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STRIP-CUTTING IN A MIXED PINE STAND

by
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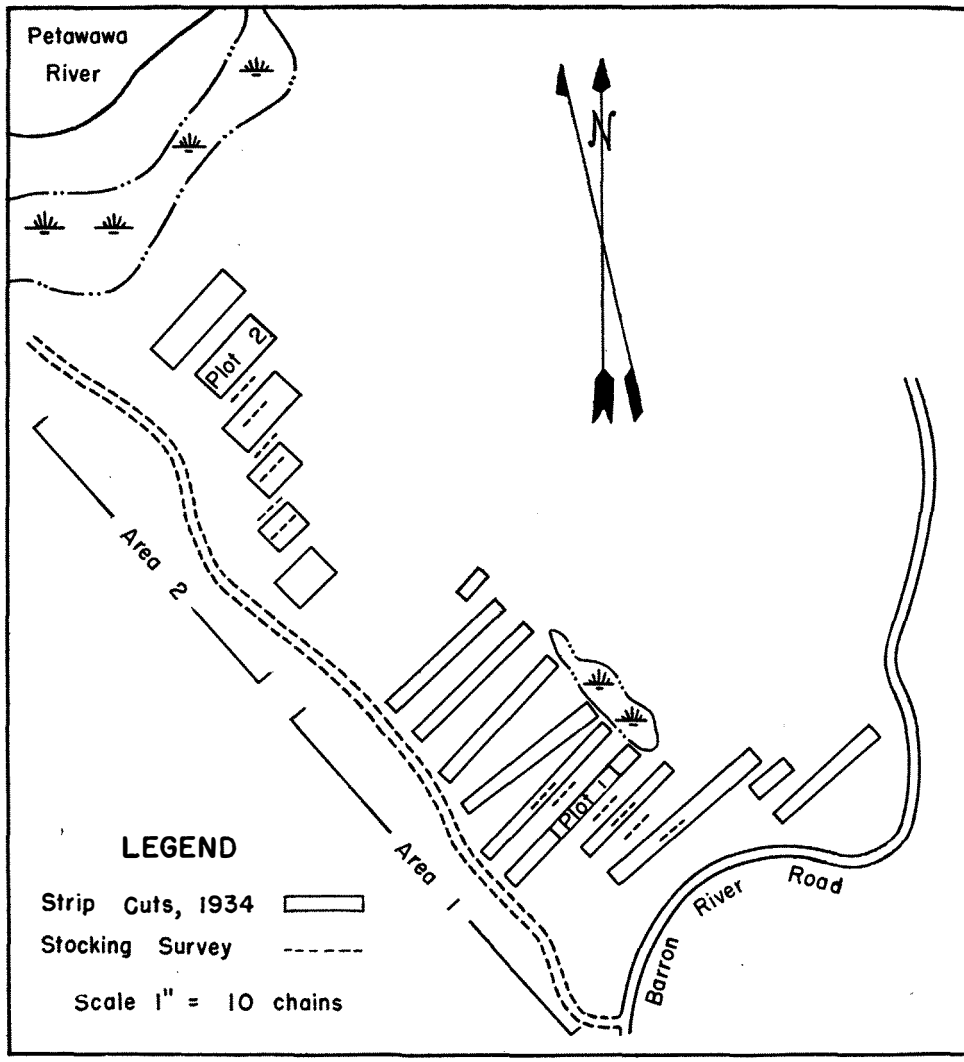

Figure 1: Location of experimental strip-cutting area, Petawawa Forest Experiment Station, near Pembroke, Ontario.

