THE MANAGEMENT OF SECOND GROWTH WHITE PINE IN CENTRAL NEW ENGLAND

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ORIGIN OF EXISTING STANDS

The so-called pine woodlots, which make up about four-fifths of the timber cut in central New England, are usually even-aged, and contain from 50 to 100 per cent white pine. Almost without exception these stands have originated on vacant land, abandoned pasture, or mowings, sites which, prior to the settlement of the region, bore forests either of hardwood alone or mixed hardwood and softwood. Except for occasional sand plains and thin-soiled summits, the areas which now bear mainly white pine are usually natural hardwood sites. The result of this is seen in the tendency of cut-over lands, so often remarked, to revert to hardwood. At the time of cutting, which is commonly at an age varying from 50 to 70 years, over 90 per cent of the second growth pine lands contain an abundant advance growth of hardwoods and, in the case of the stands of deficient density and on the moister soils, sometimes heavy thickets of underbrush or woody ground cover. Pure pine in the woodlot region is a transition type.

SCOPE AND BASIS OF THE STUDY

The following is a summary of conclusions from an extended study of the management of the white-pine type. It applies to a region including roughly central Massachusetts and southern New Hampshire, an area from which the annual cut of pine lumber for the last 10 years has averaged not far from 200 million board feet. The material here presented is in process of preparation for a paper on general forest management for the locality in question, but the present need of definite results bearing on methods of reproduction seems to justify a brief account both of the actual woods practice which has proved successful, and the investigation which has accompanied it.

The study was intended to correlate the results of experimental cuttings on the Harvard Forest with conditions following the ordinary logging operations in the surrounding region. The Harvard cuttings

have now extended over a period of 10 years, from 1908 to 1919, and have involved the marketing of approximately 2½ million feet of lumber. For purposes of test these cuttings have been made according to the following silvicultural systems: the shelterwood method, the selection method, the seed-tree method, clear-cutting by small groups, by strips, and by lots or areas of several acres. By systematic study on the ground, taken in connection with the annual records of the forest, a thorough recapitulation of comparative silvicultural results was brought together. In respect to other cut-over lands a direct examination was made of the reproduction following 54 separate logging operations. These represented upwards of 4,000 acres scattered through northern Worcester and Hampshire Counties, Massachusetts, and Cheshire County, New Hampshire. The dates of these cuttings fall between 1905 and 1908 inclusive. Each date was definitely ascertained so that results could be correlated with records of seed years, rainfall, etc.

OBSERVATIONS ON CUT-OVER LANDS

Of the 54 separate areas examined only 14 showed satisfactory reproduction of pine. This was taken to mean 500 thrifty seedlings or more per acre. All of these 14 lots were cut in seed years, that is, in the autumn or winter following the fall of seed. Two lots cut in seed years showed no reproduction, the failure being due to the fact that the previous stands were unusually dense and below the seed-bearing age. Of the remaining 40 woodlots cut over in non-seed years, only 10 showed any pine reproduction at all, and of these 10 only one anything like a sufficient seeding. These partially satisfactory results were always explainable on account of accidentally favorable conditions, such as the proximity of seed trees and the smallness of the area cut. The examination showed that general site factors such as slope and aspect had little or no effect, but that the condition of the seed-bed was apparently of first importance. Heavy ground cover and leaf-litter was unfavorable; thin leaf-litter and humus with mineral soil mixed with it or exposed made the best seed-bed. If seedlings failed to start within from 2 to 5 years after the cutting, the development of other vegetation kept them out entirely. Incidentally the study showed that under dense stands no reproduction survives, but that under open or mixed stands advance growth of white pine may survive for years. There was no evidence of reproduction from seed stored in the leaf-

litter more than one year. Outstanding facts were that on all but the lightest of the local soils, the hardwoods are gaining, and that the composition of the present forest types has been controlled in the main by the previous treatment of the land.

