light sandy soil.
Elm - moist, rich, well drained soil.

Black ash - stream bank, moist & rich site.

Monrovia Turnpike.

A lot on the Monrovia Turnpike was examined and found to contain a stand of chestnut oak, red oak, scarlet oak, hickory, white ash, and red maple. Piles of stones were found indicating that the land was used for tillage purposes, while old stumps indicated that pine had been cut off 30-40 years previously. The soil under this stand would not be too good as the worms do not like oak leaves and an organic layer tends to develop.

Pitch pine

Farther up on the ridge top some pitch pine was found growing. These would ordinarily indicate a light sandy soil but more exacting species such as white ash, white oak, hickory, black birch, white birch, and white pine were also present indicating a lack of uniformity of soil composition. Many of the pitch pines were killed as they had been over-topped by other trees and shaded out. The pitch pine in this site might be considered more or less of a freak due to soil variations.

Orange Rd.

A site was examined on the orange road along the ^{old} valley flood plain. The soil is

extremely light and sandy and mass bed indicate it is of poor productive capacity. There is here a stand of pitch pine and white pine which forms, for this site, a stab type. Some gray birch has come into the openings but has mostly died. The soil is too light and dry to encourage other hardwoods to start.

Treatment

In the past this area must have been used as tillage or pasture land and then abandoned. Probably the same species now found come on the site and were logged off making way for the present stand, most of which was blown down. At present there is abundant white pine reproduction and some pitch pine sprouting. The next stand will undoubtedly contain much white pine.

August 22

The morning was spent inspecting the Whitney Pail Factory. A man was detailed to show us the plant and did a thorough job as we saw everything from the raw log to the shipping of the finished product. This company makes bits, rails, flower pots, and tubs and has a market extending as far west as Chicago. These products are

used for packing pickles, fish, cherries, mince meat, and many other foods.

Raw Mat.

The raw material for this industry consists entirely of ^{native} white pine, any size over 4" in diameter being accepted. The logs seen were not of good form, small, and very knotty. The internodes are the only part of the tree utilized for pails and are cut out in standard lengths of 8", 10", 12", etc or in special lengths for special orders. After 70% of the log will be waste which is used to generate power for the plant. Larger logs are preferred if possible but small ones can be used. The internodes are cut into staves on cylindrical saws, and the larger pieces are cut into tops and bottoms on horizontal circular saws. All of the boards and staves are kiln dried before use. The staves are edged and clipped before fitting into pails while the bottoms and tops are fitted and glued, and cut on a lathe-like machine.

Process

Pails and pits to be used for products packed cold are treated with paraffine inside and some are varnished or painted outside. Handles are also fitted before shipping.

The general tempo of the mill was slow and a great deal of hand labor and transportation is used. A rearrangement of machinery and reworking of the system used should materially speed up and improve production. Machinery could well replace much of the hand labor done now.

This factory has been in operation for 11 years but is now starting to feel the pinch of the diminished supply of White Pine. Whether the business can be continued for many years with the present local supplies of raw materials is questionable. Undoubtedly some of the government's hurricane timber can be used in the next few years.

This plant might be an outlet for intermediate cuttings in managed white pine, but probably the price paid for logs would offer little inducement to grow white pine for this market.

The finished sails used for packing fish sell for \$3.15 per dozen.

Trip south

In the afternoon a late start was made, and we rode south thru Sandwich and Ware and return. It was interesting to note that in this district the amount of cleared tillage and pasture land is much greater than in Petersham. The only wooded areas occur on the ridges and side hills well back from the road, for the most part. The stands here consists mostly of oak, red and white, hickory, and maple. There are some few scattered white pine, thru this sprout forest, but their number is few. This area was once old-field pine which was cut and succeeded by the above mentioned hardwoods which were in turn cut to make way for the present very poor stand. It is almost impossible to find in these sprout origin stands any logs worth sawing. The whole area has deteriorated to a deplorable point.

August 23
Soils

The morning was spent studying soils under Dr. East in the office. Basic information necessary to an understanding of soil type was given us which should be fully crystallized with some reference

reading, another conference, and a field trip or two. This information will be written up after the next meeting, when my ideas are a little clearer.

Swift Riv.

Box Co.

Processes

In the afternoon we visited the Swift River Box Company and were able to follow the process from raw material to box. Here round edged white pine boards, two inch plank rather, are the raw material. These are planed and then have the worst defects such as knots and splits removed by a swing saw. The pieces are also cut to length for the various orders in this operation. Then the ^{boards} ~~boards~~ are fitted in width ~~and~~ tongued and grooved, and glued to make a two inch thick shank. These are then split into the required thicknesses on a hand saw. Cleats are nailed on for strength and hand holes cut, and any printed matter required is put on the shanks. Then three men assemble the boxes using automatic nailers or the knashed down "parts" are tied in bundles for shipping. The waste parts cut from the planks are made into apple boxes which can utilize very

poor material as they are used but once and the ^{ultimate} customer pays little attention to the looks of the box. Shavings are baled into 20 pound bales and sold to farmers locally or shipped away as far as N. J. These bales sell for 30¢ apiece in lots of less than 5, and 25¢ apiece for larger lots. The clean sawdust is sold but the rest of the waste is burned for power, except for the larger edgings which are cut and sold for fuel wood locally. This plant seems to use a close degree of utilization wasting almost no wood.

Raw Mat.

White pine is used in this industry and almost any log 6" or over in diameter is acceptable. As long as a 3" clear stick can be obtained for clearing the log can be used. Larger logs, however, are preferred. It was intimated that a higher price could be paid for high grade logs if they were obtainable. At present no logs are bought, only round-edged boards being used. Formerly and at the present time lots are bought on the lump system and a mill is hired to operate the lot. About \$600 per M is paid for

the logs on the brow. Approximately $\$9/11$
 was paid for government timber on the
 sticks. The blue stain in this material
 makes little or no difference to this
 industry. The main worry seems
 to be loose knots which drop out of
 their stock. A stapling machine is now
 used to fasten these knots. With this
 industry too there will probably soon
 be a severe problem of a source of raw
 material. The hurricane timber will
 be used while it lasts but then local
 supplies will be needed. The business
 seems prosperous at present and if
 the supplies hold out should be able
 to continue. It is doubtful if a profit
 can be made in growing pine for this
 industry at the present rate of $\$900/11$
 for logs, ^{as} this roughly leaves but a
 $\$300/11$ stumpage value which will
 allow very little ^{any} silvicultural work
 being done. This outlet might also be
 utilized for intermediate cuttings but trouble
 will be encountered in that the Co. buys
 only boards and it wouldn't pay to
 cut the few logs removed by intermediate

cuttings.

A stand of pitch pine, red and white oak was also visited in Athol. The soil was a poor sandy variety as shown by digging and the cover type. Some specimens of oak were collected for future identification and help in making a key for field identifications of red, black, and scarlet oaks found in the vicinity. This identification and key construction work is undertaken as a side problem in hopes of simplifying field work.

August 24

Soils Lect.

Definition

The lecture by Dr. East, mentioned on page 31 will be included at this point.

Soil is defined in the Atlas of American Agriculture as consisting of "the outer layer of the earth's surface, usually unconsolidated, ranging in thickness from a mere film to a maximum of somewhat more than 10 feet, which differs from the material beneath it, also usually unconsolidated, in color, structure, texture, physical constitution, chemical composition, biological characteristics, probably in chemical processes, in reaction, and in morphology."

Forces at work

There are several forces at work in the development of soil from the parent

material and in its change after development. These are "geologic, topographic, physiographic, climatic, and biologic factors." The climatic and biologic factors are active, ^{or dynamic} while the others are passive and speed up or slow down the first mentioned factors. Climatic factors act directly on the soil through rain fall, temperature changes, etc. and indirectly ~~by~~ through its effect on the biological activity in and on the soil.

classification

The study of soils started about 1900, and a great deal of work was done in Russia. Gradually our present system of soil classification was built up based on the experience of the years. This classification is based on the structure of the soil profile, a vertical section of the soil showing the different horizons or strata of its structure or make up. The profile consists of three main horizons, each of which may be subdivided several times, these horizons are ^{from top to bottom}:

A, the zone of eluviation (ex out of), B the zone of illuviation or enrichment (in-into from A to B), and C the unenriched zone of weathered parent material. Below these horizons is D the unweathered

parent material. In general the organic matter in A decomposes and the nutrients plus those of the mineral constituents are transported, in solution or mechanically, downward into B where they halt.

Following is a schematic diagram of a ideal soil profile, showing the various horizons.

Ideal profile

A ₀₀	Loose leaves & Organic Debris, largely undecomposed
A _{0F}	organic matter - Fermentation Layer - OM Recognizable
A _{0H}	" " " " - Humified Layer - OM Unrecognizable
A ₁	Zone of mixing of OM & mineral matter, Dark
A ₂	zone of eluviation - light colored
A ₃	Transition A to B, more like A.
B ₁	" " " " " " " " B
B ₂	zone of illuviation, Dark color
B ₃	Transition to C
C	weathered Parent Material
D	Parent Material.

It should be understood that several of these horizons may be lacking or reduced to a mere trace in nature. Based upon profile characteristics there are two general classes of soils mulls and moors. "Mull: mixture of organic matter and mineral soil of crumbly or compact structure, with the transition to lower layers not sharp." This soil has a thick dark upper horizon mostly A, and is the result of mechanical mixing of the organic and mineral matter thru the action of fauna. "Moor: Organic matter practically unmixed with mineral soil, usually more or less matted or compacted. Transition to mineral soil always distinct. Often composed of two layers named (after Hesselman): i-layer, i.e., fermentation layer resting on H-layer, i.e., humified layer." This soil is mostly B and A. This is also known as a podzol soil while the mull is a Chernozem soil. The former shows a distinct white leached layer, A₂, from which the mineral nutrients are leached by organic acids and deposited in the B₂ layer forming, in extreme cases, hardpan. The soils of the east are generally podzols, because of the translocation of Fe & Al, while those

Mull

Moor

F. & H.

Podzol &
Chernozem

of the west are podzols because of the translocation of albasies. Moors are found in cool, moist, sites under evergreens with closed canopies; while mulls develop under hardwoods, due to a great extent to the activity of earth worms.

Podzol = nearly ash, white layer - 0.11 thick

Chernozem = Black earth - 0.11 thick

Horizon

identification

There are many ways of recognizing the various horizons of a profile: from the organic matter content, podzols and Chernozems; texture - size of particles; color; chemical analysis; microfauna activity; etc.

work ahead

The job of the silviculturist and economist is to assess the various studies and suggestions concerning soils and forests and pass on the valuable information to persons engaged in the growing of trees. A forest should be so managed that it builds up the fertility and productive power of the soil, acting as a natural fertilizer to take the place of the agriculturists fertilizer which is added to the soil to make the production of crops possible.

Field trip

Saturday morning was spent in the field examining the soil first in the north west corner of Tom Swamp, 4, adjoining the Tom

History Swamp Road. This area was once pastured and then supported a stand of old field pine which was cut about 20 years ago. The area was planted with red pine most of which was over topped and killed by the thirty foot stand of ash, oak, and maple which occupied the area today.

Most of the area shows evidences of washing and is not very well drained while one corner is higher & better drained and it is here that the red pine has grown above the hardwoods. Here the soil had a thin

coniferous stand edge.

A₀₀ layer of undecomposed needles and a trace of A₀. The A₁ and A₂ layers were very thin while the B₁ & B₂ layers were a dark brown and an inch thick. The B₃ layer was about a foot thick and a light brown in color and the C layers were even lighter, almost alive. The hole examined was on the edge of the coniferous stand and was once a mound and is now developing into a mound.

The identification of this and many other soil profile horizons is complicated by the fact that one type is changing to another or is superimposed upon

another due to a change in the environmental factors.

Hardwood
stand

Under the hardwood stand the soil was found to have a top layer of A, about 3 or more inches thick, and the A₀₀ & A₀ layers were very thin and missing entirely on 40% of the surface. Earth worms, by pulling the hardwood leaves into their middens and by eating them have mixed the organic matter and mineral soil for a depth of about 3 inches thus creating a mull. In a hole where there has often been standing water a yellow oxidized iron soil was found in the C layer, this was created by weathering in place and not by translocation.

Translocation

Moor

In a moor soil the nutrients such as Fe & Al are carried downward from the A horizon after being ^{put in to solution} dissolved in organic acids, from the organic material, to the B horizon where alkaline conditions prevail and they are precipitated. Thus

Mull

the B horizon is enriched. In a mull soil the organic material is mixed mechanically with the mineral material and there decomposes in contact with it. This

weathering
of rocks

action is much more conducive to the weathering & breakup of the minerals than is the action in a more soil. This may be observed indirectly by noting the softer structure of the surface of rocks that have long had a cover of organic matter as compared to the surfaces of those in the open. The rate of weathering is greater in the case of the covered rocks.

Identification
of horizons

The difficulty of identifying soil profiles especially when there are relic profiles mixed with the present ones is increased if the cover type is young and the consequent soil not fully developed. The best plan in field identification of soil horizons is to first find the B & C boundary and then consider what has happened to the soil and using the B & C boundary as a base locate the other horizons.

old field
soil

A hole or plug was taken in an old field across the road and the A₂ layer was found to be about 10" thick and a dark brown in color. There were no ~~A₁~~ A₁ or A₀₀ layers present. The B horizon, ^{probably} extended

to a depth of 22 inches. If this area should reverts into forest land the change would take place above the A_2 layer, or on top of the present surface by the accumulation of ~~so~~ A_{20} , A_0 , and A_1 horizons. The B horizon would gradually creep up to within about 3 inches of the surface.

old up
stand

An area which contained a stand of old field white pine, before the hurricane, was next examined. The soil here showed the characteristic leached horizon of a podzol soil this horizon was about 5" below the organic matter on the surface. This layer is disappearing rapidly since the opening up of the area. Organic acids developed rapidly and have started to discolor the podzol horizon, in about five years it will have disappeared.

Podzol

A podzol develops more rapidly in a coarser textured soil than in a fine textured one. In the latter the greater surface area of the mineral particles neutralizes the organic acids more rapidly so that leaching is slower. A coarse sand will display the deepest A_2 horizon.

August 26

The morning was spent reading

the manuscript of H.M. Raup and R.E. Carlson on the "History of Land Use at the Harvard Forest"

In the afternoon some areas of old growth were visited with Dr. Raup who explained the preparation of the manuscript.

methods
possible

There are several methods of locating areas of old growth timber. One is by the use of local history and road surveys, another method used in the mid west is by the use of road surveys, but Raup used the records and deeds found at the registry of deeds and in the probate court. This method checks well with the evidence on the ground and gives a firm foundation for outlining areas of old growth.

method used

The routine was to trace back the titles of the land to the original grant and then from the descriptions locate the area on the ground. Then the land descriptions were thoroughly read and any mention of land use carefully noted and checked with the present land ground cover.

1830 map.

A map of Petersham in 1830 showing wood land areas was found and checked quite accurately with the areas worked out as mentioned before. ~~It was~~ The land use is also tied to the development ^{and decline} of the town and its industries. It was considered that an area which was ~~untouched~~ ^{cleared} before 1830 remained so as after that date agricultural clearing was nil in Petersham. Most of the early farming was on a subsistence basis but with developing population, industry, and a consequent market cash crops were produced after 1800.

Prospect
Hills

On prospect hill an area was examined which was a woodlot in 1820. This is a long narrow strip in Grant no 11 (see manuscript) which is high & gravelly at one end with a south slope and low and damp at the other end. Thus it runs thru several types. The north end bears a stand of red and white oak, Black birch, red maple, and an occasional white pine or hemlock. These hardwoods are of sprout origin from large stumps, long since rotted away, and are probably direct vegetational descendants of the

original forest of pre-colonial days. This area is particularly interesting as it contains several types of exposures and should be preserved untouched with the other old growth areas.

S.C. 10

The area of old growth in Slab City 10 (see page 13) that has previously visited was inspected again. This area is undoubtedly old growth but its history is incomplete and so it is not found included in the manuscript. It was impossible to find any old boundary line at the top of the ridge or the edge of the old growth.