STRIP-CUTTING IN A MIXED PINE STAND

PROJECT P-325

by

J. W. FRASER[1] and J. L. FARRAR[1]

INTRODUCTION

A major problem in the management of white pine[2] has been to secure sufficient reproduction to maintain a high proportion of that species in succeeding stands. At intervals of 2 to 3 years, white pine produces abundant crops of seeds which germinate quite readily on most sites. The difficulty usually lies in bringing the young seedlings through their early years. Many of the silvicultural techniques tried by the Forestry Branch, Department of Northern Affairs and National Resources, and others have resulted in the failure of white pine seedlings to survive and grow in adequate numbers. Therefore, it gives some satisfaction to present here the results of a silvicultural technique which was to some degree successful for these purposes.[3]

STAND DESCRIPTION

The experiment was conducted at Petawawa Forest Experiment Station, twenty-two miles northwest of Pembroke, Ontario.

The area selected for the experiment is an almost level plain less than a half-mile in width. The land to the northwest and southeast is slightly elevated. The experimental area slopes gently towards the northwest where it drops abruptly down to a river a few chains beyond the final clear-cut strip. The soil, a deep, waterlaid material of siliceous derivation, varies from dry medium sand at the southeastern end of the area (hereafter referred to as Area 1) to dry coarse sand at the northwestern end of the area (hereafter referred to as Area 2). It is considered an average site for mixed pine in this section.

Prior to treatment, the area in general supported an overstory of 80-year-old jack pine, some white and red pine, and trembling aspen—the whole averaging between 20 and 25 cords per acre—and a 47-year-old understory of scattered white and red pine. Area 2 was more open than Area 1 because of the almost pure jack pine overstory and the sparse understory. On Area 1, there was more white and red pine in the overstory and the understory was quite dense. Trembling aspen also occurred more frequently on Area 1.

In 1949, the same species of ground-cover were common to both areas. Beaked hazel characterized the high-shrub layer, but did not occur frequently enough or in sufficient density to have an adverse effect on pine reproduction. Low shrubs were quite dense, and areal cover was estimated at 80 per cent.

[1] Silviculture and Management Section, Ottawa.

[2] For scientific names of all species mentioned, see list, page 17.

[3] The authors are pleased to acknowledge the work of J. W. B. Sisam, Dean of the Faculty of Forestry, University of Toronto, who initiated this work in 1933, while a research officer with the Forestry Branch.

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Blueberries and sweet fern were the main species, with wintergreen, trailing arbutus, and sheep laurel occurring less frequently. Bracken fern was common to both areas, but was more abundant on Area 2. Herbs were scarce; four-leaved loosestrife and dogbane were the only species that occurred frequently. The grass and sedge cover was quite heavy—about 50 per cent by ocular estimate. The moss cover was generally light, never exceeding an estimated 10 per cent; it was heavier on Area 1 and consisted mainly of dicranum, Schreber's hypnum, and hair-cap moss.

This vegetation, though remarkably similar in composition, differed in that the low shrubs were much denser and more vigorous on Area 2. This relationship between the vegetation on the two areas probably existed prior to cutting, although all vegetation was probably less dense at that time.

TREATMENT

During the winter of 1933–34, one-chain-wide strips at one-chain intervals were clear-cut for jackpine on Area 1. White and red pine were cut to a diameter limit of 3·5 inches d.b.h., which left residual stands of from 200 to 500 cu. ft. per acre. Two-chain-wide strips, also spaced one-chain apart, were cut to the same specifications on Area 2. On both areas, the strips ran approximately northeast, at right angles to the prevailing winds. (Figure 1.)

The uncut strips were subsequently cut over (in 1942) for red pine poles and white pine sawlogs. One-third to one-half of the merchantable timber was removed in this operation, reducing the crown cover to between 25 per cent and 50 per cent. Throughout the remainder of this report the clear-cut strips (1933–34) are referred to as such, and the intervals which were undisturbed until 1942 are referred to as partially-cut strips.

METHODS OF STUDY

In 1935, one year after cutting, two sample plots were established on clear-cut strips, one in Area 1 (Plot 1, 0·5 acre), the other in Area 2 (Plot 2, 1·0 acre) as shown in Figure 1. Five systematically located permanent reproduction strips of ten 1-milacre quadrats were established on Plot 1; six such strips were established on Plot 2. Reproduction was tallied by species and size in 1935, and again in 1950.

