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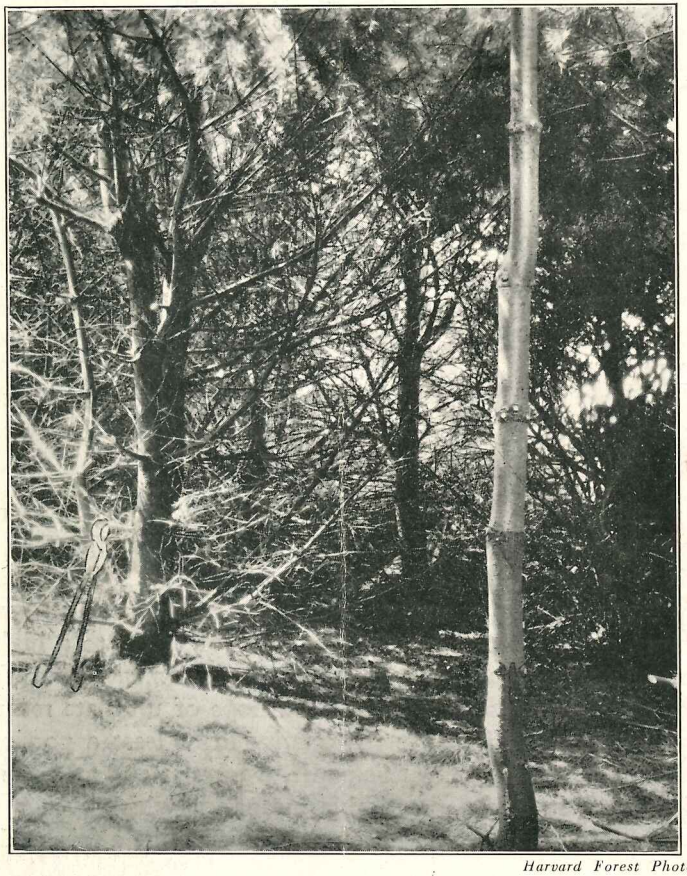
A METHOD OF RECLAIMING SEVERELY WEEVILED WHITE PINE PLANTATIONS

By
A. C. CLINE, Assistant Director, Harvard Forest
and
H. J. MACALONEY, Assistant Entomologist, U. S. Bureau of Entomology
(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.
MacAloney, H. J., 1930. The White Pine Weevil (**Pissodes strobi** Peck) — Its Biology and Control. N. Y. College of Forestry, Technical Publication 28.

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 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%			100.0%
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 1/10 to 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 ¼ inch in the lowest whorls to 1½ inches for an occasional large branch in the higher whorls, the average being about ¾ 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.

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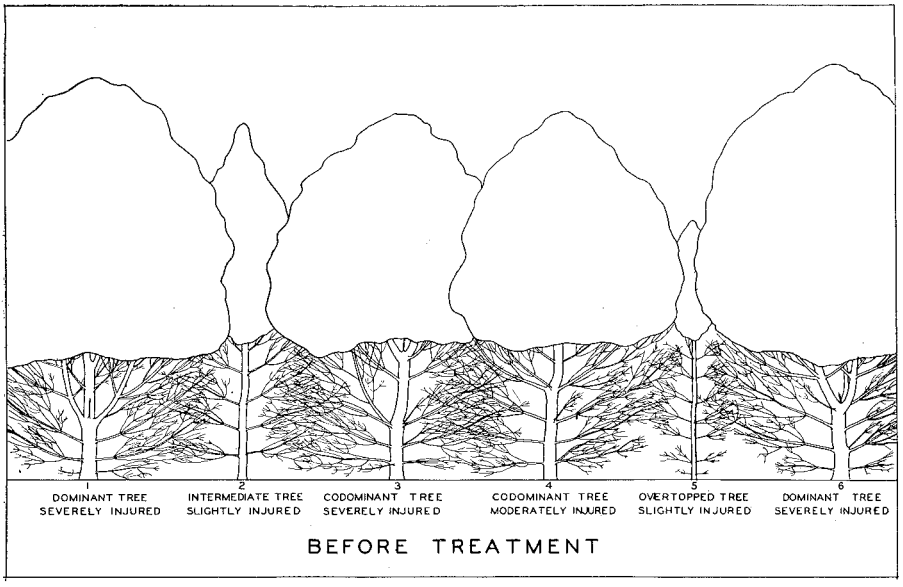
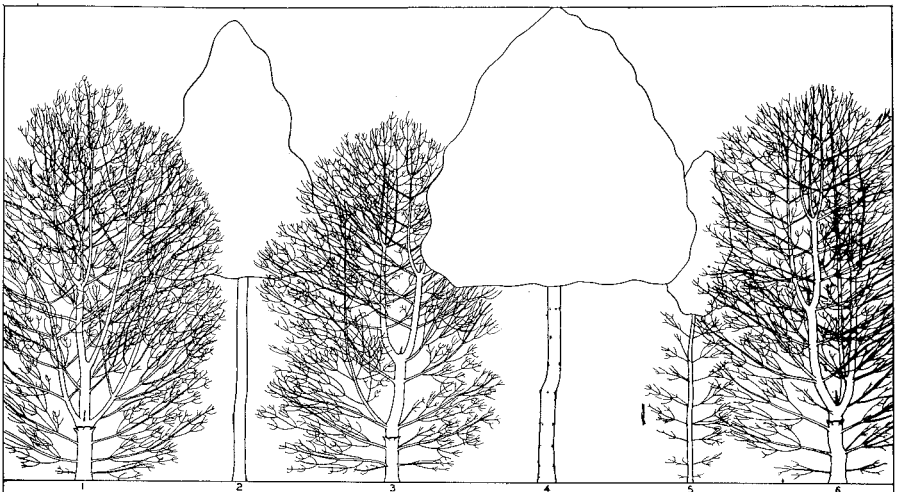
*Cline, A. C., and Fletcher, E. D., 1928. Pruning for Profit as Applied to Eastern White Pine. Joint Publication by the Harvard Forest and Massachusetts Forestry Association.



BEFORE TREATMENT



A FEW YEARS AFTER TREATMENT

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 remainer 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 ¼ 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 along 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 $400 per acre. And in addition the knotting 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.

As a part of its Research and Educational Program, the Massachusetts Forestry Association publishes the subject matter of this bulletin, in the belief that if properly applied it will be the means of large savings to owners of white pine plantations. Hundreds of these plantations ranging from 15 to 25 years in age and representing investments including cost of trees, planting, maintenance, interest and taxes of $50.00 to $100.00 per acre, have been severely damaged by the white pine weevil.

When these plantations were made no one could foresee the conditions that now exist. But, emergencies arise with nearly every form of investment that must be coped with in order to avoid loss and reforestation is not an exception. The owners of these weevil-damaged plantations are now in a position where some action must be taken in order to protect their investments, and the recommendations contained herein are simply in line with good forest management.

The authors show that an expenditure approximating $18.00 per acre on these plantations now, should result in a stumpage yield of at least 15 times that amount when the crop is harvested 25 to 40 years hence. Ten to thirteen dollars of this estimated cost is in pruning which would have to be done under any condition if any high quality lumber is to be obtained in a 50 year rotation. Pruning is now recognized as a profitable operation. The remaining cost of $5.00 to $8.00 per acre is is for the girdling which on the average would be from 5 to 10 per cent of the present investment.

It would seem that such an outlay now would be a cheap form of insurance against the possibility of total loss of the present investment. Furthermore this expenditure now will probably be more than off-set in reduction of cost of the first thinning.

HARRIS A. REYNOLDS, *Secretary.*

4 Joy Street, Boston.

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