Use of
old growth

These areas of old growth stands should be preserved to serve more or less as a yardstick or background upon which we can superimpose our present day stands and see what should be done to help and not hinder the natural succession of the stands. Thus man and nature can work together and timber can be raised in the least expensive manner. The idea of a climax being a stable end of stand development is probably not correct in

that no natural stand ever will reach a point of complete stability in every sense of the word.

August 27

The morning of this day was spent in visiting the Cass Toy Factory of Athol, Mass.

Products

Raw Mat.

Here the chief products in the summer are nursery furniture, large rolling toys, blackboards, etc. For all flat surfaces where large, knot-free areas are concerned either spruce and ponderosa pine are used. This spruce is what is rejected by the U.S. Govt. from airplane construction and is bought for \$48/M b.f. a drop of 20% from the former price.

Native ^{wt.} pine is used wherever possible for this type of work as it is cheaper. All other parts of the products are made of local hardwoods, practically all species being used. Logs seasoned two years are desired. The company buys woodlots and operates them with their own mills, sawing all R.F. there and there. Dry kilns are used to complete seasoning. The industry was originally located in Athol because of a happy union of raw materials, labor, and capital, as well as transportation and power; the chief reasons being the two former. In the winter

purchase

location

winter
Products

time the chief manufacture is wooden beach novelties and chairs for the ensuing summer's trade. Logs down to six inches in diameter are utilized. A willingness to pay higher prices for high quality logs was expressed by the plant supervisor.

General

The tempo of the factory was very fast and the machine had an orderly arrangement. Most machines are individually powered with electric motors and are geared for high speed work. A small amount of electricity is generated by water power and the rest by steam from scrap wood. Shavings are baled and sold locally. It seems likely that this plant will continue in operation for some years to come, it has already been in operation 50 years, as its markets are wide and fairly prosperous. The profit margin has been cut from 20% to 26 or 3% which in the long run will possibly eliminate the profit entirely. More data on prices is needed before any conclusions as to the possibilities of rising timber for this industry can be made.

Afternoon

The afternoon was spent assisting to make reproduction counts on a section of the Adams-Faye

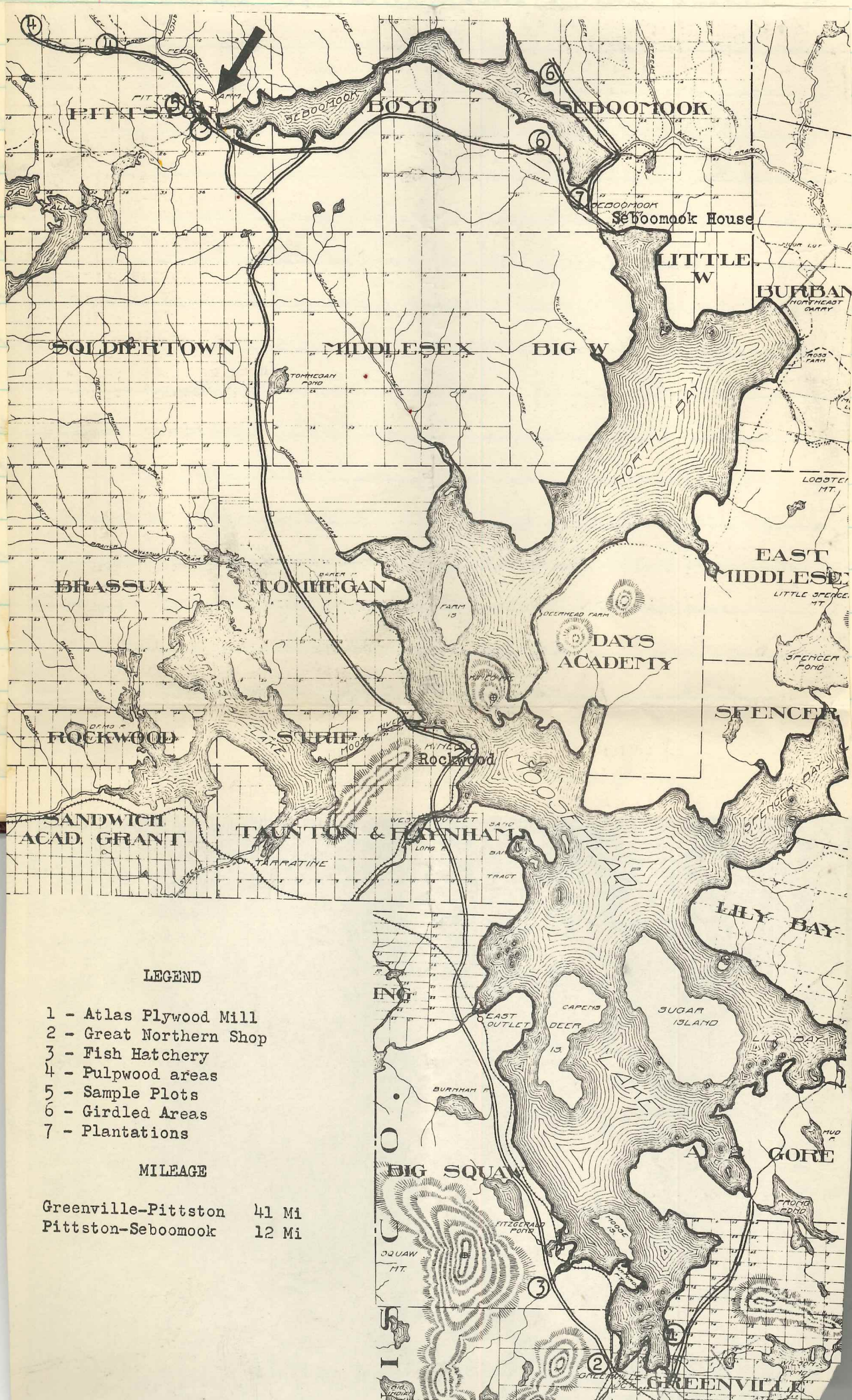
Lot known as P9. This area had been treated as a shelter wood area and later changed so that a thinning was done in 1936. The stand at the time of the hurricane was mixed pine and hemlock. Judging from the size of some seedlings a few hemlocks had become established as advance growth before the whole stand was blown down. 10' square quadrats were laid out and the coniferous reproduction counted and tallied on each. The white pine and hemlock were healthy in color but somewhat spotty in distribution although enough is present to give a fairly well stocked stand in the future. Pales weevil damage is slight. Healthy white pine ^{seedlings} ~~and~~ are prone to have 7-8 laterals, whereas white less vigorous ones have put three or four.

On a like area treated by the 3 cut shelter wood system plots 13.2' square have been tallied and pine is found well distributed over the whole area. Hemlock is somewhat spotty in its distribution, and hardwoods are found generally. A good future stand is pretty well insured. The recovery of the pine over such is still somewhat doubtful in some parts of the area, but time will tell. It seems likely that the pine will win as at present more areas

have come ahead than not.

A trip to Boston was made in the evening in order to make an early start for Greenville and the meeting of the S.A.F. on the following day.

Following is a map of the area visited for this meeting.



The following is the scheduled program of the field trips and meeting of the summer meeting of the New England section of the S.A.F. an excellent opportunity was provided for exchanging views on forestry subjects with experienced men who have been working with these problems in the field.

New England Section
SOCIETY OF AMERICAN FORESTERS

August 29, 1940

Morning Session

1. Atlas Plywood Company Mill.

Manufacturers of plywood containers and auto crates. Logs delivered at mill by water or truck, sizes 10" at small end and up, yellow birch, beech and maple for plywood. Spruce, pine and hemlock delivered for use as cleats and poor quality sold to local users.

a. Manufacturing process - hardwoods

1. Logs delivered to sawing floor by jack chain.
2. Bucked into blocks of required length.
3. Soaked in boiling water (212°F) 18 to 20 hours.
4. Veneer made on rotary lathe and cut to size and sorted.
5. Drying process - careful control of alternate heat and cooling.
6. Assembled and glued in 3, 5, or 7 ply and pressed.
7. Cut to size, cleated and baled for shipment.

b. Manufacturing process - softwoods

1. Logs cut into 1" lumber and resawed into varying sizes for cleats.

2. Great Northern Paper Company, Machine Shop.

Maintained for the purpose of repair and construction of logging equipment of all kinds, particularly motorized equipment. Some of the major activities are as follows:

GNPC

August 29

The machine shop of the GNPC was visited first, no 2 on the program. Here much of the motor units used by the company are kept in condition. The supervisor considered that catapellor tractors stood up better under hard working conditions than Cletracs. Supplies for the various camps are kept here near the railroad and delivered by truck. The company owns 19 Ford $1\frac{1}{2}$ ton trucks and one Chevrolet. These trucks are continually overloaded with 4-5 tons and only last $1\frac{1}{2}$ years covering about 35,000 miles in their life-time. They are also used to haul sled loads of pulp in the winter time.

An experimental ^{power} pulp saw was seen here weighing but 60 pounds. It was run by compressed air and with two men working could cut 10 cords in six hours. This saw is still in the experimental stage but may be found useful after a thorough trial. Thus far no grave errors have been found in its construction. About 10 can be run from one compressor.

APC

We next visited the Atlas Plywood Companies Plant no. 2 where the process

of making plywood was seen from log pond to freight car. Hardwoods down to a 10" diameter limit are used for plywood and soft wood, chiefly white pine, is used for cleats.

Tapioca, soy bean, and casein glues are used in the manufacture and about 60 M b f of plywood can be made in a day. The factory speed depends on the gluing speed. 100 M b f constitute a freight car load. The raw materials are trucked economically up to about 25 miles from the plant.

The product turned out here is used entirely for boxes or crates and is shipped either assembled or "knocked down." The plant is highly mechanized and well organized and gives every prospect of being a permanent project, having artificial influences.

afternoon
Spruce Flat. The afternoon was spent visiting forest areas of the GNPC at Pettston Farm.

The first area was a cut over area of spruce flat which represents less than 10% of the companies holdings. The data on this area, as well as others to follow, will be found on the program. At present there is a healthy stand of red and black spruce, 5000/acre,

and balsam fir, 1000/acre. This stand is growing at the rate of 9-12"/year and is gradually slowing up due to the poor soil. The soil is a greasy mor with a 2-9" organic layer and a 2-4" white leached horizon. Below this is a heavy impervious clay. Despite this poor soil the spruce and fir appear healthy but will probably slow up in growth more and more as time goes on.

The thinned area, no 2, was not seen.

mixed stands.

The next area seen was not listed on the program. It was a mixed softwood stand operated for pulp wood about 1935 or '36. a yield of $5\frac{1}{2}$ -6 cords per acre was realized. The stand consists of spruce, fir, yellow birch, and some white pine, and cedar. The reproduction on this area was fairly good but not very heavy. The soil was a greasy mor that was starting to decompose and had some zone of enrichment below the more indistinct sodial layer. There was some small evidence of ^{localized} worm action but much of the area still had a thick humus or organic ground layer. The lower part of the soil was clay with a very slight

amount of sand. There was a considerable growth of rubus showing nitrogen mobilization along the trail to the next area.

Yel. Bir. Type.

The forest type known to the GNP as yellow birch is in the transition zone between the lower spruce and fir and the higher beech type. It is sometimes subdivided into upper and lower yellow birch. A sample of the latter was seen and found to contain yellow birch and aspen with an understory of spruce. This site is quite productive and the company thinks it is the logical place for the practice of silviculture.

In these areas are found very high grade yellow birch trees, about one in 10 acres, which are shipped to England via Canada at a price of about 12.00/M.b.f.

Hard Type

A hardwood area, no 3, was visited next where the fir and spruce had been cut to a 6" diameter limit in 1910. There were a few large maples overhead and a good stand of fir and spruce coming in below about 15' high. There was some hardwood reproduction but it doesn't seem to get up to seriously compete with the conifers.

The soil was in the transition stage between a mor and a mull showing a definite horizon of enrichment about 8" thick. The organic matter on the surface was still somewhat fibrous however. The parent material and C horizon seems to be a clay loam.

Mixed softwood

Another area designated by the company as mixed softwoods was visited. Here there was a rather dense stand of spruce and fir about 20' high with a little white birch mixed in. It was calculated that due to the relatively poor soil growth would slow up slightly and the % of fir would be reduced. The soil was a typical podzol with a 2-4" leached horizon. The organic layer was fibrous with many mycelium visible and a good growth of sphagnum moss. There was a heavy iron deposit below the A₂ horizon and below this a sandy clay.

August 30

Birdled area

In the morning another field trip was made toward Lebronsok Lake. The first area was one showing the effects of girdling to induce the growth of softwoods, area no. 1, morning session.

Here was an overstory of yellow birch, maple, and beech; with an understory of spruce. Most of the spruce had been umbrella type and after the ~~per~~ girdling of some of the hardwoods had come ahead and ~~and~~ increased growth. It is too early to draw any final conclusions. A great deal of moosewood and maple reproduction is found coming in on this area. The fir is dying out with the opening of the canopy.

Norway sp.

Area no. 2, was a Norway spruce plantation established in 1914. This area contains many multiple stemmed trees probably due to squirrel damage in early life. Weevil damage has also been severe and the stocking is relatively low. Paperbark has come in and is now over the spruce, this will help to build up the soil. The stand of native spruce off the plot seems as good if not better than the planted stand.

birch/aven

This area, no 3, was one in which the hardwoods suppressing merchantable spruce were girdled. The data for this area is found in the program.

The trip back to Boston was made in

the afternoon. On the way typical stands of yellow birch, beech, and maple were observed to flourish in this northern country. The stocking of these stands is thick and the trees grow straight and tall and fairly slender. This type occurs on the better drained areas. Below is a spruce-fir-yellow birch-maple type where the hardwoods grow to considerable size. The spruce and fir do well but have been logged off before. There is below this a spruce fir type where these two species grow together to the exclusion of most other species except white birch and yellow birch and an occasional maple. The spruce flat contains a heavy stand of spruce and fir with the former predominating. The soil in this type is a stable greasy mor and not very favorable to tree growth. The soil in the spruce fir growth above this is a mor also while that in the yellow birch is on the border line between a mor and mull. The hardwood type has a mull soil.

September 3

Report ~~at~~ ~~the~~

This morning was spent walking around the land across the state road opposite

headquarters with Mr Cline, discussing ^{an reviewing} the forest types seen in the last two weeks.

Oak-Hickory

Beside a red maple swail on a gentle south west slope we found a stand of red maple-white ash-gray birch. ^{white oak} There was a good deal of gray birch in the mixture and a few scattered suppressed white pine. This type most nearly approaches the red oak-hickory type although the hickory is lacking. The site is relatively poor and rapidly drained. Old white pine stumps indicate that this was once old field pine that had been logged to make way for the present stand. Indications seem to point toward pastureage as a past use.

Typical succession

After old field pine is cut off of a medium site typically a red oak-white ash-red maple type follows. This is known as transition hardwood or better hardwoods. The red oak is aggressive and space demanding and is likely to be larger as it comes from sprouts.

Black oak

A black oak tree was found on which it was noted that the upper leaves were much more deeply cut than the lower ones, they almost resembled scarlet oak in the deep cutting. Pubescence was found on the lower side of the leaves along the veins.

Brook bed

A brook bed was found on a southerly slope on whose ~~north~~ west facing bank was a stand of Hemlock, Birch, and Yellow Birch = northern hardwoods.

Types

^{Species} Each of the forest types listed for Worcester County, see following pages, was then discussed.

1. Red oak - white ash - red maple

This type will follow the cutting of old fields white pine or the clear cutting or partial cutting of itself on best quality soils. On the higher south slopes oak and hickory are likely to be prevalent.

Ref: Harvard Forest Bul No. 8

2. White pine - red oak - white ash - red maple

This type is obtained by cutting old field white pine in a good seed year (see later notes).

w. P. Assoc.

The white pine is light-loving and goes best with gray birch and hickory, southern hardwoods. Northern hardwood have hemlock and spruce for associate species. In order to increase the % of white pine in the stand advance growth must be obtained by partial cuttings before clear cutting. (From later observations this tends to increase hardwood advance growth.)

61

List of Cover Types for Worcester County

1. Red oak-white ash-red maple

Associated species: hard maple, yellow, black and paper birch, basswood, poplar, black cherry, white oak, hickory, white pine, and hemlock.