In 1949, a further survey was carried out to obtain comparative information on reproduction on the clear-cut and partially-cut strips. Six single examination reproduction strips of twenty 1-milacre quadrats were located in each of the two areas (Figure 1); three in clear-cut, and three in partially-cut strips. The tallest white pine seedling in each quadrat was tallied by height and vigour. Field observation indicated that a great deal of the white pine reproduction had originated prior to the treatment and a height-age survey was carried out to check this observation.

Measurements of total height and height to each whorl were obtained for forty white pine saplings (0·5 inch to 3·5 inches d.b.h.) on the clear-cut and on the partially-cut strips of both areas. No saplings over ten feet in height were measured, for by whorl-count they were obviously of sapling size in 1934. For twenty of these saplings total ages were determined by sectioning the stems at the root collar and counting the annual rings under magnification.

Similar height-age data were obtained for five seedlings (less than 0·5 inch d.b.h.) in each of the one-foot, two-foot, three-foot, four-foot and five-foot height classes; total ages were determined from slides prepared from root collar

sections. No stems over five feet in height were chosen as representative of the seedling class; observations indicated that the majority of those more than five feet high were also more than half an inch in diameter and belonged in the sapling category.

RESULTS

The numbers of white pine seedlings and of saplings per acre on the plots on both areas in 1935 and in 1950 are shown in Table 1.

TABLE 1.—NUMBERS OF WHITE PINE SEEDLINGS AND SAPLINGS PER ACRE ON THE PERMANENT PLOTS IN CLEAR-CUT STRIPS IN 1935 AND IN 1950.

Area Number	Treatment	Size Class and Date of Survey							
		Under 3·0 feet		Over 3·0 feet and less than 0·5 inch d.b.h.		Saplings 0·5 inch to 3·5 inches d.b.h.		Total	
		1935	1950	1935	1950	1935	1950	1935	1950
1	1-chain strip	780	4,800	60	1,240	0	320	840	6,360
2	2-chain strip	170	330	80	250	0	100	250	680

White pine seedlings were more abundant initially on Area 1 and this superiority has increased as time has passed mainly with seedlings under 3·0 feet in height; however, the increase in the number of those over 3·0 feet in height and of those in the sapling class was also substantial.

Stocking to white pine by one-foot height classes on the clear-cut and partially-cut strips of both areas is presented in Table 2. The tallest seedling is considered to stock the quadrat; hence a quadrat stocked to any given size may also support smaller seedlings of the same species.

TABLE 2.—PERCENTAGE (CUMULATIVE) OF QUADRATS STOCKED WITH WHITE PINE SEEDLINGS BY ONE-FOOT HEIGHT CLASSES IN 1949.*

One-foot Height Classes	Per Cent Stocking			
	Area 1 1-chain-wide strips		Area 2 2-chain-wide strips	
	Partially-cut	Clear-cut	Partially-cut	Clear-cut
8	0	0	0	0
7	2	5	2	5
6	5	15	10	10
5	10	30	15	20
4	30	45	25	30
3	65	65	40	35−
2	95	80	50	35+
1	100	85	65	55
less than 1	100	90	70	60

* For example, the 95 (Area 1—partially-cut) opposite the 2-foot height class indicates that 95 per cent of the quadrats supported a seedling at least 1·5 feet high.

These data show that stocking was better on Area 1 than on Area 2, on both the clear-cut and partially-cut strips, to all size classes except the largest. They also show that the partially-cut strips were as well or better stocked with seedlings up to and including the three-foot class than were those strips which were clear-cut.

Stocking with vigorous white pine (annual height growth of 0·5-foot or more within the past three years) is shown in Table 3.

