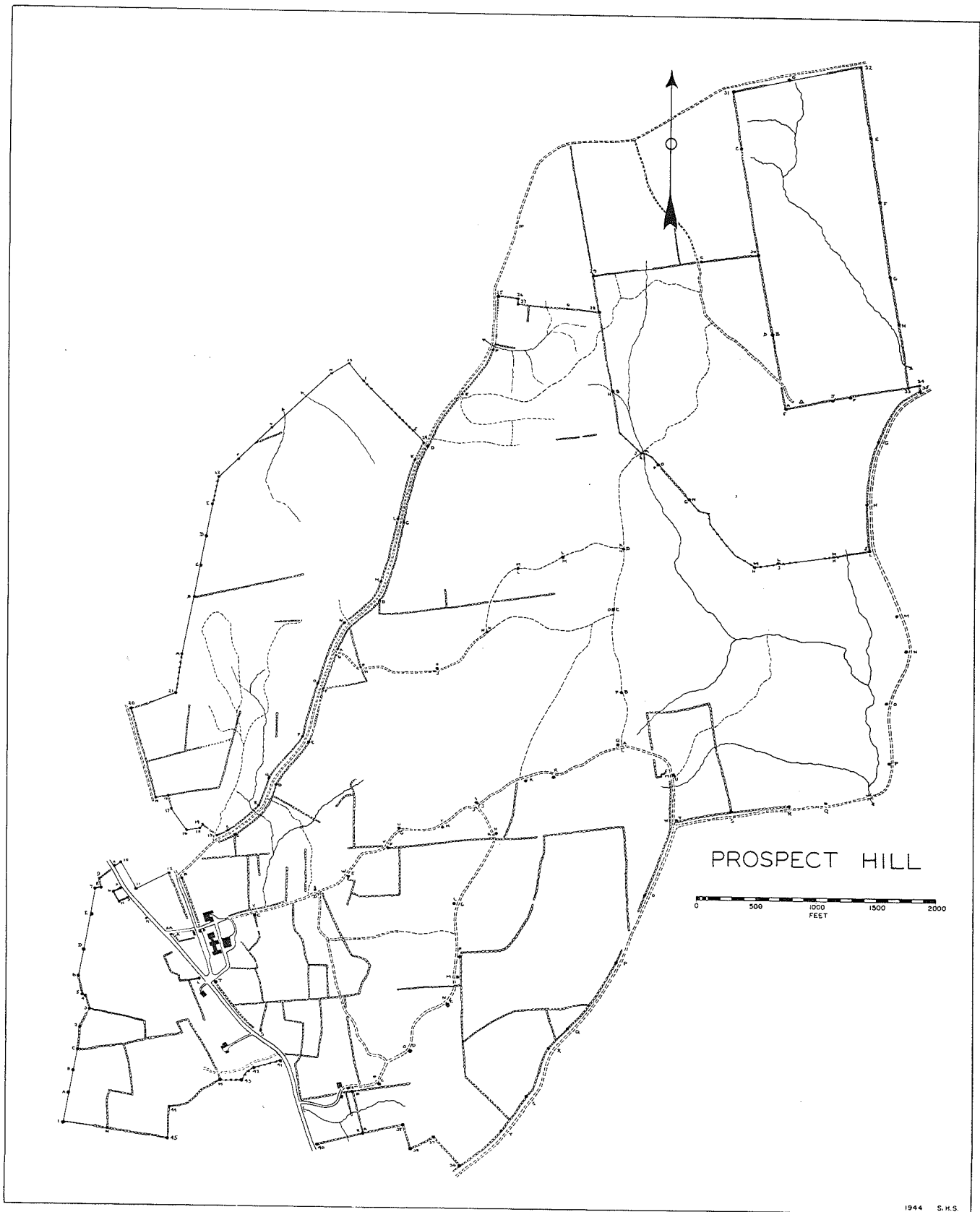


CASES IN
SILVICULTURAL HISTORY



HARVARD FOREST
HARVARD UNIVERSITY
Petersham, Massachusetts

1944



October 16, 1946

TRANSITION HARDWOODS

31-year-old Stand off Sunset Lane

TS I, Stand 10, south portion, 1946
(P-Hd-3, south portion, 1937)
9.0 Acres

Soil:

Charlton stony loam. Acton stony loam.