Occurrence: on best quality sites.

Place in succession: close to permanent type composed on higher percentages of the longer-lived and more shade-tolerant species.

Importance: one of the most desirable and commercially valuable types.

2. White pine-red oak-white ash-red maple

Same as type No. 1 above, except for an increase in white pine to 20 percent or more of the mixture.

3. Mixed oak-hickory

Species and associates: white, scarlet, black, red and chestnut oak, pignut, shagbark and bitternut hickory, red maple, hornbeam, poplar, gray birch, and white pine.

Occurrence: chiefly on quickly drained, light sandy or gravelly soils and exposed situations such as ridge tops and southern and western slopes.

Place in succession: near the climax type.

Importance: one of the most important and commercially valuable types.

4. White pine-mixed oak-hickory

Same as type No. 3, except for an increase in white pine to 20 percent or more of the mixture.

5. Red maple (on springy slopes)

Associated species: elm, yellow and black birch.

Occurrence: on slopes where outrunning seeping ground water results in a black, mucky soil, frequently characterized by hummocks.

Place in succession: temporary type which tends towards a mixture of moisture-tolerant species including chiefly elm, ash and yellow birch.

Importance: secondary importance in point of area and productivity. Capable of producing sawtimber under proper management.

6. Red maple (swale)

Associated species: yellow birch, elm, ash, and white pine.

Occurrence: in typical swales with wet, mucky soils and slow drainage, usually along small streams.

Place in succession: temporary type succeeded by mixture of moisture-tolerant species including chiefly those listed above as associates.

Importance: secondary importance in point of area and productivity. Capable of producing sawtimber under proper management.

7. Red maple (swamp)

Associated species: practically none; spruce, white pine, hemlock.

Occurrence: in very wet, all-year-round swampy areas with very poor drainage, hummocks, heavy grass and patches of sphagnum.

Place in succession: permanent type.

Importance: of little importance in point of both area and commercial value. Will produce chiefly cordwood.

8. Red maple-gray birch

Associated species: poplar, all local species of oaks and birches, white ash, hickory, and white pine.

Occurrence: chiefly on poor to medium quality soils following clear cuttings or abandonment of pastures.

Place in succession: temporary type. On the lightest soils the tendency is towards white and pitch pine and on the medium soils towards mixtures of white pine and better hardwoods.

Importance: extensive in area but of little commercial value. Capable of conversion to sawtimber crops through proper management.

9. White pine-red maple-gray birch

Same as type No. 8 above, except for an increase in the proportion of white pine to 20 percent or more of the mixture.

10. Gray birch

Associates: Practically pure gray birch.

Occurrence: on poor to medium soils following abandonment of pastures.

Place in succession: temporary type. On the lightest soils the tendency is towards white and pitch pine, and on the medium soils towards mixtures of white pine and better hardwoods.

11. White pine-pitch pine-mixed oak

Species and associates: white, black, scarlet and scrub oaks, gray birch, poplar, and red maple.

Occurrence: on light, quickly drained sandy or gravelly soils, usually at lower elevations (Merrimac and Hinckley soils).

Place in succession: close to a permanent type on the very light soils, with tendency towards conifers or longer-lived oaks.

Importance: very limited in area and of low productivity, but capable of producing pine sawtimber on a commercial basis.

12. White pine

Associated species: red maple and gray birch.

Occurrence: originates on abandoned farm land of medium and better quality.

Place in succession: temporary type followed by mixed hardwoods, or, less frequently, by mixed white pine and hardwoods.

Importance: formerly extensive in area and of high commercial value but now greatly reduced due to cutting and replacement by other types.

13. Hemlock-mixed hardwood

Species and associates: red oak, white ash, hard and red maple, black and yellow birch, and white pine.

Occurrence: on cool, protected sites, usually in ravines or on north and east slopes.

Place in succession: close to a permanent type.

Importance: small in area but of high commercial value. Capable of producing high quality sawtimber under management.

silviculture

As recommended in H.F. Bull & the shelterwood method can be used to attain a group-wise distribution of pine and hardwood reproduction. The groups may be reversed after cutting due to the tendency for hardwoods to come in under pine and vice versa. Our later observations in the field seem to indicate that the majority of the pine will not grow to maturity as it is crowded out by the more aggressive hardwoods.

sprouts

Hardwoods seventy years or older do not sprout well, except to rare cases.

4 White pine - mixed oak-hickory.

On this site the white pine doesn't need so much silvicultural treatment in order to maintain its place in the stand as the competition from hardwoods is less violent due to the poorer soil. There is also less of the very aggressive red oak. Usually white, black, and scarlet oak provide competition which varies greatly with the site.

8 Red maple - gray birch

This type is also known as inferior hardwoods and cordwood and contains many species although the stocking is not very good.

Gray Birch
occurrence

Gray birch is like hemlock in that it occurs on a wide range of sites from swamps to dry ridges. There is recognized a so called Bastard Birch which has the size and leaves of the paper birch and bark of the gray birch.

Good stocking is often indicative of a good site while the more varied the composition of the stand the better is the site.

9 White pine - red maple - gray birch

The white pine usually does well with these inferior hardwoods as the soil is less favorable for them than it is for the pine.

11 White pine - pitch pine - mixed oak

This type is hard to find in Petersham. The Merrimac and Hinkley soils are of outwash origin and are therefore more porous and layered in structure than a glacial till.

12 White Pine

On a light soil it is possible to get an uneven aged permanent stand of white pine.

an area of red maple swam was found with a scattered wide stocking of red maple and white oak on a mucky soil. Grass has come in between the trees. Evidently some cuttings had been made to favor the white

R.M. Swail

ash as double stems had been corrected and some red maple sprouts were cut out. No attention was paid to rat hazards.

weevil
damage

White pine will straighten out after weeviling if the stand is dense enough.

If silviculture is to be a success every cast must be cut to the bone. In order to do this nature must be followed as closely as possible, this will eliminate most planting and involve the growing of natural mixture which require less treatment.

Repro. sys.

In the afternoon work was started on the various reproduction systems used in forestry. A reproduction system may be defined as a silvicultural ^{system of} cutting or cuttings to perpetuate a forest stand.

There are three general methods:

Clear cutting -

in a seed year - or non seed year
leaving seed trees

Shelterwood

Partial removal and establishment of reproduction under the shelter of the old stand. A seed and removal cutting are usually made.

Selection system

This involves cutting the mature trees in the so called normal forest.

Selective system

Culling of the desired species or quality of trees from a stand.

30 year plot.

Treatment

This was once pastured and came in to pine and hardwoods upon abandonment, the former predominating except along the brook bed. This stand was cut in the winter of 1908-'09, a good pine seed year, with the idea of reproducing a pine stand. White pine reproduction started to the number of about 25 M/acre. This stand was ~~thinned~~ weeded in 1912, '16, and '19 and thinned in 1933 & '39. At present the stand is well stocked and about 60-70 feet high, the trees having good form. On the higher portions the present stand is primarily red oak which grows aggressively with a slight admixture of white ash. Lower down the slopes the stand is almost pure white birch which seeded in from an adjoining area. While the wet stream bed is occupied by white ash and maple. The pine is practically all gone but for a few suppressed trees scattered thru the stand. The present hardwood stand came from advance growth

comp.

under the pine and is of sprout and seedling origin. The hardwood underbrush was mowed to facilitate logging thus giving the best possible conditions for sprout growth.

Conclusions

It would seem from this that on good sites it isn't possible to grow white pine in a stem-wise mixture with hardwoods, and that the method of clear cutting pine in a good seed year will not result in the establishment of a new pine stand but in a hardwood stand, if the site is good.

Red oak

As red oak is aggressive and space demanding a very dense stocking is needed to grow good red oak. This is the oldest managed stand in

Beathere

the United States. If this stand was managed on a selective basis the resulting forest would probably consist of hard maple, ash, basswood, yellow birch, hemlock, etc. the shade tolerant species coming in below the stand in openings.

T.S. 2

Another area was found nearby from which the old field white pine had been clear cut in 1921-22. In 1924 red pine was planted throughout the area to insure complete stocking. Today the stand consists of red oaks, white ash, red and sugar maple, some hickory, black birch, and white birch with a few of the red

pines surviving scattered thru the stand.
 It is unlikely that the red pine will
 come thru to maturity except as a few
 scattered individuals as most of it is over-
 topped by the more vigorous hardwoods.

This stand has many species from
 which the final stand can be made up and
 selection should be made before it is 30 years
 old and canopy differentiation has taken place.
 The red pine planting was almost a complete
 loss and shows the folly of introducing
 conifers on a good site with hardwoods. The
 stand is now 25-30' high and well stacked.

T.S.S.

WP-Hwd 6

This old field pine was thinned lightly
 in 1911-12 but the work was so light
 that it is doubtful if the canopy was greatly
 disturbed. Clear cutting took place in 1928-29, and
 weeding of the new stand were done in 1932 '33 & '35.
 The present stand White pine was planted in 1931
 throughout the area. The present stand consists of
 red maple, ~~red oak~~ ^{white} oak, some white ash and cherry
 with the white pine still on top of the
 stand 15-20' high. The site is not very good
 and the pine is able to keep ahead, but the
 eventual result is still doubtful. A heavy thinning
 or several light ones should have been put in the

old pine stand to prepare the advance growth of hardwoods before clear-cutting. In the end the stand will probably be ash, sugar maple, hickory, and the white oak and red maple of the present stand.

Blow-down

across the road is an area that was entirely blown down and now has a good stocking of red oak, white ash, and white oak.

T.S.S.

Strip 2 of an area originally intended as a 2 cut shelterwood area to reproduce.

strip 1

white pine was visited. Strip 1 was thinned in 1911-12 and cut in 1917-18 and weeded in 1920. Here very dense white pine 25-30' high is found badly snow damaged. This pine owes its present to accident.

strip 2

Strip 2 was thinned in 1917-18 and cut in 1922-23. It also was lightly thinned in 1911-12 but as mentioned before this had little effect. This whole area contained reproduction from the good seed year of 1714 which destroyed its significance as a shelterwood cutting. These seedlings owe their survival to the unusually favorable weather conditions which followed. Logging losses destroyed much of this reproduction.

The present stand on strip 2 is red oak, white birch, white ash, and red maple with a few white pines persisting in clumps. These pines will probably not appear in the final stand except as a few scattered individuals. The idea was abandoned in 1923 and work was discontinued so that the final result will be a hardwood stand.

Sept. 4

T.5IV

Treatment

The area known as white pine hardwood 1 was visited. This area was pasture land which upon abandonment seeded in to white pine. This was thinned in 1911-12, and by 1918 an advance growth of mixed hardwoods had become established which was mowed back at the time of logging in 1918. In 1919 red pine was planted over this area. The stand was weeded in 1920, '21, '26 and an improvement cutting for the cultural control of gypsy moth was put in in 1938. This cutting removed much of the red oak, the favorite food of the gypsy moth.

Present

stand

Today the forest stand consists of red oak, white ash, red maple and some sugar maple, black cherry, and white birch about 30' high and of good stocking. White ash is found mostly along the damper drainage channels and on the south side of the area are groups of white pine on dryer sites. The red pine is reduced to a few

scattered individuals which due to dryer conditions have managed to keep ahead of the hardwoods. This stand has a rather wide variety of species which makes it possible to chase the crop trees. It would seem that the red pine planting was unnecessary and almost a total loss. The thinning of the area was a good move before cutting as it allowed hardwood advance growth to become established.

T.S. 4.

Hardwood area 2 was next visited where it was found that hardwoods have followed a hardwood stand. This area was never cleared completely and was probably used as a wooded pasture. It is very rocky and at times quite wet. The old stand was probably ~~has~~ chiefly hardwoods with an admixture of hemlock and white pine. Certain wolf hemlocks present today indicate that the stand was once more open. Upon abandonment more hardwoods entered the stand until 1910-11 it was clear cut. Today there is a good stand of red oak, white ash, red maple, basswood, and yellow birch. The stocking is not very heavy. These hardwoods come in on a rather wet slope with a

heavy soil which was not very conducive to white pine growth.

T.S. 4.

The area known as white pine - hardwood 2 was thinned in 1911-12 with little effect. It was clear cut in 1923-24 and planted with white pine in 1926. This was one of the earliest attempts at discriminatory planting on areas which seemed understocked with hardwoods. Subsequent weeding was made to help the white pine, which considerably reduced the quality of the hardwood stand. Despite the surrounding hardwood stand there is excessive weed damage to be found in the pine today.

If the system of establishing hardwood reproduction before clear cutting is to be followed a preparatory cutting or thinning should be made at least five years before clear cutting.

Sept 5
Gravel pit

The afternoon of this day was spent in the field with Dr. East working on soils. We first visited a gravel pit near the entrance to the Tam Swamp block. Here the gravel showed that it ~~the~~ had been water borne because of the stratified annual layers. The stream evidently varied greatly in

velocity because there were two strata of very coarse material with many large cobbles and stones, this was deposited by swift water. Some stones were found with a heavy red encrustation of iron oxide. These stones - sometimes occur in layers cemented together to form a very thick hardpan. There are two theories as to their origin. One side claims that minerals with a very high iron compound content weathered to deposit this iron oxide. While the other side claims that during the last interglacial period certain plants grew on these sites which greatly leached the iron and deposited it in the hardpan below. The plants were removed by the subsequent ice invasion while the hardpan remained.

Iron coated stones

Sawdust pile

We next visited the sawdust pile on the Adams-Faye lot. The soil here was under a mixed white pine hemlock stand until 1924 when a cutting was made and the sawdust pile established. This pile was added to after the hurricanes in 1938. Plugs were cut both under the pile and in the open at the side.

Podzol

These soils were the same until 1924 but since then the one in the open has changed greatly. The soil under the sawdust has remained essentially the same as it was in 1924 and the leaching of the organic acids thru it from the decaying sawdust has only served to accentuate and clarify its various horizons. We find here a typical podzol with a heavy greasy A layer about $\frac{1}{4}$ " thick, a $\frac{1}{4}$ " gritty A₁, $\frac{1}{2}$ " white leached A₂ and a brownish yellow B horizon extending downward 9"+.

Mull

The soil that has been in the open since 1924 has been transforming towards a mull structure. The A₀ horizon is 2-3" thick, A₁ 1-2" thick, and the A₂ leached layer has disappeared, and the B horizon is considerably darker than it is under the sawdust. The chief change has been the building up of the A₀ and A₁ horizons and the downward extension of the humus and disappearance of the A₂ layer.

Red Pine

Plantation

Nearby, in the old sticking yard the soil was originally of the same podzol structure. The sticking yard allowed grass and some gray birch to become established,

after which the red pine was planted. The grass roots were very influential in getting organic matter down into the upper layers of mineral soil above the B₁ horizon. There is in the soil a mottled gray and yellow with mixed grass roots and organic matter for 3-4 inches. The A₂ horizon is 2" or so in thickness. In this soil which ~~is~~^{was} in the process of changing from a mor. to a mull there is still a latent podzol layer although it cannot be detected with the naked eye. The concentrations of iron and aluminium are no doubt still there although the humus color has taken over. This soil would more easily develop a podzol layer than would one which had been pastured for many years.

Fertilization

It has been found that in the fertilization of seedlings that pot cultures can get along with ~~less~~^{smaller %'s} of various essential elements and can grow with ~~more~~^{greater %'s} than can trees in nurseries. Secondary influences set in in the nursery which account for this fact. Growth is increased if the % of the element is above a certain point and

continues to increase until a certain higher percentage is reached, after which if more of the element is added growth is stunted.

Range of % of various elements seedlings will stand:

Pot culture	element	Ministry
.6 - 3	N	1.1 - 2.5
.4 - 1.6	P	.4 - 1.2
.06 - .60	K	.08 - .35

The growth increment is not constant with each addition of the elements, each successive addition results in a smaller increase in growth. The law of diminishing returns comes into play here. This response has not yet been fully proven to take place with middle aged trees.

Foliar
analysis

It has been found possible to determine the minerals being used by plants by chemical foliage analysis. It might be possible to determine the ~~best~~ beneficial effects of thinings on the soil and consequently growth in this same manner.

Dry soils

In very dry soils the organic matter in the soil is used up by biota and burned out by chemical action and thus greatly reducing the tilth of the soil.

scarified plot.