TABLE 3.—PERCENTAGE (CUMULATIVE) OF QUADRATS STOCKED TO VIGOROUS WHITE PINE SEEDLINGS BY ONE-FOOT HEIGHT CLASSES IN 1949

One-foot Height Classes	Per Cent Stocking			
	Area 1 1-chain-wide strips		Area 2 2-chain-wide strips	
	Partially-cut	Clear-cut	Partially-cut	Clear-cut
7	2	5	0	5
6	5	10	10	10
5	10	25	15	15
4	20	28	20	15
3	35	30	28	15
2	40	30	30	15

Considering only the vigorous seedlings, the same relationship exists between Area 1 and Area 2, and between clear-cut and partially-cut strips, as with all seedlings.

The date of origin of seedlings in the various size classes is shown in Table 4.

TABLE 4.—DATE OF ORIGIN FOR REGENERATION BY PRESENT SIZE CLASSES

Height Classes (feet)	Date of Origin							
	Before 1934				1934–1942			
	Area 1		Area 2		Area 1		Area 2	
	Clear-cut	Partially-cut	Clear-cut	Partially-cut	Clear-cut	Partially-cut	Clear-cut	Partially-cut
1					*	*	*	*
2			*	*	*	*		
3, 4, 5,	*	*	*	*				
Saplings	*	*	*	*				

All suppressed seedlings now in the one-foot class, and most of those in the two-foot class, originated after the 1934 cut. The larger reproduction was established prior to the cut but most of it was less than six inches high; by 1950, the majority of the material over three feet in height was growing vigorously with the growth roughly proportional to height. Height growth was slightly better on Area 2 from 1934 to 1942, but after the polewood cut in 1942, it improved on Area 1 until by 1950 it equalled or, more frequently, surpassed that on Area 2.

The clear-cutting of 1934 exposed the uncut intervals on Area 1 to sufficient side light to favour the survival of existing seedlings and the establishment of new ones. Dense crops of seedlings became established under these conditions in subsequent years. The partial cut of 1942 opened up the stand enough to release these seedlings without subjecting them to the dangers of weeviling and severe competition such as followed the earlier clear-cutting. On Area 2 the initial overstory of jack pine was more open, with only a sparse understory of white and red pine, and the site was drier. The low shrub vegetation was quite dense and there were only a few white pine seedlings. Conditions were poor for germination and only fair for survival. On this Area also, the 1934 clear-cut exposed the uncut intervals to increased light. However, it reacted unfavourably on the uncut strips because it promoted an even denser shrub growth and created conditions almost as favourable for weeviling of the few existing seedlings as those on the actual clear-cut strips. Conditions for germination actually worsened as a result of this treatment. It is, therefore, understandable that the 1942 cut further accentuated the already unsatisfactory conditions.

White-pine-weevil damage was widespread on Area 2, especially on the clear-cut strips, where repeated weeviling of otherwise healthy, vigorous individuals resulted in serious malformation. Weevil damage was of a minor and isolated nature on Area 1, though no more severe on the clear-cut strips than on those partially-cut.

Browsing by deer was also more widespread on Area 2, especially during the winter of 1951–52, when practically all leaders and top branches projecting above the snow, and within reach of the deer, were browsed back to the surface of the snow. Although the seedlings on Area 1 appear to be recovering satisfactorily, the repeated browsing on Area 2 has caused excessive branching which, in association with the weevil damage and the open nature of the stand, has resulted in a very unsatisfactory class of reproduction. (Figure 6.)

White pine blister rust was present on both Areas, but showed no signs of becoming serious.

Aspen suckered freely in the spring following the cut. For a number of years they grew vigorously and seemed likely to crowd out some of the much shorter white pine, especially on Area 1. However, after 4 or 5 years, height growth of aspen fell off rapidly and the trees began to die. It seems now that their effect was probably beneficial in two ways; they provided the pine with light shelter against sun and spring frosts, and the litter had a beneficial effect on the humus condition. The development of the aspen is portrayed in Figures 3, 5 and 7.