Site:

Moist, gentle, west-facing slope. Elevation 1000 to 1070 feet.

Land-use History:

Pasture from middle-eighteenth century until time of abandonment about 1850.

Silvicultural History:

Thinning, 1908-9. Old field white pine stand about 60 years old. 10% of area in scattered hardwoods. About 4,500 board feet per acre or about 12% of stand volume removed. Grade B low thinning, with all overtopped trees, many intermediate trees, and a few poorly formed dominant trees being cut. Treatment intended as preparatory cutting for shelterwood cutting which was never made.

Clearcutting, 1914-15. Following a good white pine seed year, overstory was removed, and hardwood advance growth cut back. Yield about 35 Mbf per acre.

Weeding, 1919. 3.5 acres treated. Dense pine reproduction (4000 per acre) was overtopped by faster-growing hardwoods (2100 per acre). Hardwood weed species cut back, and promising pine groups released. 3-man-hours per acre.

Weeding, 1927. 2.0 acres treated in strip 200 feet deep along Sunset Lane. Hardwood weeds and hardwoods overtopping pine groups cut back. 2-man-hours per acre.

Weeding, 1935. Entire stand. To improve quality of stand by removing coarse dominant red oaks, and by thinning ash clumps. All gray birch, aspen, and white oak were cut on the theory of elimination of favorite foods of the gypsy moth. 186 trees per acre 2 inches DBH and over were removed, totalling 150 cubic feet per acre, or probably about 50% of the stand volume. 6 man-hours per acre.

Discussion:

This is an example of clearcutting following a seed year, as the preparatory cut was too light to be considered a shelterwood cut. Soil is too moist and fertile for white pine reproduction to compete successfully with hardwood advance growth. Stand is now of high quality, but of low volume for its age. With present knowledge, the 1935 treatment would not have discriminated so heavily against red oak. S.H.S.

October 18, 1946

TRANSITION HARDWOODS

37-year-old Managed Stand

TS II, stand 4, 1946
(Hd-1, 1937)

6.6 Acres

Soil:

Acton stony loam. Whitman very stony silt loam. Charlton stony loam.

Site:

Medium to poorly drained hollow and low slope. Elevation 850 feet.

Land-use History:

Pasture until abandonment about 1850.

Silvicultural History:

Clearcutting, 1908-9. Following white pine seed year. Mixed stand of white pine and hardwoods, 60 years old, 80-90 feet high. 75% of volume was pine and the rest chestnut, black cherry, red oak, white ash, and black birch. About 30,000 board feet of pine, 16 cords of hardwood and 5 cords of pine cut per acre. Abundant hardwood reproduction was expected to furnish from 1/3 to 1/2 the final stand. Most of stand was cut in 1909, but a strip of 1.5 acres along the west edge was cut in 1910.

Weeding, 1912. Entire area cut in 1909. Red maple, aspen, birch, cherry, and chestnut sprouts were cut back to release the white pine reproduction. 9-man-hours per acre.

Weeding, 1914. 0.6 acre along southern edge of stand. Pines and better hardwoods released.

Weeding, 1915-16. 4.0 acres including all of 1909 cutting except for sample plots and isolation strips. Pines and better hardwoods released. 9 man-hours per acre.

Weeding, 1919. 4.5 acres. Little work needed. Pines and better hardwoods released. 1 man-hour per acre.

Weeding, 1925. 1.0 acre. Long strip south of brook weeded. Pine groups and better hardwoods treated.

Thinning, 1933. Entire stand. Selected crop trees freed. 5 man-hours per acre.

Thinning, 1940. Hurricane leaners removed and Danish crown thinning continued. Wood left in stand. 7 man-hours per acre.

Measurement, 1946. 1928 sample plots. Plot A had 223 trees per acre 5" DBH and over with 1190 cubic feet of which 1080 was red oak. Also many smaller white ash. Plot B had 228 trees with 1160 feet, of which 960 were red oak and 160 white ash. Intermediate trees largely white ash, yellow birch and red oak in that order. Also sugar and red maple.

Discussion: A fine example of a managed hardwood stand, on a high quality hardwood site. The thinnings cost less per acre than did the weedings.
S.H.S.

October 18, 1946

TRANSITION HARDWOODS

26-year-old Stand Unsuccessfully Planted

TS II, stand 2, 1946
(P-Hd-1, 1937)
1.8 Acres

Soil:
Charlton stony loam.