An old scarified plot was found and the organic matter had been well mixed for about 4" down to the B horizon, as shown by the dark color. This plot was made in 1924 before the soil had been exposed long and was still held together by organic matter. Later plots were easier to make as the organic matter had decomposed more and allowed the soil to be mixed more easily. No great success was met with in getting reproduction on these plots.

2 cut shelter-wood

On the area which was once handled at the two cut shelterwood the soil shows a distinct transition from the enriched layer to the yellow B horizon. The leached layer is still discernable but a definite F & H layer has developed, especially the latter while the humus color has extended downward for 3-4 inches.

3 cut shelter-wood

Here a light cutting was put in first which induced the establishment of hemlock to a very limited extent as it did little to open the canopy or reduce root competition. The soil here has gone a long way toward developing into one like that on the

two cut area, but has not advanced as far as yet.

Sept. 6

In the morning we went out with Mr. Bess of the govt. entomology dept. Our first stop was at the old "mother tree," on Tom Swamp, whose needles have recently turned brown. Numerous round holes were found in the bark which are made by *Dendroctonus valens*. Many of these borers were found under the bark. In fact the bark was honey-combed with the chambers of borers of various kinds and the insects themselves abounded. A pink colored worm-like insect called a clerid was found to be quite abundant. This insect was introduced to this country in 1890 as a predator on the ips and dendroctonus beetles, but it never accomplished much. One in the beetle stage was found.

Many *asenum molatum* were found in the bark where they lay their eggs. There were many evidences of the work of ambrosia beetles which burrow in the wood. These beetles eject white frass from their holes while that of bark

bores is reddish. It was finally decided that the tree had died from the cumulative effects of hurricane damage, old age, and sudden exposure. All of these things weakened the tree to such an extent that it was attacked by insects which in the majority of cases are only secondary.

Soils

The afternoon was spent in the field and lecture room with Mr. Johnston studying soil biota. The changes which take place in the soil in its many reaches can to a great extent be traced to the soil biota. For example a mor and mull differ chiefly in the A₁ horizon because of worm action in the latter type. Every soil, with the possible exception of a virgin soil, has a biological population of plants and animals living together in a community. These communities are definitely tied to the commutation of the soil from one type to another and hence to forestry. There are no populations of animals which are harmful to the soil and only a few populations of plants which are ~~of~~ harmful.

Mor & Mull

A fibrous mor has practically no worms in it while a coarse mull has many.

The biota of a mor is great in number and species but low in aggregate weight and hence in its effect upon the soil. The biota of a mull is smaller in variety of species and number but has a large aggregate weight and therefore a great effect upon the texture, structure and other characteristics of the soil. The action of the biota in a mor is largely confined to the L, F, H, and A₀ horizons due to their smallness.

Distribution.

The numbers of biota in a mor soil are greatest in the upper layers and below the A₁ horizon there is a sharp drop in population which continues until at 10-14" the biota are very scarce. In a mull soil the reduction of population with depth is much more gradual until at 6-8" there are actually more biota present than at an equivalent depth in a mor. The biota go deeper in a mull than in a mor soil, worms hibernation 6-15' below the surface. It has been estimated that the worms in a mull soil will bring to the surface 10-12' tons of earth per acre in one years time. In addition to the worm action there are also many micro animals at work in the soil. These have great effect, especially in breaking

up leaf material.

Sunset Lane

The thirty year old pine stand on Sunset Lane was visited and worm middens were found to be present with some skeletonized leaves. It takes over 85 years for a pine stand to eliminate worms from the soil thru the development of a mor soil, so there are still many under this stand. In many pine stands enough hardwoods will be mixed in to keep the worm population from being eliminated.

Soil bacteria

The worm pellets were found only on the ground surface cementing the F horizon together, thus creating only a superficial crumb layer. Soil bacteria, which are necessary for the complete breaking up of mineral and organic material and to form nitrate, are found most abundantly in the worm pellets. Untouched soil contains five units of bacteria, soil in the worm 16, and worm pellets 20. These figures are merely for comparative purposes to indicate abundance.

Biota
class.

The biota of the soil consists of plants and animals. The latter may be classified

as follows.

Humivorous - living on humus material

Mycetofagus - living on fungi

Phytophagus - living on live plant material

Carnivorous - living on animal material

Hard:

The 17 year old hardwood stand, hardwood, was next inspected. This stand consists of white ash, red maple, red oak, black birch, and white birch which came in after a clear cutting of old field white pine in 1908-10. This in the time since, the soil has developed from a granular mor to a coarse mull. At present the A horizon is about 14" thick.

This condition has come about for many reasons chief among which is the action of the large worm population. There are at present about 50-50 worms per square meter, 14" deep. This fact is evidenced on the surface by many middens and the action of the worms is shown by the fact that almost all of the leaves on the ground have disappeared, except the red oak leaves. The forest stand in this case supplies an excellent abundance of worm food.

Colonization

Efforts to colonize worms under

spruce and white pine stands to improve the soil have failed due to adverse food and soil conditions.

Breakup

Worms break up leaves by feeding on them with the aid of enzymes. They often pull leaves down into their burrows to feed on later. Insects on the other hand actually break up the leaves with their jaws. Worms because of the enzyme action differentiate between species of leaves and will not attack some until well seasoned or rotted. The worm

middex

middex is mainly a pile of worm pellets and rejected food such as mid ribs, veins, and less desired species of leaves. The worm is active in the soil from the time snow melts until cold weather forces hibernation late in the fall.

activity

Preference

A general classification of these preference groups which worms bore for leaves is given here.

No 1 Sumach

No 2 White ash, basswood, tulip poplar, black locust, black walnut, birch, sycamore, red maple.

No 3 flowering dogwood, sassafras, hickory,

sugar maple.

SS
F.S. 9

The next stand inspected was an oak birch slope on Farm Slab City 9. This slope was found to contain no middens although it was a hardwood site. The soil was a mull but had no crumb structure, it could be called an "insect mull" as it is entirely formed by their action unaided by worms. There was a relatively shallow A, horizon and a coffee brown B. The smaller zone of mixing of the organic and mineral constituents of the soil is because the insects cannot move humus down into the soil as can worms. The Flayer can't be separated from the H or that from the A, and some fungi are developing in the humus.

The absence of worms can probably be traced to rapid drainage and the absence of food very high in the preference scale.

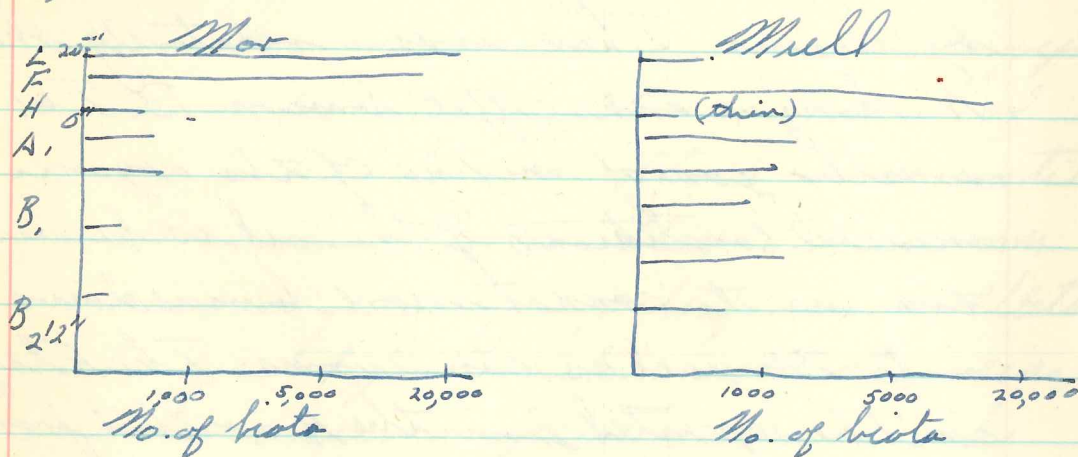
Prospect Hill

a hemlock stand with a slight hardwood understory ~~was~~ on Prospect Hill was next visited. Here leaves were found mixed with the needles on the ground where decomposition was under way, showing some degree of faunal activity. The H

horizon was greater than the L or F horizons and the color below was fairly good. The significant point is that decomposition is going on and a few worms do appear under this type.

Lecture

Below are comparative graphs of the number of biota per square meter at various depths in the soil.



As can be seen the biota are more dense in number in the upper layers of the moor and falloff sharply below. While in the mull the numbers falloff much less rapidly below. Thus the mull has a richer sub soil below due to biota action.

Food

The food present has a direct influence on the biota found in any soil. Experiments were conducted to show the rate of consumption of deers in pure culture in nature by biota. Frames 5' x 3' x 3" were

placed on the soil & filled with leaves and left for biota to act upon. In each frame was a metal envelope sealed with some leaves inside. These envelopes were a very fine mesh screening which would exclude biota but not fungi.

at the end of two years the experiment was finished, observations were taken periodically during this period. It was found that in general decomposition went on faster on mull soils than on mor soils. One factor influencing this is that on a mor soil the forest stand maintains a cooler temperature and tends to shorten the activity active period of the biota.

The leaves used varied from thick to thin textured and a list is given below in their order of preference by worms and other biota

White ash

Paper birch

Red maple

Red oak

White Pine

White ash - mull; gone in 6 months
 mor; " " " 12 "

- Paper birch - Mull; gone in 9 months
 Mor; " " 14 "
- Red maple - Mull; started in ^{30%} 1 year gone in 2.
 Mor; not quite gone in 2 years.
- Red oak - Not attacked in 1 year, some
 feeding at end of 2 years. Lesson
 more than an mull said.
- White pine - 30% gone in 1 year.

The leaves in the metal envelopes,
 untouched by biota, showed almost no
 signs of break up at the end of two years.

control

By applying the list of preferences
 of species to a stand in controlling its
 composition it would be possible to maintain
 a mull or develop it on the site and
 thus increase the productivity of the soil.
 In Finland birch and Scotch pines were
 planted in mixture and it was found that
 with 30% hardwood in the stand the
 conifers made better quality and volume
 growth than pure coniferous stands.
 Composition control by thinning, nurse
 crops, under and inter planting can be
 used to improve the soil and forest stand.

It should be remembered that although
 the biota of the soil greatly influence its

make up that chemical reactions also have a great effect and that the results come from interactions of all the soil influences.

Soil Biota

1. Plant

algae

Bacteria

fungi

Mychorrhizae

2. Animal

Protozoa

Ratifiers, etc.

Mites

Worms

nematodes

annelids

Insects

Reptiles &

Small reptiles

Mice

White footed Deer, Red backed, Pine, jumping

Shrews

Long & short tailed

Wales

Red squirrels

Flying

In considering the effect of the population of any constituent of the soil biota upon the soil not only the density of population must be known but also the time, mass, and intensity of the group. Knowing these factors for any species makes it possible to evaluate their effect on the soil.

Spring tails, or collembola, for instance have the highest density, but a small mass, and low intensity and are greatly affected by weather and hence last a relatively short time. These facts combine to show that the spring tails are of less importance than mere figures of their population would lead one to think.

Sept 7

This morning was spent in conference with Mr. Cline and Mr. Lutz discussing our work thus far, especially reproductive systems.

white
Pine

At present it seems that in order to grow good quality white pine it should be kept partially suppressed by hardwoods, thus avoiding ^{white pine} salt ~~injury~~ damage. There remains to be discovered the right degree of suppression and right length of time it is to continue.

Forestry

To make the practice of forestry financially possible for the small woodland owner it must be done without investing any large sums of money, In fact almost the only possible investment is in the form of labor. In the life time of a stand at least one catastrophe should be expected to destroy part of the forest, so that the investment of money is risky. Also cultural operations must be properly timed and only that amount of work done which is necessary, Thus avoiding extra unnecessary work.

class-ification	Seedlings	0' - 3' high
	sm. sapling	3' - 10' "
	lg. "	10' - 4" D.b.h.
	sm. pole	4" - 8" "
	lg pole	8" - 12" "
	standard	12" - 24" "
	release	24" - "

lt seeded species Light seeded species are those whose seed is light and usually wind borne, they are very often light demanding and short lived as well.

Soils The soil is one of the extremely important factors in determining the forest stand. After a clear cutting of pine on good

soils hardwood will come in, on poor soils pine will grow, and on the medium soils the two will grow in mixture. On the poorer and medium soils the number and variety of hardwoods will neither be as great or desirable as on a good soil, there will be a tendency toward the predominance of oak and hickory with less ash and basswood.

Thinnings

In thinning a hardwood or mixed stand it should be remembered to avoid large stools, especially if the purpose of the operation is to encourage reproduction as the more often a stump sprout is cut the more stems grow from it. Therefore one clear cut seems better than several cuttings if good reproduction is desired.

Shelterwood

The purpose of a shelterwood cutting is to reproduce the stand in the shelter of the old forest. Cuttings can be uniform, in groups, or in strips, and are usually started on the lee side of the stand or down if hill. The first opening used to be a preparatory cutting to prepare the seed bed and increase the vigor of the stand. Today this is taken care of in cultural operations throughout the life

of the stand. The next step is to wait for a good seed year and to make, at that time, a seed cutting to open the canopy somewhat. When the reproduction is firmly rooted and beyond the age ~~where~~ of greatest susceptibility to scales weevil damage the final removal cutting is made. This results in the establishment of an even aged stand.

Dilemma

On the southern end of the Tom Swamp tract an area was cut in bunches and large stand of white pines remain. Below these & suppressed by them are good hardwoods 5" in diameter. If the pines are removed the rest of the trees will be broken, if not the stand is a loss.

There seems to be a difference in the ability of the various hardwoods to recover after cutting & exposure, as evidenced by one clump of black birch which hardly sprouted after this treatment.

Difficulty has been experienced locally in planting hardwoods because of frost damage. The transplants seem to be shocked and thus grow low & slowly staying near the ground where the frost is worst. Oak is quite subject to frost damage especially

for a few years after an area is logged.

Sept 10

A short session was held in the evening with Mr Johnston upon the importance of bacteria in soil decomposition. These bacteria are essential in breaking down complex organic-mineral compounds into nutrients available to plants. The importance of various biota in the soil and their distribution was also discussed, considering the population, density, weight, time element, and intensity.

Sept 11
weeding

Ref: W.A. Campbell - Bureau of Pathology
In untreated stands of this region red oak is likely to constitute in youth about 12-15% of the stand and at maturity to occupy 75% of the area. Because of its aggressiveness, gypsy moth susceptability, and limited market, and ~~relative~~ poor soil building qualities it is not to be favored very highly as a crop tree.

Definition

Weeding is a silvicultural treatment carried on in a stand not beyond the sapling stage to improve the composition and release potential crop trees; it can usually be done with a machette. Trainers are usually left in the stand. The proper timing of this treatment

is essential but due to local differences of site, stocking etc. no hard and fast rule can be made for all stands. The first weeding usually comes when the stand is old enough so that composition and some relative ^{quality} ~~worth~~ of the various species can be seen. There are usually two weedings which with the first improvement cutting will not pay for themselves. These can possibly be paid for from later cuttings. About four man hours per acre should be enough to weed an average stand.

Time

T.S.Z

The area known as pine-hardwood / was visited, see page 68, where weedings to favor red pine were originally made. These weedings were very detrimental to the ~~present~~ hardwood stand, which today is 25-30 feet high and consists mainly of red oak in the dominant position, and hard maple and a few scattered white oak below. A weeding which will require axe work is now needed if anything, but ^{red} oak is to constitute the final stand. Even with proper treatment, now red oak will make up a large percent of the stand. This is an example of what poor timing and weeding for the wrong purpose can do to a stand.

In all weeding before a tree is cut the present position in the stand, future effect of the tree, present form and possible value, possible damage, and soil building characteristic must be carefully considered.

On the area a few clumps of white pine which seeded in naturally will produce a few trees. This is a case of natural group mixture. The planting of red pine on this good hardwood soil is poor utilization of the site as it is a low value species.

orange on WP

The brown, irregular, depressed areas found on the young green bark of white pines is a fungal disease known as *Caliciopsis pinea*. The circular, grey green, fuzzy, growths on the pine bark are septo-basidia pinicula.