Figure 2: General appearance of a two-chain-wide strip in 1935, one year after it was clear cut. Note dense low shrub vegetation and scarcity of seedlings.

Figure 3: General appearance of a one-chain-wide strip in 1935, one year after it was clear cut. Note dense aspen sucker growth that conceals small white pine seedlings.

Figure 4: The same strip as in Figure 2, six years later. Note beginnings of reproduction stand.

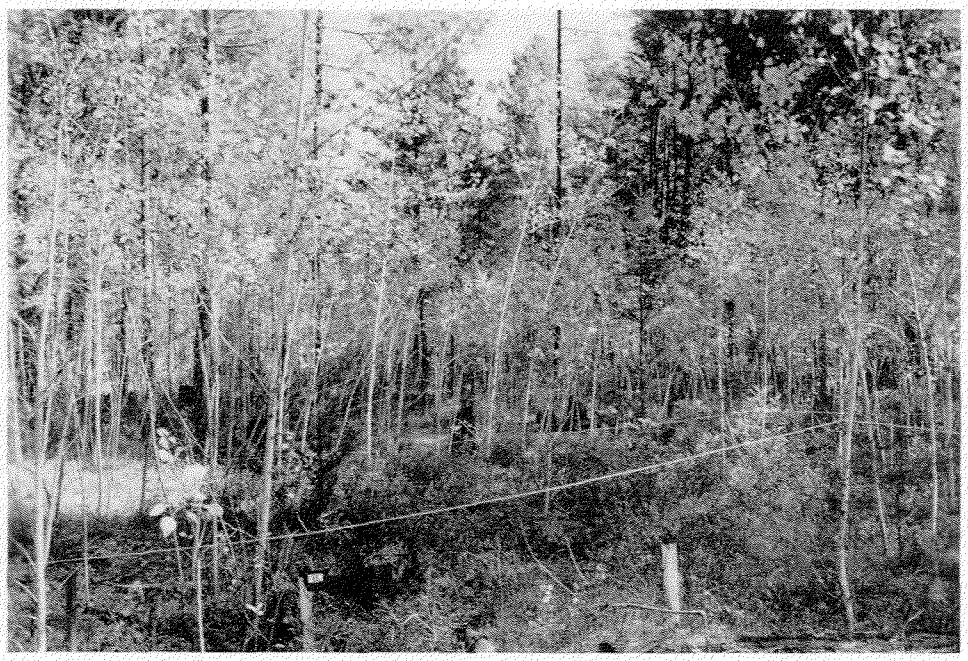

Figure 5: The same strip as in Figure 3, six years later. The pine seedlings can now be seen under the still dense, fast-growing aspen.

Figure 6: The same two-chain-wide strip as in Figures 2 and 4, in 1949. Note the increased shrub growth and malformation of established pine seedlings.