Site:
Low slope. Elevation 860 feet.

Land-use History:
Pasture until abandonment about 1850.

Silvicultural History:

Clearcutting, 1920. A mature stand of better hardwoods, 70 years old, mostly red oak and chestnut, with an increasing amount of pine on the east edge. Clearcutting yielded about 27,000 board feet per acre. 22 cords were cut per acre, mostly from the tops. Slash burned.

Planting, 1922. 750 red pine, 2-3 stock, planted throughout area to supplement natural reproduction. No tree was planted within 3 feet of useful advance growth. 11 man-hours per acre. Heavy natural stocking of white pine in east portion of stand, and of red oak seedlings throughout stand.

Weeding, 1923. Pines released from overtopping hardwoods. 10 man-hours per acre.

Weeding, 1926. To free pine so as to develop stemwise mixture of red pine and better hardwoods. Rank-growing stump sprouts cut. 11 man-hours per acre.

Weeding, 1931. Hardwoods occupy 80% of area. Best formed hardwoods and well-defined pine groups released from gray birch, pin cherry, black birch, and hornbeam. 10 man-hours per acre.

Inspection, 1938. Hardwoods occupy 90% of area. Red oak, white ash, and sugar maple being the dominant species.

Weeding, 1940-41. Large-crowned, coarse-limbed red oaks removed. Paper birch and white ash thinned. Pine groups released. 185 trees per acre, totaling 132 cubic feet, were cut -- about 25% of stand. 10 man-hours per acre.

Discussion: An excellent example of the futility of trying to grow softwoods on a moist low slope which has always come in to hardwoods, even after pasturing. The hardwoods today are of fine quality. S.H.S.

October 2, 1946

INTEGRATED SILVICULTURAL OPERATION
IN TRANSITION HARDWOODS AND HEMLOCK

PH III, Stands 3, 4, and 5, 1946
16 Acres (Part of 30-acre cutting)

Soil:

Gloucester stony loam. Acton stony loam. Whitman very stony silt loam.

Site:

Northwest facing mid-slope. Medium to poor drainage. Elevation 1150 to 1250 feet.

Land-use History:

Upland pasture until abandonment, probably about 1840. Old field pine cut about 1902, followed by transition hardwoods over most of area. Older hemlock along northeast boundary.

Silvicultural History:

Stand 3. Hemlock. 60-90 year old stand. First treatment in 1945 was light thinning which removed about 10% of stand, leaving 3540 cubic feet per acre, of which 2830 were hemlock, 270 white pine, 370 red oak, 50 beech, and 20 paper birch.

Stand 4. Hardwoods. Plot A had, in 1944, 1450 cubic feet per acre, was 42 years old and 52-55 feet high. After 1945 improvement cutting, 1090 cubic feet, or 75%, of which 570 were red oak, 250 red maple, 200 paper birch, 50 beech, and 20 black birch. Plot B had, in 1944, 2320 cubic feet, of which 1420 were white pine. Removal of pine clump for sawlogs in 1945 (spot clearcutting) left 1180 cubic feet per acre, or 51%, of which 450 were white pine, 300 red oak, 210 red maple, 130 black birch, 80 hemlock, and 10 white oak.

Stand 5. Plantation 13-D. Planted in 1913 with 600 Norway spruce grown in Forest nursery, 2-1 stock. Sprout hardwoods 7 years old, 12-18 feet high. 57 man-hours of student labor per acre. Rocks and roots made planting difficult. In 1944, spruce was completely suppressed, 2-6 feet high, heavily infested with spruce gall aphid, 80% survival. Overstory comprised 432 trees per acre, 54 feet high, comprising 1300 cubic feet, of which 670 were red maple, 380 red oak, and 150 black birch. No treatment.

Entire area was cut over in 1944 and 1945, with treatment varied to local conditions. Stand 5 left as control. In 1944, 80 cords were removed, requiring 8.9 man-hours per cord, including yarding. In 1945, 156 cords were removed to complete operation.