The afternoon was spent in reading about soil nutrients & mycorrhizya.

Ref: Black Rock Bull No. 6 A.B. Hatch

The Physical Basis of Mycotrophy in Pinus

Theory & Practice of Silviculture - Baker

Black Rock Bull No. 11 Mitchell-Chandler

The N Nutrition and Growth of certain Deciduous Trees of N.E. U.S.

USDA Tech. Bul No 348

Use of The Exponential Yield Curve in Fertilizer Exp's.

Sept. 12

We spent this morning in the field observing the effects of and planning weedings with Mr. Lutz.

WP
Hwd #3

The first area visited was ^{WP} Hardwood # on T.S. 1. This is the only real example of the results of a pure shelter wood cutting to reproduce white Pine on the forest. After the final cutting ¹⁹¹⁴⁻¹⁵ the area was weeded in 1919, '26 & '30, the first two to favor pine. As the good natural stocking of white pine died planting was resorted to but today only a few suppressed trees remain. The stand consists of Red Oak, white ash, white birch and some hickory, basswood, and black birch about 30-40' high. An improvement cutting for gypsy moth control was done in 1935³⁰ which removed much red oak and all of the gray birch and popple. So far treatment could have been done for 20 man hours or about \$0/acre. at present the stand doesn't need attention except for a few scattered whips. The crowns are established and the canopy isn't open enough to encourage side suckering. The percent of red oak is not too high, less than 50%

The area will, no doubt, need one improvement cutting in about five years, when some return may be expected.

Hard 5

The area known as hardwood 5 in T.S. 1 was next inspected. This area was clear cut and given no planting, nature did the rest. There is now a good stand of red oak, white ash, sugar maple, basswood, black cherry, and white oak ^{Nick's} ^{Balsa} on the land with good stocking. The trees are about 20-30' tall and thrifty.

Hard 4

Hardwood four near by was cut and treated in the same way, but is a small two acre plot. The slash was burned and thus burned over most of the area. Today stocking is rather scanty in spots, especially along the old windrows which are covered with sumach. But basswood is seeding in quite well from a nearby tree and the stocking will eventually reach normal. The stand consists of white ash, hard maple, white birch, and basswood and is growing well. Red oak has mostly been cut out of the stand.

Improvement cutting

An improvement cutting is made each about the same seasons as a weeding but

the stand has reached the stage where an axe is needed for the work. The object is to improve stand composition and not especially to stimulate growth. Four tree classes are recognized: crop trees, excess crop trees, inferior elements, least, and inferior elements cut, these can be identified as the stand becomes differentiated in the crowns. Trainers are retained to keep crop trees clear of side branches and fillers hold the stand together and protect the soil. All but the first improvement cutting should give a financial return at least equal to cost.

M.P.H.5

White pine - hardwood 5 on T.S. 1. was inspected next. This area was cut in 1922 & 23 and the area covered by the sticking ground, where hardwoods were killed out, was planted with red pine which is growing well today. There are a few hardwoods creeping in between the pines, and even if well grown, this is a poor utilization of good hardwood soil. The rest of the area now supports a good mixed hardwood stand 25-30' high.

Ref H.F. Bul No 2 Spathe - yield tables of
Hard stands

NEFEES Occasional Paper 3 - V.S. Jensen
Weeding in N. Woods.

NEFEES Occasional Paper 6/8 WA Campbell
Decay in Oaks

USDA Bureau of Plant Indust. Roth & Sleeth
Decay in Sprout Oak Stands.

Sails

The afternoon was spent in reading and lectures with Dr. East. The chief discussion was upon exponential curves, law of diminishing returns, and mycorrhizae. The material will soon be published and we were instructed not to take notes.

Sept. 13
P 3

The morning was spent in the field with Mr. Lutz. The first area visited was a seed tree experiment section in Prospect hill 3. The old field pine here was cut in 1934-'35 and large old pasture pines were left for seed trees in hopes that they would be wind firm. These trees are all dead now and due to large part to the hurricanes of '36, although many blew over before this date. In 1937 the area was planted with white pine, larch, red pine, and spruce as some felt that natural reproduction was not proceeding fast enough.

The area had no advance growth of hardwoods at the time of cutting and all of the present scattered stand of Red oak, white oak, red maple, gray birch, and black birch has seeded in from outside. The soil here is not as good a hardwood soil as is found in the Tam Swamp tract and this is evidenced by the tree species present. At present there is a limited seed source from hardwoods on the margins of the area. Near the edges reproduction is noticeably thicker and taller. Some pine has seeded in among the rest of the reproduction.

The soil here is capable of supporting a group-wise mixture of pine-hardwoods, and such a stand might have been obtained if the cut had been delayed and made on a shelter-wood basis. If this plan had been followed a better stand might be present today.

Norway S.

A Norway spruce plantation established in 1946 on Prospect Hill was next visited. Here the trees have reached a height of 40-50' and are growing very densely. Certain areas due to heavy ground cover such as

sweet fern failed and have not been filled in. White Pine weevils have damaged many of the leaders but the effect is not as disastrous as in white pine. Animals such as squirrels also damage this species.

The stand is very dense & gives a great deal of shade to the soil making it cold and damp, ice is found here in May. This fact causes damage in that when the taps become active the roots are still frozen and concentrations of food etc cause stresses and cracks in the bark. Thru these cracks a fungus, *Cytospora kungii*, enters and forms a running canker. This condition can possibly be eliminated or at least alleviated by thinning.

This type of stand is subject to hurricane damage because of its density, and swaths of trees have been blown over.

mixed soft 8

The area in Prospect Hill, known as mixed softwoods & was next visited.

Here red pine and white spruce are planted in alternate rows and are today approximately the same height, although

some of the spruce has fallen behind and other ahead of the red pine. This area was an old mowing planted in 1925. Measurements show that the red pine branches next the pines are smaller than those next the spruce. Evidently the latter don't have as good a suppressing effect as does the pine. This is not a natural association of these species and perhaps a pure stand of either would be better. The stand is now 25-30' high and growth rings show a slight slowing up of growth indicating the need of a thinning.

Sept 14

The early part of this morning was spent indoors with Mr. A. C. Clene and Mr. Lutz. Later we visited several plantations with Mr. Lutz and Mr. Johnston.

WP-14 3

The ~~facility~~ facility of planting or trying to bring natural white pine reproduction to maturity on the best sites was again discussed with the example of the north end of pine-hardwood 3 on T 51 being sighted. Here the area was clear cut 1916-17 and planted two years later with white, red, and Scotch pine in different groups. Today the red pine can be found in the stand only as a

few scattered individuals and the others are gone entirely.

Gypsy moth

In this 20 acre tract that has an almost uniform exposure and stand five plots were located to study the effect of Gypsy moth damage. Notes were taken on the species and numbers of trees present, with the percentage of moth favored food ranging greatly. After each feeding season notes were taken on the severity of damage. It was thought with the higher percentages of favored foods present damage to all species would be greater, and that by reducing the favored food supply all trees would be less damaged. By reducing the amount of red oak in a stand the percentage of other species such as white ash is increased and the stand is protected from moths, has its composition improved, its soil protected and favored, and future form improved all at once. A good stand of white ash will increase the B₁ horizon of the soil from only a few inches to 14" in 25 years.

Protection

In a stand to be weeded we have several tree classes.

I Cut

Tree classes

a. Weeds Dominant & Codominant

b. Excess Crop trees D & C

II Leave

a. Crop trees D C & possibly I

b. Trainers Overtopped

c. Superior hardwoods - filler, D, C, I.

Buttrot.

The occurrence of butt rot in hardwoods depends on several factors

1. Diameter of the stump - $\leq 3-4"$
2. Height of origin - $\leq 4-5"$
3. Healing of stump wound - rapid
4. Companion sprouts - low union, no friction.
5. Rate of heartwood development - cut before development of connection between sprouts.

This consideration of rot development is especially important today because of the multiple stemmed character of our extensive coppice and wood forests.

Hard 5

On the hardwood 5 area certain advanced growth was not cut back at the time of logging, and today these trees have partially stagnated in growth. The release after suppression often causes this slow up if the reproduction isn't cut back for a better start at the time of release.

NP-Hard 5

The northern end of pine-hardwood 5

is understocked with advance growth and the effect on distribution can be seen. The light-seeded, wind borne species have a ~~general~~ spotty distribution, red maple, white birch, pin cherry, etc. The heavier seeded species, planted by animals have a more general distribution throughout the area, red oak etc.

Girdling

After the most economical method of removing red oak of no commercial value is girdling. This also reduces the number of stands of stumps sprout origin.

Stuck lumber

Lumber piles kill the dark trunked species such as white ash, red oak, red maple, etc that are present and these areas seed in to white birch. Thus it is often possible to find the location of old sticking yards by stands of light barked trees.

Utilization of site

To best utilize a site the stand should consist of the most valuable species of trees that can be grown there economically. In this region the practice of good silviculture is necessary to grow white pine of any value.

Plantations
N.S. & R.P.

In the field various plantations on Prospect hill were visited. We first inspected a planting of alternate rows of red pine and

Check

N 59

soil Norway spruce done in 1926. In 1927 the Norway spruce which seemed richly was replaced with white spruce¹⁹²⁷, but it has since recovered. The soil here is good, and was formerly an old mowing with good drainage. A few worms still remain in the soil but are being gradually killed out. This type of forest is very bad for the soil and a morass developing as evidenced by the 1, 2, 3 ratio of the H, F, and L layers of the organic mat. Light frequent thinnings might allow enough light to enter to break up this mat and decompose old surface roots present in the cool damp soil today. The canopy if kept from interlacing would lengthen the soil activity season appreciably.

This unnatural type will probably not be perpetuated, perhaps as time goes on conditions like those under a white pine stand will develop and a hardwood stand may possibly develop to follow the present stand.

Checkerboard
X59 WP

An area planted on a 36 tree checkerboard plot with 4'x4' spacing of white pine and Norway spruce was visited. The soil is good here and since the planting in 1926-27 the

soil

insect damage of the pine has been great, evidently Norway spruce affords the pine little protection. The soil is today developing towards a mor as evidenced by the "fetting" of the heavy organic mat.

WP, WS, Hem

An old conwood area was planted in 1924 to white pine, white spruce, and hemlock on a 16 tree square checkerboard plan with 4' x 4' spacing. The hemlock grew stowly at first but today has caught up with the rest of the stand and is doing well. However the insect damage of the pine is great and little protection is afforded it by the spruce and hemlock. This area has had eight weedings!

Hurricane
Plots.

Twelve plots, four of them 32' x 32' and the rest 12' x 12' have been laid out in blow-down areas to study the growth that will follow the blow-down. The stand development will be carefully recorded until the stand is fully formed, and its effect on the soil will be noted. Beside each plot is a mil acre scarified plot. The work was done to a depth of 6-8" and here after the present herbaceous growth trees may follow.

SP, RP, Hem

An area of scattered plenty of scotch pine, red pine, and hemlock was seen next. The scotch pine has been attacked by weevils as much as the white pine but its recovery is good, 95%. The weevils are drawn out in most instances and overall damage is slight. However the squirrels do great damage by removing the terminal buds causing "brooming".

RP

An area of gray birch 35'-40' high was clearcut and planted with 2-3 red pine stock in 1919. This stand was weeded in 1921, '23, and '30; and pruned in 1936. The stand today is growing very well and shows good form for red pine, it is about 35'-40' high.

Planting

The first season after planting growth is good and is made on reserves accumulated in the nursery, but the second year may be slow as no spring starting reserves were accumulated during the first season. This may be found true after a good or bad growing season later in life.

RP, WP & S

After the cutting of a coned area white pine, red pine, and spruce were planted in 1925 in alternate rows. In order to bring this

crop there much weeding has been necessary to keep out the sprouts from the old hardwoods. Where sprouts will develop to compete with planted stock, a large investment in weeding will be necessary to develop a coniferous stand.

NS&RP

an area planted to alternate rows of Norway spruce and red pine in 1926 shows that the spruce has not done as well as the pine. Evidently the soil does not meet the spruce requirements. A pure pine stand would have been better and would have given better side crowding.

Natural R.S.

an area of natural red spruce was visited. This stand is quite wet and boggy and there is much natural reproduction. The margins contain red spruce, hemlock, and red maple in a fairly dense stand.

Sept. 16

The morning was spent with Mr Cline and Mr Johnston on the Adams-Faye Lot.

Head

The north end of the area was once pasture land with a light sandy loam. This gradually seeded in with pine with a very spotty distribution. Natural openings occurred where culms were mired beds of ~~but~~ reindeer ^{or lichen} moss and polytrichum moss. This mixture

openings

seed bed Creates an unfavorable seed bed. However on pure beds of polytrichum moss red pine broadcast grew quite well. Around the bases of old clumps of gray birch pine seedlings started and grew in clumps. This was probably due to better seed bed conditions.

Pruning Some of the white pines were pruned and afterward attacked by bark beetles, but no damage was done. This may be characteristic on poor sites.

Growth The younger trees show slow height growth and fairly vigorous development of side branches. The weevil damage to these trees is not great. Older trees are more characteristic in growth of good sites and seem to have been more severely damaged by weevils.

cut '24-'25
seed bed On the area cut in 1924-'25 it was found that blueberries come in thickly on the organic layer under the pine-hemlock. This creates a very poor seed bed for pine and removes much of the soil nutrients. Cuttings in this type must be very small to avoid the encouragement of blueberry. Perhaps a group selection system, opening small holes in the canopy, is indicated on these sites.

Of course, the hurricane will cause ~~much~~ a great increase of blueberry because of the large openings created.

Ground
cover

This whole area has been mapped for ground cover. The bad seed bed created by blueberry and a mixture of lichen and polytrichum mass has been mentioned. Polytrichum mass (*P. pilosella*) in pure beds creates a favorable seed bed.

Hypnum mass (*H. ciliatum*) in pure beds occurs on old rotting slash in protected spots and creates an excellent seed bed.

Between the extremes of blueberry and hypnum mass ground cover there is a wide range of mixtures of many plants, checkerberry, partridge berry, wintergreen, rubus, ~~strawberry~~, etc. with medium seed bed qualities.

Site

This antwash soil is a natural pine site and with it might be expected white oak and red maple. This combination seems to be present in seedlings and sprout growth.

advance growth

Around the bases of old standing pines the hardwood advance growth has come in thickly. Perhaps the use of the tree by animals & birds accounts for the presence of the heavy seeded species like white oak,

and cherry. Red maple is also present, perhaps animal planted or wind borne.

selective cut

The area across the road was cut selectively for white pine and hemlock. The hardwoods present were given away and reproduction awaited. The had to be weeded to favor the conifers over the hardwood reproduction.

Pales Weevil

The pales weevil attacks white pine at all ages, cutting the bark from the bases of small seedlings only. On older trees, the weevil eats only the tender green bark, especially around the upper lateral branches. Seldom is an older tree killed.

RP & WS

Nearby the old stand was clear cut and the area planted with alternate rows of red pine and white spruce. The red pine is pretty well adapted to this site but has made only fair growth. The spruce has done quite poorly, thus removing the side pressure on the pine and allowing large branches to develop. A shelterwood cutting might have achieved natural reproduction of pine on this site. ^{Plus} Last years red pine growth was small because last years poor growing season built up no reserve for

RP Growth

early growth this spring.

Poor site

On this poor site a stand should be created which will maintain itself and reproduce itself with a minimum of handling, as the products will always be of poor to medium quality and never make a large return.

Group selection

In the group selection area (see Marshall) the stand was nearly pure hemlock. Small openings were made which favored the reproduction of hemlock over pine. Some black birch came in also but has mostly died since. Much of the hemlock reproduction died in 1924-25. Today, after the hurricane, the light-seeded species such as pin cherry, gray birch, and white birch are seeding into the area.

2 cut shelter
wood

On the 2 cut shelterwood area the stand consisted of mixed white pine and a slightly lower layer of hemlock. The ground was covered with a thick organic mat, as it hadn't been treated for 70 years, creating a very bad seed bed. In 1924-'25 a heavy cut removed 50% of the canopy, over 50% of the trees, to establish reproduction.