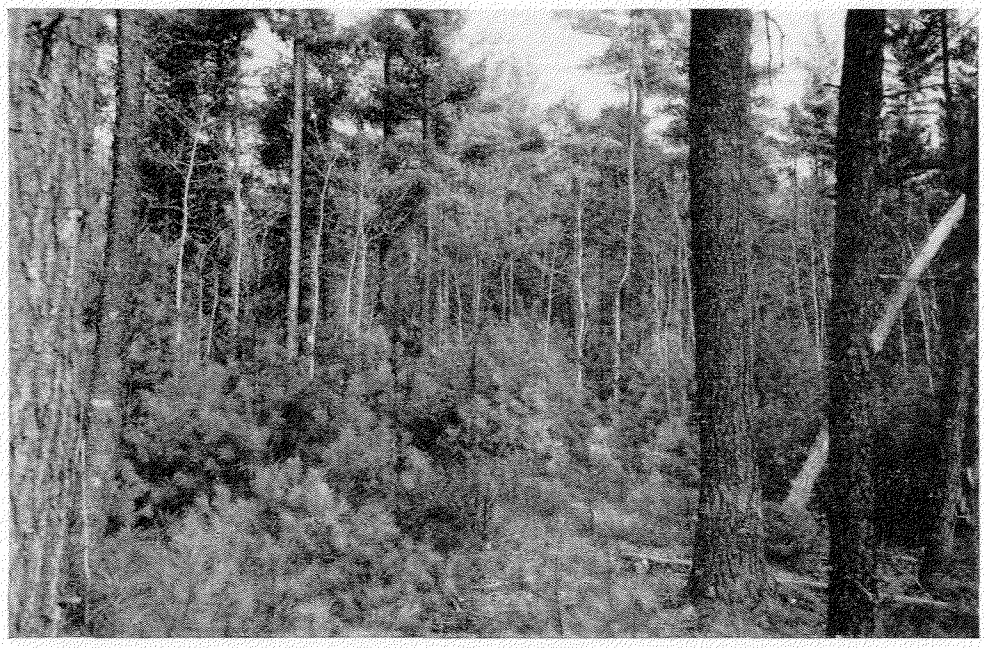

Figure 7: The same chain-wide strip as in Figures 3 and 5, in 1949. Note the deterioration of the aspen stand and the excellent white pine seedling and sapling ingrowth.

Figure 8: Close-up of Figure 7, showing variation in size and vigour of white pine reproduction on the chain-wide clear-cut strip.

Figure 9: The chain-wide strip, adjoining that shown in Figure 8, which was cut over in 1942 for poles and sawlogs. Note the absence of aspen.

DISCUSSION

The reproduction stand of white pine on Area 1 is highly satisfactory, both on the clear-cut and partially-cut strips. The number per acre is more than adequate, the distribution good, and the growth in height all it can be without attracting the weevil. On Area 2 the situation is not so satisfactory. Seedlings are less abundant and poorly distributed. Some have grown so rapidly in height that they have been attacked by the weevil. The above features are illustrated in Figures 2 to 7. What is the explanation of this difference?

One reason is that the soils on Area 1 have a somewhat higher water-holding capacity than those on Area 2; hence Area 1 is more suitable for white pine and red pine whereas Area 2 is more suitable for jack pine. This was reflected in the composition of the original stands. At the time of cutting there was more advance growth of white pine on Area 1 than on Area 2. This probably resulted from a better seed supply and more favourable moisture conditions of the seed-bed.

Moreover, jack pine seedlings were scarce because the seeds stay in the cones; red pine seedlings were scarce because only small amounts of seed are produced, and the seed-bed under a stand is unfavourable. As long as the overstory remained intact, suppressed white pine would occur in great numbers with new seedlings coming in to replace those dying.

Clear-cutting could have two unfavourable effects: first, shrubs might benefit more than the white pine and crowd them out; second, the white pine which did get above the shrubs would be exposed to weevil damage. The problem therefore, was to open up the stand just enough to benefit the pine without undue stimulation of shrubs, and to keep the pine sufficiently shaded and suppressed so that the weevil would not damage it. Apparently clear-cutting in 1-chain strips provided about the right amount of release. In the clear-cut strips the white pine have grown well, are now above the shrubs, and new seedlings have come in. In the intervening strips, the growth of pine seedlings was first stimulated to a lesser extent, but since the polewood cut, it has been as fast as the others; more new seedlings have come in, and weevil damage has been small. (See Figures 8 and 9.)

Clear-cutting in 2-chain strips has not been so successful although, owing to the differences in site and previous stand, it is hard to be certain that the width of strip is the reason for this. Opening the stand to a greater degree seems to have permitted the shrubs to provide serious competition for the white pine; almost undoubtedly it has created conditions which favoured damage by the weevil. The small number of seedlings in Area 2 results from a combination of poor seed supply, dry seed-bed conditions, and heavy competition from shrubs. (See Figures 2, 4, and 5.)