Taking the total area of the woodlots examined, about 15 to 20 per cent showed good pine reproduction; on another 20 per cent pine seedings were scattering. On the other hand from 60 to 70 per cent of lots cut both in seed years and non-seed years, was satisfactorily stocked with valuable hardwoods such as red oak, white ash, hard maple, etc. These figures apply only to the first 10 years after cutting. However successful the reproduction may be at the start, within 10 years from 10 to 80 per cent of the desirable elements, both pine and hardwood, was overtopped and suppressed by inferior species and clumps of stump sprouts.

RESULTS OF CUTTINGS ON THE HARVARD FOREST

In respect to the various ways of handling the pure pine type which have been tested on the Harvard Forest it can be said that all of those methods which involve the removing of the stand in two or more cuts have proved successful. On account of certain practical and financial factors good reproduction, however, is not the only criterion of a workable method. This will perhaps appear more clearly from a statement of experience with the different systems of cutting.

Clear-Cutting the Whole Stand.—This method has been tried on areas of from two to four acres. Cuts were made in the winters following the seed years of 1908 and 1914. All slash was burned in piles. A reproduction followed in which there were from three to four thousand thrifty pine seedlings per acre at the end of four years. This method is obviously the best from the point of view of cheapness in logging, but can be practiced with success only in seed years.

Clear-Cutting in Strips.—Strip cuttings have been made in several different years. The cleared areas varied from 100 to 200 feet in width and in all cases were made on the margin of the stand away from the prevailing wind. The results have been variable. On well-drained sites, where the underbrush and small vegetation was scanty, good reproduction has appeared within five years. On moist or rich land pine has been entirely kept out by dense herbaceous growth.

Clear-Cutting in Patches.—The patches cleared by this method varied from 50 to 100 feet in diameter. The results have been similar

to those on the cleared strips, although the reproduction has been, on the whole, more successful. Abundant seedlings have come in on the drier sites where the competition with woody vegetation was not too keen. This method, like the preceding, is open to the serious objection of greater cost due to the smaller, scattered areas. Furthermore, even if the groups of young growth become established, it is difficult later to log the surrounding uncut timber without undue damage or expense.

The Selection Method.—Small areas cut over by the selection method where only single large trees or groups of trees were cut, have resulted in fair reproduction. It is not, however, a practicable means of handling pure pine, being too costly and not calculated to provide the necessary density and growing conditions for the new crop.

The Seed Tree Method.—All experiments with the seed tree method have proved failures. In many cases the trees blew down. Even when windfirm trees could be selected, woody and herbaceous growth covered the ground before sufficient pine seedlings got started.

The Shelterwood Method.—Of all methods tested this has resulted in the best reproduction. The first cutting has consisted in a uniform thinning in which mainly the overtopped and defective trees were taken. This meant the removal of about one-quarter of the trees and one-fifth of the volume per acre. Up to the point where windfall becomes a risk the heavier the thinning the better was the reproduction. Stands so treated have in five years shown as many as 25,000 seedlings per acre. Where the overwood was allowed to stand more than five years the reproduction became stunted and too weak to recover promptly when the removal cutting was made.

MANAGEMENT NOW IN PRACTICE

The cutting method now in practice on the Harvard Forest, though based largely on the outcome of the experiments above described, was adopted with considerable reference also to practical and financial considerations. The rotation for white pine is set at 60 years. As the working plan is based upon the principle of a sustained annual yield, final cuttings have to be made each year. In this respect the property is in the same case as that of a wood-working concern which requires a steady annual supply. Since seed years for white pine occur not oftener than once in three years, this means that any cutting method

based on the periodic fall of seed must make provision for securing reproduction after the operations of the off years. The established logging and milling methods almost necessitate the clear-cutting of a considerable area in one place, a minimum of not less than 5 to 10 acres. Bearing on the composition of a desirable forest crop is the fact that the present pine woodlots are transition types and as such are difficult to maintain. Furthermore, the market for the better hardwoods has greatly improved, and bids fair to improve still more in the near future. In view of these considerations, it has become the silvicultural policy on the Harvard Forest to replace the pure pine type with mixed stands containing, in addition to pine, the best of the local hardwoods, an abundance of which is almost always present on the ground.