Because of poor seed bed conditions reproduction

was very scanty and spotty, consisting mostly of hemlock with some pine where the charcoal of burned slash was accumulated. Scarification did not bring in any more reproduction.

Study

In 1934-'35 Duffield and Cramer made a reproduction study and on their recommendation the stand was further opened up. From then remaining hemlock was removed leaving a 40% canopy of pine.

This would have probably worked well if it hadn't been entirely blown down in 1938.

Today counts show that more than 50% of the area has white pine reproduction enough for a pinus crop. Other hardwoods of light seeded species are seeding in.

BB, GB,

In the early stages black and gray birch seem to have similar light requirements with hemlock.

Future

Undisturbed by man this stand would probably result in a group-wise unmanaged stand which might be brought about by treatment on a groupwise selection system. Openings would have to be small to avoid the creation of small pure stands and the introduction of blueberry. This may be a method of handling farm wood lots economically.

Sept 17

This morning was spent inside with Mr Cline.

weeding

Three rules to be remembered in weeding are set forth in Forest Weeding by A C Cline, page 7. Extra crop trees should be maintained in the stand as it is impossible to foresee what catastrophes will eliminate trees from the area before maturity. The silvicultural system should be flexible enough to adapt itself to the varying conditions encountered throughout the life of the stand and in different stands.

When the weed elements of the stand are beyond 4" DBH the stand is beyond the sapling stage.

Weedings are especially important in our local forests because of the complex and various nature of their composition. To be of the greatest value weedings should be properly timed. They should be delayed as long as possible without doing harm to the better elements of the stand, such as suppressing, whipping, etc.

Timing
weedingTiming
Thinnings

Thinnings should be done at a time when the greatest profit can be realized in the products and still the cutting is done

before the better stand elements aren't harmed

32 yr stand

On the 32 year old stand the Danish crown thinning system is used. This leaves relatively few crop trees per acre, red oak 50 white ash 70, and seeks to obtain but two clear logs, thus reducing the rotation to about 60 years.

growth

The first thirty years of a hardwood stand are spent primarily in height growth and canopy establishment; consequently the side pruning is rapid and about 2 clear logs develop. ^{In} this time weeding should strive to merely establish the crop trees ^{quality} and composition of the stand without much attention to growth rate. At thirty years of age height growth slows and crowns expand with a corresponding increase in diameter growth. In the next thirty years treatments should strive to give the crop trees room for crown expansion and thus increase diameter growth. The Danish system requires treatments about every 10 years leaving expansion room of about 5 feet for each crown. In the first 30 years weeds are removed, crop trees + chosen, and trimmers kept in the stand with fillers.

In the second period the trunks aren't as important as clear length is established, but they remain to protect the soil and hold the stand together.

Even aged
stands

Even aged stands are easier to control as to density, form, and composition than uneven aged stands. The latter present very complex silvicultural problems and are therefore poorly adapted to the farm woodlot. The advantages of both systems might be available to the small woodlot owner by making ~~the~~ selective cutting over small areas $\frac{1}{2}$ acre or less and obtaining several small even aged stands in a given area.

Pruning

The pruning of hardwoods is seldom, if ever, profitable or advisable, with the possible exception of doing a small amount of work on the red oaks.

Pruning of white pine can, if properly done, be profitable. As white pine will not prune itself and cannot reproduce itself in its own shade thus eliminating trunks if clear lumber is desired artificial pruning must be done in pure stands. A hand saw and ladder make the best tools for this type of work. About three

pruning will be needed to obtain one clear butt log, which is enough. Care must be taken not to reduce the crown area too much, and the timing is governed by the growth rate, as the butt log should be the same size throughout. The best timing results if work is done just before growth starts in the spring, pitch will seal the cuts if branches are alive and not too large. Dead limbs have a concentration of pitch at their bases which prevents the entrance of fungus, *Stereum sanguinolentum* causing rot.

Timing

The first pruning should be done on potential crop trees when they have reached log height and the butt log is therefore beyond danger of weevil damage. The branches should be cut, ^{as} close to the tree as possible about as high as can be reached conveniently. The second and third prunings for the clear butt log should follow at about three year intervals, depending on the growth rate. Only the trees which have good form & growth should be pruned and care should be taken to keep the per acre investment at a minimum as many things can happen to a stand before

maturity

winds

In order to be wind firm a tree must have a good anchorage in soil not too wet or rocky or in too exposed a location. The top should have a low center of wind pressure. It has been found that species vary in their wind firmness; white oak and white ash are fairly firm while white pine is less firm than the hardwoods. Even in groups in hardwood stands white pines are blown over. Sprouts from stumps are more likely to break at the base than seedlings. The cutting of more roads and cones thru our coniferous forests has been advised to increase the numbers of wind firm trees which are to act as screens for the rest of the stand. These roads are also useful as protection against fire, and in extraction of products, etc. By proper treatment it might be possible to increase the age of complete wind destruction of our coniferous forests.

Insect control

There are two main ways of controlling insects: 1. Biological control thru parasites, diseases, predators, and silviculture: 2. Artificial control thru spraying, poisoning, etc. The latter

method is too expensive to be applied widely to forest insect control. The natural enemies of insects constitute one of the best controls. Silviculture may be used to so alter forest conditions as to be unfavorable to insect development, such as removing the desired food of the Spruce moth. Weeviling can be reduced by growing white pine under shade. Much research and knowledge of ecology is required to know the best method of attacking insects and how best to manipulate the forest environment.

Sept 18

This day was spent in the field with Mr. Chise and a gathering of state and CCC foresters. The hurricane area on Sunset Lane was first visited and the excellent possibilities of reproduction of a hardwood stand were seen. (See page 25). White pine-hardwood 5 was looked over. The planting of red pine on the old sticking ground and its possible treatments. (see page 68). The rest of the hardwood reproduction on this area and the 22 ~~year~~^{acre} old stand nearby was inspected. Here the folly of planting conifers on cutover lands on good soil and the excellent hardwood reproduction was seen, (see page 69). Advance growth which was set mowed back at the time of cutting the old

field pine groves, ^{more} crooked and forked than that which was cut back. The girdling of red oak to reduce gypsy-moth food was also seen.

In the afternoon the 32 year old stand was visited (see page 67). Next a thinning for a small section of white pine-hardwood was discussed, showing considerable question still remains about which trees should be removed. The marking already done was discussed, (see page 71).

The reproduction on T 55, a blown down area was inspected and considerable discussion ensued as to its possibilities and treatment. It was suggested that the hardwoods be mowed back because many have been beaten to the ground and are sprouting from high stumps. It was finally decided that with proper treatment, the area could be fully stocked with volunteer growth.

The hardwood area with its underplanting of red pine on T 54, (see page 71), was visited and discussed, as well as the example of hardwoods following hardwoods nearby, (see page 72). The old growth remnants near the "boulder site" were inspected and their

origin and composition was discussed, see the first section on old growth.

Sept 19

In the morning we visited the peat bog with Mr P. Smith and observed his method of peat sampling. A drill with an extension handle and a chamber on the end which can be opened, filled, and closed is used to get samples from various depths. Mr Smith is taking a series of borings on a straight line across the bog at 20' intervals to find the deepest spot. Here he will take samples at different ~~and~~ depths for future analysis. From the depth, amount of decomposition, composition, and the preserved pollen it is possible to discover the past climatic changes and consequent vegetational changes for ^{the last} 10-12 ~~th~~ thousand years. These bogs started after the glacier receded and have continued until the present. Their pollen analysis agrees fairly well with the sequoia climatic analysis and the interpretation of the European warm days.

In general bogs show the following climatic changes, from the bottom up.

At the bottom are glacial sands then lake ooze, above this is peat. The peat

shows the following. 1st a cool spruce-fir period and then a sudden readvance of the glacier and a recession. 2nd Cool dry post-glacial period when pine was at its height. Peat bogs began their great development then. 3rd warmer & moist period like that of today followed by 4th a very warm dry period. After this came a 5th cooler moister period also like that of today. This was about the start of the Christian era. 6th there was a dryer and moister period and finally the cooler moist conditions of the present.

In the boring taken we found at the top decomposed sphagnum peat, due to the drying of the area when the dam was recently removed. Then a layer of undecomposed sphagnum peat followed by a thick bed of decomposed sphagnum peat. Decomposition usually occurs when the area dries up, after a forest cover develops. Below was lake ooze and at the very bottom marl and sand. The marl may have developed due to the abundance of stone worts in the ancient lakes. These plants were

able to precipitate calcareous material. Another theory of marl origin is that calcareous matter is precipitated when calcium containing stream water hits acid lake water.

This bog shows lake oze in its center and more on the sides so it is thought that the bog formed in the old lake and overflowed to its present edges.

TS 7.

TS 7 was visited and the plantations on old pasture land, planted in 1930, of European, Japanese, and Siberian Larch, red pine, ~~and~~ white pine, and Scotch pine were seen. The larch is growing very well on this light dry soil while the white pine seems less well damaged. This is a characteristic of white pine on the lighter dryer soils.

The rest of the morning was spent studying means of identifying oaks and hickories.

Whitney

Chair Factory

In the afternoon we visited the Whitney Chair Factory in Ashburnham. Here fine furniture is made in a well equipped plant. The woods used are almost entirely hard maple and a little birch and red oak. Materials from Wisconsin and Tupper Lake in NY are used as this

western stock has a light colored heartwood. Only the best grades, according to the National Hardwood Lumber Association rules, are used. Stock must be sawwood four sides or one side and edge. The company is very particular about the color of the wood and will not use native stock as the heart wood is mineral stained.

A price up to \$5/M delivered and sawn 5 ft. is paid but the average is \$38. Poplar about \$20 freight. Stock must be practically clear. Most all of the wood is bought a year ahead and cut to specifications and air dried. Before use all wood is kiln dried a maximum of 5 days and average of 3, and then equalized for about 3 days to 4-6% moisture, and equalized at 6-8%.

Yellow birch is about 10% easier to work than hard maple but is little used but for a few chairs and bed rails.

Many very efficient high speed machines are used but there is also an excessive amount of skilled hand labor involved in the making of fine furniture at this plant. The tempo is not fast but business-like. Perhaps

the plant could be better organized, but not without remodeling the entire plant.

If high enough grades with much sap wood and unstained heart wood could be grown it would pay to do it for supplying this company. It is a question, however, whether grade requirements could be met. Small lots of high grade logs might be sold profitably to this company. The market is nation wide and appears to be permanent thus sustaining the ~~market~~ business.

Sept 20

W.S. planting

This morning was spent in the field with Mr. Cline in the northern end of the Slab City Tract. The first area on SC 2 was an old field pine dot cut in 1931-'32 and planted to white spruce in 1934. The soil here is light and dry so the stocking of hardwoods was scanty. There was a good deal of black birch in the advance growth but after mowing most of it died. This seems to be characteristic of this species. Today there is a ten to fifteen foot stand of pin cherry, red maple, white and red oak, and gray birch over the spruce which is 3-5' high. a good deal of oak die-back is present, cause by frost killing back the leader giving

Erastor oak

a zig zag form to the tree.

Treatment

at the present time a conservative weeding is needed to bring the spruce thru; but it is not necessary to cut all the hardwoods, the best should be saved.

The cheapest method of regeneration would have been possible by obtaining nature reproduction by silvicultural methods. On this light soil it is probably possible to carry a stand of mixed soft and hardwoods. If a shelterwood system of cutting had been used the group wise distribution of white pine and hardwoods would probably have resulted. This would have been best as no great money investment is justified on these poor soils.

shelterwood

on another section of this same area and cutting the shelterwood method was used. This method resulted in fairly good groups of white pine reproduction between hardwood strips, which were not very well stocked. Here the hardwood elements which must be used are red maple and red oak as in its present condition the soil will not

acorn
planting

readily support the more exacting species.
An ^{untreated} old field pine area planted in 1935
with acorns was seen. These acorns were
collected just as they began to germinate in
the spring and planted the same day. At
present there are many growing and they have
reached a height of one to two feet.

W. A. planting
in open.

another old field pine cutting area was
planted with white ash. Here survival
has been rather poor and the trees have been
greatly damaged. This light soil is not very
well suited to growing white ash.

Pruning

a dense white pine stand was seen
that was pruned when quite small. The
diameters of the tree at the time of pruning
were painted on each tree. The cuts healed
well and some have laid on almost an inch
of clear wood. Experiments in spring and winter
pruning at different times were started but
the trees were blown over before any
definite conclusions could be drawn.

W. P. planting

The side hill of old field pine cut
^{about} 1926 and planted to white pine ^{about} 1928
was visited. Today, on this light soil, the
hardwoods red oak, white oak, red maple, and
pin cherry are about 10-15' high and for the

most part overtop the pines. Considerable damage from weevils has resulted in the pines. Probably the best thing to do with this stand would be to try and develop a mixed stand of white pine and hardwoods. It will be difficult to bring all of the pines there on this light soil because of the stemwise distribution, therefore only the best should be considered and immediate treatment should aim to improve only the best pine and hardwoods. No great investment is warranted on this poor soil as returns are likely to be ~~to~~ small.

Wendell

A trip was made in the afternoon State Forest with Mr. Lutz to the Wendell state forest and vicinity. One stand of pine was seen along the road which had evidently originated on an old pasture.

The soil was a glacial till, moist and well suited to the growing of hardwoods, ^{although rocky}.

The stand consists of white pine about 40-50 years old with a considerable admixture of red oak and white ash and red maple about 60-70 feet high. The stocking is fair and was evidently denser

in the past as the hardwoods are relatively clear. Advance growth has not really started to come in under this stand as yet but undoubtedly will in the near future.

Probably the best procedure on this area would be to obtain advance reproduction thru light openings and then cut the stand to obtain a new hardwood stand. The hardwoods present are mostly grouped in the lower regions where natural drainage maintains moister conditions.

Hardwood stand

across the road is a stand of hardwoods about 30 to 40 years old. This came in after the cutting of the old field pine stand which contained quite a few hardwoods. Most of the trees, red maple, sugar maple, and white ash, have originated from stump sprouts. Popple has also seeded in to a considerable extent and the stand is now 40-50 feet high with a somewhat scanty stocking. The soil here is the same as that in the previous stand but because of the tree origin the form is very poor and rot is now doubt prevalent. There are also only a few of the ~~less~~ ^{more} desirable species

in the stand.

Probably the best treatment of this area would be to gradually cut the present stand and convert it to one of better hardwoods. The present stand will no doubt produce only cordwood.

Black heart of maple, a rot, usually enters thru the parent stump and penetrates the whole tree. It is invariably present in stump sprouts from large stumps.

Some of the poorer state land was seen with its small stands of gray birch, white birch, red oak, and white oak. Probably the original stand contained a high percentage of chestnut which is gone today. This coppice forest has resulted from continual cordwood cuttings and fire which have depleted the growing stock and the soil. It would probably be best to let these stands remain for a time and try to improve the soil in this way. On this soil it will probably be possible to gradually build up a stand of mixed white pine and hardwoods in a groupwise manner. This will take

some time to accomplish and for the present the only possible product will be cordwood cut for the betterment of the stand. No great investment is warranted as the soil is low in productivity.

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Gould

Bulletin No. 152

A METHOD OF RECLAIMING SEVERELY WEEVILED WHITE PINE PLANTATIONS

By

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and

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(in cooperation with Northeastern Forest Experiment Station)

Harvard Forest Photo.

A nineteen year old white pine plantation severely attacked by the weevil. In the foreground is an intermediate-sized tree which has escaped severe injury, and will produce a straight butt log, if freed from the overtopping, severely weeviled "dominant" in the background. The straight tree has been selected and pruned as a final crop tree while the worthless "scrub" will be eliminated by girdling.

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Foreword

The experience of the last twenty years has shown that the former high value and productiveness of the white pine woodlot were no indication that pure plantations of the same species would be equally profitable. The factors which made the natural crop a success have not been repeated with the artificial or planted forests. Even without the decline in use and marketability which old field pine has recently suffered, the reasons against growing it would still be conclusive. Pure pine stands bring about a deterioration of soil, which is reflected in early falling off of growth. They are highly susceptible to disease and injury. Natural pruning is slow, and even under the best conditions — expertness in planting and sufficient density — no high grade lumber is produced. Most serious of all, such plantations have greatly contributed to the present prevalence of the white pine weevil. In many parts of New England the destructiveness of this insect is now so great that without some corrective treatment the great majority of plantations will have lost what little prospective value they had in the beginning.