Clear-cutting in chain-wide strips, in many of its silvicultural effects, is probably not much different from shelterwood cutting. Yet shelterwood cuts have often failed to regenerate white pine. The difference probably lies in the soil conditions: Area 1 is a sand flat; the fertility and water supply, though low, are yet high enough to support white pine. On sites which are slightly moister or more fertile, an opening in the stand, great enough to favour white pine, seems to stimulate hardwood shrubs and trees even more—thus crowding out the white pine.

SUMMARY

A mixed stand of pine with an 80-year-old jack pine overstory, and a 47-year-old understory of red and white pine was clear cut in one-chain-wide and two-chain-wide strips at the Petawawa Forest Experiment Station, near Pembroke, Ontario, in 1934. The clear-cut strips were at right angles to the prevailing winds and separated by chain-wide uncut strips which were eventually cut-over in 1942 for poles and sawlogs.

The influx and development of white pine reproduction was studied on the basis of number of seedlings per acre on two permanent sample plots. A stocking survey was also conducted on both clear-cut and partially-cut strips in 1949, and the date of origin of all classes of seedlings was established by a height-age survey in 1950.

The clear-cut strips and their associated intervals were at least 60 per cent stocked with white pine seedlings in 1949. The one-chain-wide strips and intervals were better stocked than the two-chain-wide strips and intervals, and the seedlings were better developed.

The greater amount of regeneration after cutting in one-chain strips is attributed to the more abundant seed supply and better seed-bed conditions rather than to the width of the strip.

The better development of the regeneration on the chain-wide cuts and intervals is attributed to width of strip (through its relation to absence of weeviling and browsing which were repeatedly severe on the wider cuts and intervals), and to less vigorous shrub growth.

Seedlings which were over two and one-half feet in height, 15 years after cutting, were shown to have been present prior to the treatment; as seedlings provided the greater part of the stocking the major effect of the cutting was one of release. The success of this cutting technique, therefore, was dependent largely upon the existence of seedlings prior to cutting. Where such crops exist on a sandy site with a satisfactory distribution and frequency, any cutting technique that encourages their release and minimizes the dangers attendant upon vigorous white pine seedling growth should be satisfactory.

Although strip-cutting is here shown to have been effective on light sandy soil, it is suggested that it would be less successful on heavier soils. Furthermore, any method such as a shelterwood cutting that would open up the stand moderately would likely have been equally successful.

REFERENCES

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2. LUTZ, R. J., and A. C. CLINE.—Results of the first thirty years of experimentation in silviculture in the Harvard Forest, 1908–1938. Part 1. Harvard For. Bull. No. 23. Cambridge, 1947.

SCIENTIFIC NAMES

White pine	*Pinus strobus* L.
Red pine	*Pinus resinosa* Ait.
Jack pine	*Pinus banksiana* Lamb.
Beaked hazelnut	*Corylus cornuta* Marsh.
Velvet-leaf-blueberry	*Vaccinium myrtilloides* Michx.
Low sweet blueberry	*Vaccinium angustifolium* Ait.
Sweet fern	*Comptonia peregrina* (L.) Coult.
Wintergreen	*Gaultheria procumbens* L.
Trailing arbutus	*Epigaea repens* L.
Sheep laurel	*Kalmia angustifolia* L.
Bracken fern	*Pteridium aquilinum* (L.) Kuhn. var. *latisculum* (Deav.) Underw.
Four-leaved loosestrife	*Lysimachia quadrifolia* L.
Dogbane	*Apocynum androsaemifolium* L.
Grass spp.	*Oryzopsis* spp. Michx.
Sedge spp.	*Carex* spp. L.
Wavy dicranum	*Dicaranum undulatum* (Ehrh.) Sturm.
Schreber's hypnum	*Calliergonella schreberi* (Bry. Eur.) Grout.
Hair-cap moss	*Polytrichum* spp. Dill.
Trembling aspen	*Populus tremuloides* Michx.
White pine weevil	*Pissodes strobi* Peck.
White pine blister rust	*Cronartium ribicola* Fischer

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