The method of cutting is a combination of preliminary thinning with clear-cutting. Each year an area large enough to yield the bulk of the annual cut is cleared, and ordinarily thinnings are made on adjacent areas in amounts sufficient to yield the balance of the total cut. The object of the thinnings is primarily to stimulate reproduction of pine so that it will be available when and where cuttings are made in non-seed years. In years when there is a heavy fall of seed a clear-cutting made without preliminary thinning, especially if the operation is carried out on bare ground, results in successful reproduction. Thus there is no rigid relation between the clear-cuttings and the thinnings, either in area or time. In some years, for convenience in logging, the thinnings may be omitted; in other years, where the location is favorable, an extra large area may be thinned. Each year, however, the bulk of the operation is a clear-cutting which keeps the cost of the job within reasonable limits.

Before the final clear-cutting is begun all the advance growth, hardwood and underbrush, both small and large, is cut close to the ground. Usually this can be done with a bush-scythe and at a rate of an acre or an acre-and-a-half per man per day. The purpose of this is to eliminate misshapen and overdeveloped reproduction and to insure the uniform starting of straight, vigorous, seedling sprouts. Cost records show that the work is much more than paid for by a saving in the cutting and hauling of logs due to the much greater ease of handling and loading. When the logging starts the slash is burned in piles, much of it in broken time while the job is in progress. The cost of slash burning has varied from fifteen to fifty cents per thousand,

depending mainly on the crown form and density of the stand. But here again the burning can often be handled so as to cheapen other parts of the job. In any case, it does not bear any very serious relation to the net return on the timber, and, for a permanent land owner, is properly chargeable to fire protection. When the operation is over the land is thus entirely clear, with a prospective crop consisting of from 5,000 to 20,000 pine seedlings per acre in addition to the hardwood adance growth about to start. The following table gives a summary by species of the reproduction secured on a typical acre which has been cut over in this manner.

Summary of reproduction, October, 1917. Thinnings made 1911-1912—Removal cutting 1915-1916.

[Number per acre.]

Species	2 years old	3 years old	Over 3 years	Total
White pine	410	2,870	70	3,350
	Seedlings	Seedling sp'ts	Stump sp'ts	Total
White ash	390	1,990	20	2,400
Red oak	20	540	10	570
Chestnut	10	510	40	560
Black cherry	360	890	...	1,250
Red maple	9,000	1,000	40	10,040
Hard maple	.....	10	10	20
Basswood	10	40	10	60
Beech	.....	.....	10	10
Black and paper birch	.....	200	...	200
Gray birch	130	.....	...	130
Total	9,920	5,180	140	15,240

DAMAGE FROM SNOUT BEETLES AND WEEVILS

It is a further recommendation of this combination of thinning with clear-cutting that it tends to offset the inevitable losses due to the snout beetle (*Hylobius pales*) and the pine weevil (*Pissodes strobi*). The work of the snout beetle was first described by E. E. Carter in a paper entitled, "Hylobius Pales as a Factor in the Reproduction of Conifers in New England" (Proceedings of the Society of American Foresters, Vol. XI, No. 3, July, 1916). These beetles, breeding probably in the fresh cut stumps, swarm upon cut-over pine land and remain active for two growing seasons, during which period they destroy up to 80 per cent of all the pine seedlings over two years old. If a second contiguous cutting is made within three years the infesta-

tion is prolonged or renewed upon the area previously attacked. After this interval the reproduction is usually too large to be seriously injured. In two cases where the lumber was piled directly on the ground from which it was cut, thereby attracting the beetles in larger numbers, the destruction was practically complete over several acres. (Observation of H. B. Pierson.) As a rule, however, the amount of pine reproduction secured by thinning is so large that, even after the beetles have taken a toll amounting to 75 per cent, enough remains to form, with the hardwoods, a valuable stand. Furthermore, since the beetles do not eat one year seedlings, cuttings made without previous thinning in seed years are followed by comparatively little loss.