As a matter of general forest policy the way out is to turn to natural mixtures, widely available already in the young growth on cut-over lands, to grow white pine sparingly and always with other species, preferably hardwoods, a procedure which has been shown in many cases to be cheaper, always better for the soil, and conducive to a higher grade of timber and comparative freedom from weevil damage. For thousands of acres of existing plantations there is no hope of ultimate return unless a way can be found to improve the quality in at least a portion of the mature stand. The authors of this paper, a forester and an entomologist, have collaborated to find a practicable means by which even a seriously weeviled plantation may be so improved as to promise a fair, and in some cases a considerable, profit.

R. T. FISHER, *Director,*
Harvard Forest.

Introduction

WITHIN the past few years it has become increasingly evident to woodland owners in the Northeast that injury caused by the white pine weevil (*Pissodes strobi* Peck) has in many cases reduced the quality and value of white pine to the point where there is little or no profit in growing it. So serious has the damage become in the past twenty years, particularly in pure plantations, that many owners have been forced to consider their efforts wasted, and have either given up planting altogether, or are favoring other species. Fortunately, it is now known that when white pine is grown in mixtures with hardwoods weevil injury is comparatively slight, and the application of this knowledge will materially reduce damage in future stands, but to date very little consideration has been given to the possibility of improving the hundreds of young pine stands already severely injured and apparently beyond the possibility of improvement. It was with the hope of finding some method of treatment which would stop further degradation and take advantage of whatever ability for future "quality" growth such stands might possess that the authors undertook an analysis of a number of the most severely weeviled pine plantations to be found in Central New England.

THE IMPORTANCE OF THE INSECT AND THE DAMAGE

The white pine weevil is by far the most injurious of all insects attacking white pine. It is native to the region, and in the original forests where pine was found chiefly as scattered individuals or groups among hardwoods and hemlocks, the damage was comparatively slight and often passed unnoticed. But with the widespread abandonment of farms during the latter part of the past century and their subsequent seeding in to white pine, the abundance of weevils and the severity of their attack increased enormously. To make matters still worse, a pine planting boom was started in the early years of the present century, and white pine was planted on additional thousands of acres of open fields and pastures, still further increasing the weevils' food supply.

As shown in numerous publications on the habits and control of the weevil*, the damage is most severe in pure plantations with a spacing of six feet or more. With close spacing, such as three or four feet, the earlier closing in of the crowns prevents extreme branching and forking in spite of severe attacks. Damage has been especially severe in certain sections of Massachusetts, Connecticut, and New York, in the southern portion of Maine, New Hampshire, and Vermont, and in the northern portion of New Jersey and Pennsylvania. In many plantations all of the most vigorous trees have been weeviled, usually several times, so that

*Peirson, H. B., 1923. Control of the White Pine Weevil by Forest Management. Harvard Forest Bulletin 5.
Graham, S. A., 1926. The Biology and Control of the White Pine Weevil, *Pissodes strobi* Peck. Cornell Univ. Agric. Exp. Sta. Bulletin 449.
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they have taken on the appearance of bushes, and are known by such names as "cabbages," "scrubs", etc. So many are the forks caused by repeated attacks that it is often impossible to identify the main stem, if indeed there be any.

Knowing from previous observations that the severity of weevil attack was considerably influenced by the size and vigor, or "crown class" of the individual trees composing a stand, it was considered necessary first of all to establish more definitely this relationship. Sample areas were laid out in a number of severely weeviled plantations and each individual tree was tallied according to its relative size and vigor, and the extent of weevil damage. Four size classes were recognized: * *dominant*, *co-dominant*, *intermediate*, and *overtopped*; and likewise four classes of weevil injury: *severe*, *moderate*, *slight*, and *none*.** The results of this analysis are shown in the following table.

THE RELATION OF WEEVIL DAMAGE TO THE SIZE (OR CROWN CLASS) OF THE TREE

Size Class or Crown Class	Severity of Injury by Number of Trees Per Acre and by Per Cent								
	Severe Injury		Moderate Injury		Slight Injury		No Injury		
	Trees	Percent	Trees	Percent	Trees	Percent	Trees	Percent	
Dominant	281	76.4%	77	20.9%	10	2.7%			
Codominant	201	48.8%	152	36.9%	58	14.1%	1	.2%	100.0%
Intermediate	66	22.0%	107	35.7%	111	37.0%	16	5.3%	100.0%
Overtopped	5	6.1%	7	8.5%	28	34.1%	42	51.3%	100.0%
Totals	553 per acre		343 per acre		207 per acre		59 per acre		

Based on sample areas of from $\frac{1}{10}$ to $\frac{1}{5}$ acre in size located in ten very severely weeviled pure white pine plantations set out on open fields with the usual spacing of 6 to 7 feet. Heights ranged from 14 feet in the youngest plantation to 24 feet in the oldest; ages from 15 to 22 years.

***Dominant Tree.** Tree with crown extending above the general level of the forest canopy and receiving full light from above and partly from the side; larger than the average tree in the stand, and with crown well developed.

Co-dominant Tree. Tree having crown forming the general level of the forest canopy and receiving full light from above but comparatively little from the sides; usually with medium-sized crown more or less crowded on the sides.

Intermediate Tree. Tree with crown below, but still extending into, the general level of the forest canopy, receiving a little direct light from above but none from the sides; usually with small crown considerably crowded on the sides.

Overtopped Tree. Tree with crown entirely below the general forest canopy and receiving no direct light from above or from the sides.

****Severe Injury.** Tree forked or crooked to such an extent that there is no possibility of correcting the damage; usually weeviled three or more times.

Moderate Injury. Tree not forked, but crooked and capable of partially straightening itself in time; usually weeviled from one to three times.

Slight injury. Tree not forked and not more than slightly crooked; capable of straightening entirely in time; usually not weeviled more than once. In addition a fourth class was included for trees which escaped attack.

It will be noted that a very high percentage (76.4 percent) of the largest and most rapidly growing trees, the "dominants", falls under the class of "severe" injury; while only a small part (6.1 percent) of the smallest and most slowly growing trees, the "overtopped", shows similar damage. Unquestionably, the weevil prefers the thriftiest trees in the stand, and thus the very trees which in the normal course of events would form the final crop are just the ones which are the most forked and crooked, and hence the least valuable. It is important to note, however, that between the "dominants" and the "overtopped", both in point of crown size and the severity of weevil damage, there is a large number of "co-dominants" and "intermediates" which have been only "moderately" or "slightly" injured. For the plantations studied the sum total of all trees which escaped "severe" injury, and which would produce straight or nearly straight butt logs, *if given freedom to grow to maturity*, is 609 per acre. Not all of these better trees, of course, are suitable as final crop trees. None of the "overtopped" should be included, as they are too small and weak-crowned; and further deductions should be made for undersized "intermediates" and very coarse-limbed "dominants". Furthermore, proper spacing of the crop trees necessitates the elimination of some well-formed trees which are too close to others equally suitable for the crop. But, after making every possible allowance for size, condition and spacing, there will remain at least 200 to 300 trees per acre of acceptable form and quality to use for the final crop.* This number is all that is needed to form a fully stocked stand at 50 to 60 years of age; but it should be understood that, unless freed from the trees overtopping them, only a few of these better trees would ever attain a dominant place in the final stand. For the most part they would be dead, half-rotted poles by the time the stand was ready for cutting.

METHOD OF TREATMENT

The nature of the corrective treatment has already been indicated. It necessarily involves seeking out the least injured trees with due regard for size and spacing, and favoring or freeing them for use as final crop trees. As shown in the table, the most desirable trees (those which have escaped "severe" injury) will be found largely in the "co-dominant" and "intermediate" sizes. Freeing trees selected for the final crop requires the elimination of overtopping trees, chiefly scrubby, severely injured "dominants", which are not only worthless in themselves, but are preventing better trees from getting ahead. Thus, this part of the treatment completely upsets the usual course of development of a stand in that it takes leadership away from dominant trees, which normally would form the final crop, and turns it over to subordinate trees, which ordinarily would be suppressed or killed before the crop reached maturity. If, as a further step, the selected trees are pruned, wood free from knots will be produced and a final yield per acre of 200 to 300 choice butt logs will be assured.

*Actually the authors were unable to find any plantation which did not have at least 400 trees per acre suitable for crop trees, except where the spacing was greater than 6 to 7 feet.

Since nearly one-half of the entire volume of a tree grown on the ordinary rotation of 50 to 55 years is contained in the first 14 to 16 feet of bole, pruning the butt log can be shown to be very profitable. The upper logs will be of the usual "box lumber" grade, and cannot be expected to return better than the going price for rough lumber.

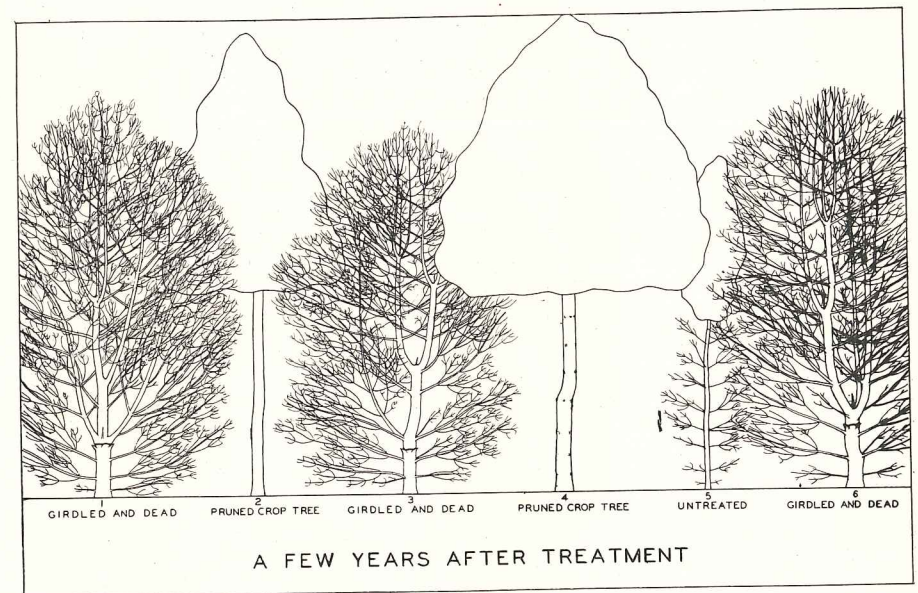
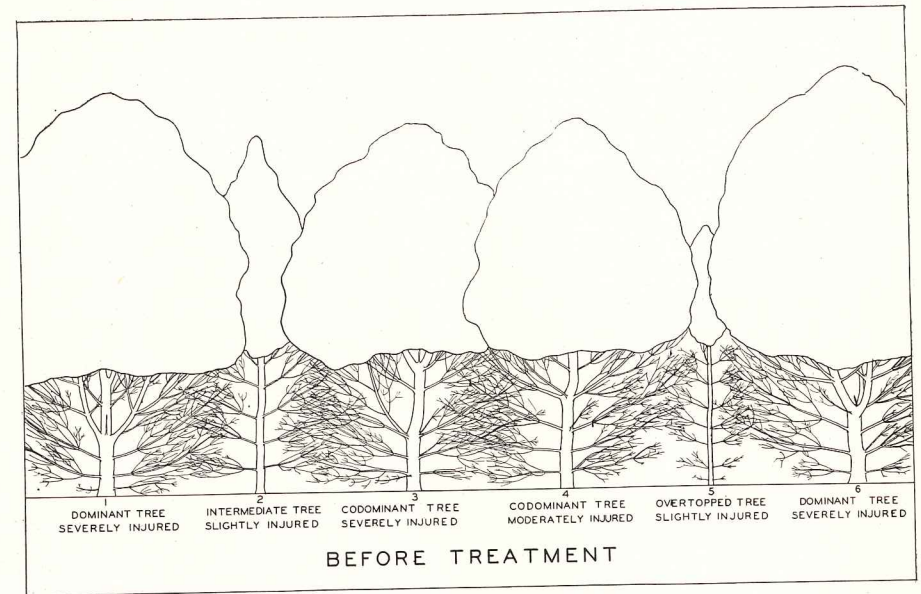
TREATMENT OF PLANTATIONS NOT PAST PROFITABLE PRUNING SIZE.

Plantations One Log High (12 to 16 feet)

Treatment of severely weeviled plantations should not commence until the trees have reached one log in height, for until then it is impossible to be certain what the shape of the full length butt log will be. Trees one log high range in age from 12 to 18 years, and in diameter from 2 to 5 inches. Branch sizes vary from $\frac{1}{4}$ inch in the lowest whorls to $1\frac{1}{2}$ inches for an occasional large branch in the higher whorls, the average being about $\frac{3}{4}$ inch. Dead length, the length of that portion of the bole bearing dead branches, will vary from none to 4 or 5 feet.

The first step in the treatment is to select the trees best suited for forming the final crop. As previously stated, the least injured trees of good size and vigor are chiefly in the "co-dominant" and "intermediate" size classes. A desirable spacing of the final crop trees is about 15 feet, equivalent to approximately 200 trees per acre, but, due to the irregular distribution of suitable trees, spacing will actually vary from about 8 to 20 feet, and the number of trees finally selected from 200 to 400 per acre. As the trees are selected their lower branches are pruned. By following the common practice of pruning not to exceed one-half the total height of the tree at any time*, the height of the first pruning will vary from 6 to 8 feet.

After the best trees have been selected and pruned they are freed from any overtopping, severely weeviled "dominants". This can be accomplished easily and cheaply by girdling. Girdling results in the death of the tree within two years, and nothing remains finally but a dead stub which can be cut down or pushed over if one wishes to go to the trouble. Girdling the overtopping trees frees the crowns of the trees saved for the crop and reduces root competition. With the competition thus reduced, the selected crop trees respond almost immediately; diameter growth is greatly accelerated, and thick layers of clear wood are annually laid down on the pruned butt. Felling is undesirable as it leaves large openings in the stand and a great amount of debris on the ground. Removing the down trees from the area would be too expensive. In test plots established by the authors the number of trees girdled in the first treatment ranged from 100 to 220 per acre.



*Cline, A. C., and Fletcher, E. D., 1928. Pruning for Profit as Applied to Eastern White Pine. Joint Publication by the Harvard Forest and Massachusetts Forestry Association.

The permanent freeing of the crop trees and the pruning of full length butt logs (12 to 16 feet) are accomplished in two more pruning and girdling treatments spaced at intervals of about three years. The upper portions of the butt logs are finally cleared of branches, and any weeviled "scrubs" which have gained dominant positions since the previous treatment are girdled. All told, not more than 450 trees per acre will need to be girdled. The remaining living stand will then be made up of pruned crop trees, and untreated trees subordinate in height to the pruned crop trees. The latter are too small to prune and too slow growing to interfere with the pruned trees.

No further treatment will be needed until the stand has closed in sufficiently to require a thinning. As the girdling accomplishes the purpose of an early thinning, it is expected that not more than one other thinning, at about 40 years of age, will be required. Rapid growth in the pruned butt logs is, of course, highly desirable, and there may be cases where two or more thinnings will be more profitable than one. However, it is not considered advisable or safe to follow the plan, sometimes recommended in connection with pruning, of eliminating as soon as possible all except the selected crop trees. While this would probably result in producing a butt log of maximum size, the remainder of the tree would be a great, coarse top with numerous forks and heavy branches. The entire upper portion of the tree would be practically worthless for anything but fuelwood or pulp. Furthermore, working up such coarse tops and disposing of the debris would add considerably to logging and slash disposal costs in the final cutting.

Plantations from One to One and One-Half Logs High (16 to 24 Feet)

At the present time there are many older plantations which are from one to one and one-half logs high, but still within the range of profitable pruning, provided the spacing is not greater than 6 feet. With wider spacing the trees are generally too large in diameter and too coarse-limbed to prune. Ages will range from 15 to 24 years, diameters from 3 to 7 inches, limb size from $\frac{1}{4}$ to 2 inches, with an average 1 inch, and dead length from 4 to 10 feet.