Injuries by the pine weevil begin usually in the small sapling stage. Their chief drawback is that they check the height growth of the pine at the very period when it is essential for keeping pace with the hardwood. The weevil, however, is less numerous in the mixed growth of cut-over lands than in pure pine plantations. Both weevil and snout beetle seem, so far, beyond the reach of any effective check, so that to provide more food than they can eat seems to be the safest provision against them.

WEEDING ESSENTIAL FOR THE NEW CROP

As a result of experience in the Harvard Forest nothing is clearer than that the critical period for a forest is in the small sapling stage. The money value of the final crop can be more greatly influenced by proper treatment at this time than at any other stage of the rotation. The young growth summarized in the table above, from the standpoint of quantity and species, is potentially more than sufficient to produce a full stand of good timber. Actually, if left to itself, it will never reach a valuable maturity. The new crop, therefore, has to be weeded, once when it is from 3 to 5 years old, and again when it is from 8 to 10 years old. It is only after about 3 years that the harmful effects of crowding begin to be apparent and the inevitable damage to pine seedlings from snout beetles, and to hardwoods from deer and rodents can be accurately discounted. After about 10 years the pine and hardwoods of seedling origin have reached a uniform and roughly equal rate of height growth. Meanwhile, however, the weed elements in the stand will have again become dominant, so that the cleaning has to be repeated. On light, sandy soils a satisfactory result can be achieved with one weeding, applied in such cases after a longer

interval. On rich, moist sites it is occasionally necessary to weed the crop a third time, in order that the best advantage may be taken of the very productive land. When this work is begun at the proper time, that is, before the crop has passed the small sapling stage, it can be done at the rate of 1½ to 2½ acres per man per day. On the Harvard Forest areas which have been weeded twice and which are in condition to produce valuable timber without further expense have cost, for reproduction, from $7 to $9 per acre.

EXPECTABLE YIELDS

Exact figures bearing on the final yield of such weeded stands of mixed hardwoods and pine are lacking. They can be approximated, however, by reference to existing stands where, over small areas, similar mixtures of species have reached maturity. The yield for well-stocked natural-pine stands, as based on the mill figures, runs from 40,000 to 55,000 feet per acre at 6 years. For mixed stands of the same age the yield varies from 20,000 to 35,000 feet per acre being higher according as the percentage of pine in the mixture is higher. These figures all apply to natural stands in which irregularity of stocking and abnormalities of crown development create a very considerable waste of growing space. It seems fair to assume, therefore, that in a stand where both distribution and mixture have been properly regulated by early weedings, the yield will not only be better in quality, but at least equal in quantity the production of volunteer growth. On suitable sites red oak and white ash, for example, will produce two to three log timber of the highest quality at 60 years. Speculation as to lumber prices 60 years hence is perhaps uncertain, but it is certain that they will be no lower than they are today. If, therefore, the mixed stands produced by the management above described are reckoned as yielding a final valume of 35,000 feet per acre, the value of the crop at present stumpage prices will be from $400 to $500. Given a reasonable security from fire and fairly equitable taxation this seems a satisfactory return on an investment of not less than $10 per acre.

SIMPLEST POLICY FOR THE REGION

It is difficult to reduce practical silviculture to a rule-of-thumb. Only the knowledge that comes from residence experience in a given

silvical region can apply the best treatment for varying forest conditions. Nevertheless for much of central New England, where the second growth forests are vigorous and prolific and, for the most part, uninjured by fire, a very simple policy will go far toward maintaining forest production. Slash disposal, while not indispensable on hardwood lands, must be carried out on pine lands. The wind-rows of tops on cut-over pine woodlots often cover from 30 to 50 per cent of the ground surface and so densely as to preclude all reproduction. There is thus a serious waste of growing space in addition to the fire risk. The better the market and the greater the available technical skill the more intensive can be the methods applied to forest production. But, if on either pine or hardwood land, merely the present clear-cutting is practiced, on a rotation of not less than fifty years, if slash is disposed of and fire subsequently kept out, it will be a long step toward successful forestry.