As in the case of stands not past one log high, the first step is the selection of a sufficient number of well formed and properly spaced trees to form the final crop. Pruning to one-half the total height will give a pruned height of about 8 to 12 feet for the first treatment.

Similarly, the second step is the girdling of any severely injured "dominants" which are overtopping the selected crop trees.

In stands which approach the upper limit of one and one-half logs high (22-24 feet), only one more pruning treatment three or four years after the first will be required to complete the clearing of the butt log; but in those nearer one log in height two more treatments generally will be needed.

In the later pruning treatments, as in the first, pruning and girdling are carried on simultaneously, with the aim of finally clearing the butt logs of the selected crop trees, and freeing them for rapid growth.

TREATMENT OF PLANTATIONS PAST PROFITABLE PRUNING SIZE

Plantations in which the best formed trees have passed a diameter of 5 to 6 inches are too far advanced for profitable pruning, but a great improvement may be made by selecting the straightest trees, as in the younger plantations, and freeing them by girdling the overtopping, severely weeviled "dominants". Where the trees to be eliminated are merchantable, girdling will be replaced by cutting; but in the majority of cases coarse-limbed, weeviled "scrubs" are without a market. In many of the older white pine plantations the proper application of girdling will accomplish the purposes of both an improvement cutting and a thinning with a resultant improvement in quality and growth rate which will offset many times over the cost of such a treatment.

EFFECT OF THE TREATMENT ON THE HAZARDS OF FIRE, INSECTS, AND FUNGI

Fire. Any fire hot enough to burn a plantation in which the crowns have closed in would necessarily be a crown fire which would destroy living as well as dead trees, and it is believed that the presence of dead girdled trees and pruned branches on the ground would make little difference. As a precaution, however, it would be advisable either to clean up dead limbs around the margins of the stands where fires would be most likely to gain entrance, or leave an untreated "green" strip around the edge, but otherwise no extra expense for fire protection seems warranted. As a general protective measure applicable to all young coniferous stands, it is sometimes recommended that the lower branches of border trees be pruned to prevent fires from jumping into the crowns. This eliminates dry branches close to the ground and reduces the chances of grass fires being able to ignite the trees.

Insects. It can be expected that girdled trees and freshly cut limbs will be subject to infestation by various slash inhabiting insects such as bark beetles and round-headed and flat-headed borers, but it is extremely doubtful if the trees being favored for the final crop will be injured in any way, as these insects are essentially secondary in nature and attack only dying trees or slash. In some cases where stands are open-grown, or poorly stocked, the common eastern pine bark beetle (*Pityogenes hopkinsi* Sw.) has been observed to attack trees which have been pruned. In all these cases, however, the beetles were drowned by the flow of pitch before eggs could be laid or hatched, and no damage whatever resulted.

Fungi. The probability of the red-rot fungus (*Trametes pini*) entering a tree at the point where the limb is sawed off is still unsettled.

However, authorities agree that the exudation of pitch which results from pruning a green branch on a young tree seals the cut and prevents the entrance of fungi. Furthermore, at least one author* has found in the case of dead branches that "When the branch dies, the free exudation of pitch causes that part which lies adjacent to the cambium, as well as that inside the tree, to become hardened and impenetrable . . ." It was found that the fungus was not able to penetrate this resinous wood in the base of the dead branch. Examination of numerous saw-cuts made in pruning shows that in the case of large green limbs, upwards of 2 inches in diameter, the heartwood (of the limb) is not completely sealed over with pitch exuding from the surrounding sapwood. Thus, it may be concluded that since the red-rot fungus enters only through the heartwood, the only danger is in the case of pruning large, green limbs. But this should cause no alarm, as there are good reasons for not attempting to practice pruning on trees with large branches. As already pointed out, pruning is not a profitable undertaking when applied to trees with large boles and branches. Pruning young plantations is not likely to lead to any serious trouble from red rot, especially where the plantations are not close to old pine stands infected with the rot.

TECHNIQUE AND TOOLS

A severely weeviled plantation is admittedly somewhat difficult to work in, but once an opening is made and a few trees are pruned, the difficulties of moving from one tree to the next and doing the necessary work are greatly reduced. Pruning is carried on in the same way and with the same tools as when applied to unweeviled stands.** The use of a saw or double-action clippers instead of an axe should be emphasized in all cases. Axe work always results in unnecessarily large scars and defects. For the higher branches a ladder and hand saw are considered preferable to a pole saw.

In the test plots established by the authors both the axe and chain saw were used in girdling. The kind of girdling with an axe known as frilling, which consists in making a single row of deep, connected cuts around the stem, seems preferable to other methods of girdling such as notching or peeling. The girdle may be made at any convenient height above ground, and care should be taken to cut well into the sapwood, so as to prevent any bridging over. The chain-saw promises to be an excellent girdling tool, but to date insufficient time has elapsed since the tool was first tried out on pine to warrant a positive statement of its effectiveness. It is almost certain, however, to prove successful.

The girdled tree dies gradually and breaks up bit by bit, and no damage is caused to the neighboring trees by the remaining stub. Except

*Abbott, F. H. The Red Rot of Conifers. Vermont Agricultural Experiment Station Bulletin 191, p. 9.

**Cline, A. C., and Fletcher, E. D., 1928. Pruning for Profit As Applied to Eastern White Pine. P. 17. Joint Publication by the Harvard Forest and Massachusetts Forestry Association.

where aesthetic considerations are paramount there will be no expense for slash disposal. Pruned branches and dead trees will gradually disappear through the activity of natural agencies.

COSTS AND RETURNS

While the complete treatment has been tried out only on a small scale, the cost of pruning at least is well known from past experience in pruning pine under other conditions. Under average conditions one may figure on pruning about 275 crop trees per acre, to an average height of 14 feet and at a rate of about 150 linear feet per man-hour* With labor at 40c to 50c per hour the total cost for pruning alone would range from \$10.00 to \$13.00 per acre. The remaining labor charge is for girdling and this will vary considerably with the age and condition of the stand and the kind of tool used. On sample areas treated by the authors it was found that an average of 40 trees could be girdled per man-hour with the chain saw, but not more than 25 to 30 with the axe. Assuming a total of 400 trees to be girdled, the cost will vary from approximately \$4.00 to \$8.00 per acre.

There can be little doubt of the profitableness of improving severely weeviled plantations, if the pruning and girdling treatments are carried out efficiently. By delaying treatment until the plantation is one log high and limiting the pruning to the least injured trees, straight, clear butt logs are sure to result, regardless of how much damage the weevils do to that portion of the tree above the pruned butt. The expenditure of approximately \$18.00 per acre will convert a plantation dominated by weeviled "scrubs" of little or no prospective value into one composed of only the straightest and best shaped trees, pruned to produce high grade lumber and freed to form the final crop.

At the end of a 50-55 year rotation the pruned butt logs alone may be counted upon to yield from 10,000 to 15,000 board feet of clear lumber. Even though clear lumber should then be worth no more than \$50 per thousand, the deduction of logging, milling and delivery costs would still leave a net value on the stump of well over \$30 per thousand, equivalent to from \$300 to \$450 per acre. And in addition the knotty cores of the butt logs, and the upper logs together will yield at least 20,000 to 25,000 board feet of lower grade "box" lumber which may be given a stumpage value of approximately \$5 per thousand, equivalent to from \$100 to \$125 per acre.

*In actual tests under conditions herein described, a higher rate was maintained.

Gould

FOREST WEEDING

WITH SPECIAL REFERENCE TO
YOUNG NATURAL STANDS IN CENTRAL
NEW ENGLAND

By A. C. CLINE



Harvard Forest Photograph

Figure 1. Weeding in Practice on Cut-over Land.

Fast-growing red maple stump sprouts, worthless except for cordwood, cut back in favor of single-stemmed saplings of valuable sawtimber trees. White ash and red oak marked with an X.



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Sould

IMPROVEMENT CUTTING and THINNING

AS APPLIED TO CENTRAL NEW ENGLAND HARDWOODS

By A. C. CLINE



Harvard Forest Photo

Fig. 1. A 27-year-old stand of mixed hardwoods growing on cut-over "old field" white pine land. This stand has received four silvicultural treatments since the time of its origin, 1908. The first thinning was made in 1933. Through the elimination of the weeds and the reduction of competition the very best individuals in the stand, the crop trees (CT), have been favored from the start, and they are rapidly developing into excellent sawtimber trees. They are now from 4 to 7 inches in diameter, nearly 50 feet in height, and cleared of all branches for upwards of 20 feet.

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Characteristics of Black, Scarlet, and Red Oak

Nine of the better known books on the subject of tree identification (Petersham, Massachusetts characteristics of the oaks under consideration) by data from one book was tabulated and checked against Ernest M. Gould, Jr.'s and the others, when a controversy or discrepancy appeared the rule of the Introduction used. The facts have been organized for use in the problem of quickly identifying red, black, and scarlet oak in the field has been troublesome for some time. The striking similarity of these members of the "black oak group" makes it difficult to separate one from the other without a close examination of the minute differences in the structure of their various parts. As the ideal towards which identificational studies should tend is the ability to recognize a tree at a distance* this purpose this paper has been prepared in an attempt to find some means of separating these species by their more gross characteristics which can be observed from the ground. There are several ways of distinguishing tree species in nature; by the use of so called "tree manuals" and tree keys, by comparisons with herbarium specimens, or through the knowledge of certain characteristic features. The bases of distinction used in this work are of the last type; habitat, bark, twigs, fruit, buds, and leaves. All of these things cannot be observed from a distance but two or more can always be obtained and used to form an opinion about the tree in question.

Bark - broken into flat-topped, rough, irregu-

leaves bar blocks; rough farthest towards the top.

* Blakeslee and Jarvis: Trees in Winter, page 12.

Nine of the better known books on the subject of tree identification were used to find the characteristics of the oaks under consideration. The data from one book was tabulated and checked against the statements of the others, when a controversy or discrepancy appeared the rule of the majority was used. The facts have been organized for use in the winter, spring, summer, and fall as the availability of the different parts of the tree varies with the seasons. There are certain things such as habitat and bark that can be used the year round and these have been listed separately. These last mentioned points can be used more easily while the seasonal bases can be used as checks.

A short field strip was made to discover the correlation between the "book facts" and the local species, but unfortunately it was impossible to observe all of the seasonal characteristics.

Table I presents the more gross points of difference between red, black, and scarlet oak, similarities having been omitted. The more reliable and more obvious characteristics are underlined and can be used most easily, but oak should be checked with at least one of the other points of difference.

Important differences. pointed; smooth except for occasional

Black Oak: apical hairs.

From both red and scarlet oak

Bark - broken into flat-topped, rough, irregular

Leaves lar blocks; rough farthest towards the

top.

Black Oak
(*Quercus velutina*)

Dry gravelly plains and ridges, poor soils

Bark gray to black

Thick ridges formed by deep furrows and cross flutings. Lenticular, black-like striate. Inner bark yellow-orange and bitter.

From black oak

Twigs - glabrous.

Leaves - glabrous.

Scarlet Oak
(*Quercus coccinea*)
GENERAL

Dry sandy soils

Light to dark brown

Shallow furrows forming irregular ridges. Intermediate between black and red oak in roughness. Inner bark reddish, not bitter.

Red Oak

From black and scarlet oak

Bark - shallow, flat-topped, regular, ridges; smoother than black or scarlet oak.

Inner bark - cream to light pink, not bitter.

Fruit - cup saucer-shaped.

Buds - pointed; smooth except for occasional apical hairs.

Red Oak
(*Quercus borealis*)

Widely distributed on many soil types

Dark brown

Shallow furrows; regular, elongated ridges. Roughened lower trunk. Ridges are flat topped, firm and coarse. Inner bark cream to light pink, not bitter.

Scarlet Oak:

From both red and black oak

Bark - Less rough than black and rougher than red.

Inner bark - reddish, not bitter.

Leaves - very deeply cut sinuses, glabrous.

Fruit - cup-shaped cup, unfringed rim.

Buds - pale wooly on upper half only, rounded apex.

From black oak

Twigs - glabrous.

Black Oak
(*Quercus velutina*)

Scarlet Oak
(*Quercus coccinea*)
GENERAL

Red Oak
(*Quercus borealis*)

	Black Oak	Scarlet Oak	Red Oak
Habitat	Dry gravelly plains and ridges, poor soils	Dry sandy soils	Widely distributed on many soil types
Bark	Dark gray to black Thick ridges formed by deep furrows and cross fissures. <u>Irregular block-like strips.</u> Inner bark: <u>yellow-orange</u> and <u>bitter</u>	Light to Dark brown <u>Shallow furrows forming irregular ridges.</u> Intermediate between black and red oak in roughness. Inner bark: <u>reddish, not bitter</u>	Dark brown <u>Shallow furrows; regular, elongated ridges.</u> Roughened on lower trunk. <u>Ridges are flat topped, firm and coarse.</u> Inner bark: <u>cream to light pink, not bitter.</u>
WINTER			
Fruit	Oval $\frac{1}{2}$ " to 1" long <u>Cup covers $\frac{1}{3}$ to $\frac{1}{2}$ nut</u> <u>Cup-shaped cup with rim fringed.</u>	Oval $\frac{1}{2}$ " to 1" long <u>Cup covers $\frac{1}{3}$ to $\frac{1}{2}$ nut</u> <u>Top-shaped cup, rim scales appressed.</u>	Ovate, broad at base, $\frac{3}{4}$ " to $1\frac{1}{4}$ " long <u>Cup covers $\frac{1}{5}$ to $\frac{1}{4}$ of nut</u> <u>Saucer-shaped cup, flat, shallow</u>
Buds	<u>Sharp pointed, five-sided, densely covered with dirty gray tomentum.</u>	<u>Rounded apex, upper $\frac{1}{2}$ pale wooly.</u>	<u>Sharp pointed, rusty hairs at apex only.</u>
SPRING			
Leaves	May persist until spring Turn brown, dull red, or yellow and brown late in the fall.	absent Turn bright scarlet.	absent Turn rich red, sometimes brown.
Fruit	see Immature, slightly wooly, main scales appear like single row	general Immature, smooth, shiny, main scales appear like two rows	above Immature, main scales appear like three rows.
Buds	see	winter	above
Leaves	Bright crimson, spring tint reddish and silvery white turns to silvery greenish white	Bright red, spring tint bright pink and silvery white.	Pink, spring tint pink and white

Black Oak

Scarlet Oak

Red Oak

SUMMER

Fruit	see	fruit spring	above
Buds	Forming-green	Forming - green	Forming - green
Leaves	Seven lobed Type a. Sinuses shallow, lobes broad, rounded mucronate. b. Sinuses deep, $\frac{1}{2}$ way to midrib or more lobes oblong or tri- angular. <u>Lower surface scurfy</u>	Five to nine lobed. <u>Sinuses very deeply and widely</u> <u>cut, $\frac{2}{3}$ of way to mid rib or more</u> Middle lobes largest. Smooth	Seven to eleven lobed. Sinuses cut $\frac{1}{2}$ way to midrib. Lobes taper gradually from broad bases, <u>usually glabrous.</u> Lobes second from apex largest.
		FALL	
Fruit	see	spring	above
Buds	see	winter	above
Leaves	see	summer	above
	Turn brown, dull red, or yellow and brown late in the fall.	Turn brilliant scarlet.	Trunk rich red sometimes brown.

TABLE I SHOWING THE GROSS DIFFERENCES BETWEEN RED, BLACK, AND SCARLET OAK

Conclusions. Nichols - Woody Plants in Summer

There are many points of difference between black, red, and scarlet oak that may be observed and used in the field for identification purposes. With practice it should be possible to tell these oaks apart from inspection of the bark, checked against the ~~dark~~ inner bark colors. If some of the other parts such as leaves, buds, acorns, and twigs are easily available they might be more quickly used as checks. The great variety of similar leaf shapes and the fine lines of distinction between those of different species eliminate this part as a reliable single test, but it may be used in conjunction with others. It is often impossible to obtain leaves, twigs, acorns, or buds due to the season or their location on the tree and in this case the appearance of the outer bark and the color of the inner bark are the tests that can be used.

As yet no single characteristic or group of characteristics have been found which will make it possible to positively identify these three oaks without getting within reach of the tree.

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G. E. Nichols - Woody Plants in Summer

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