Discussion: This is an example of an integrated silvicultural operation made on a commercial basis over a moderately large area. In various places, the operation partook of the character of a hurricane salvage cutting, improvement cutting (Stand 4, Plot A), thinning (Stand 3), spot clearcutting (Stand 4, Plot B), and release cutting (Stand 2. See separate case history). Only sample marking was done. Supervision was light. Cost per cord was less than in nearby clearcutting made the same winter by the same crew, which required 11.1 man-hours per acre per cord cut and yarded, including slash disposal. The suppressed Norway spruce plantation is a fine example of the capacity of the species to endure shade, and the futility of planting it on cut-over areas with a heavy wet soil. S.H.S.

October 2, 1946

WHITE PINE SEED TREE CUTTING
ON SANDY SOIL

PH III, Stands 1 and 2, 1946
3 Acres

Soil:

Jaffrey stony fine sandy loam. Kame of poorly assorted loose sand and gravel.

Site:

Mid-slope. Medium drained. Elevation 1150 feet.

Land-use History:

Cultivated at one time. Abandoned about 1882. Came into medium box quality white pine and scattered hardwoods.

Silvicultural History:

Hurricane damage, 1938. Previously untreated stand largely blown down, except for strip along northwestern edge. Prior volume: white pine, 4,492 cubic feet per acre; red oak, 164; paper birch, 77; other hardwoods, 18.

Hurricane salvage, 1941. Down trees cut into logs and piled on skidway by Forest crew. Yield: 15,800 board feet. Time: 9.2 man-hours per Mbf. Logs sold on skidway for \$12.00 per Mbf (\$15 for sound logs and \$10 for wormy logs). Slash piled and burned on snow.

Liberation cutting, 1945. At time of improvement cutting in surrounding area, dense white pine reproduction from 1940 seed crop was noted on this area. All hardwoods were cut, yielding perhaps 3 cords, and brush was piled, care being taken to free pine seedlings. Strip of pines along border was left to furnish seed in expected seed crop.

Discussion:

Though not a planned experiment, this area illustrates the possibility of reproducing white pine on a sandy soil. The hurricane and subsequent log salvage were an ideal seed tree treatment. The 1940 and 1943 seed crops thoroughly restocked the area, there now being 2600 white pine seedlings per acre. Hardwood reproduction includes 850 seedlings, 480 seedling sprouts, and 280 stump sprouts per acre; red maple, red oak, and black birch making up three-quarters of the total. The 1945 treatment removed residual hardwoods and left the site in condition for white pine seedlings to take over. After the next seed year, the remaining white pines in the strip will be removed, being easily accessible to the road. A low-cost, successful regeneration of white pine on a "white pine soil". S.H.S.

October 2, 1946

HEMLOCK STANDS EAST OF
PROSPECT HILL PEAT BOG

PH II, Stand 1, 1 Acre
PH II, Stand 2, 5 Acres

Soil:

Gloucester stony loam. Acton stony loam. Whitman very stony silt loam.

Site:

Lower slope. Medium to poorly drained. Borders peat bog (red spruce-hemlock-red maple-black gum-yellow birch) on upper (east) end. Elevation 1180 to 1200 feet.

Land-use History:

Extreme outer portion of farm granted in second division (1738) to Benjamin Miles. Map of 1830 shows woodland in this area, and all deeds speak of this particular tract as woodland. Although there is evidence of repeated cutting throughout the whole woodlot, the area has apparently never been completely cleared for cultivation or pasture.

Silvicultural History:

Stand 1. Old growth hemlock. Originated about 1765, probably following first logging of area. Ring analysis shows that the stand was opened up by light cutting in 1790, by the 1815 hurricane, and that the trees were released again in 1838 and 1876. Large hemlocks up to 3 feet DBH were cut in 1888, and a few more trees were cut in 1894. Some release was caused by the death of the chestnut due to the blight following 1916, and by the 1938 hurricane. The oldest trees are now about 180 years old. On the quarter-acre permanent sample plot, volume per acre in 1944 was 8,800 cubic feet, or 36,700 board feet. Largest tree, 31 inches DBH and 85 feet high.

Stand 2. Second growth hemlock, white pine, and hardwoods. Originated mostly between 1874 and 1878, about the time the trees in Stand 1 were released. Some trees originated 10 to 20 years earlier. Chestnut and other trees cut about 1893, and possibly also in 1913. Stand opened up by chestnut blight, 1917-1921; by improvement cutting in 1931 (11 cords per acre of overtopping hardwoods removed); and by some windfall in 1940. One acre permanent sample plot contained, in 1944, 1770 cubic feet, of which 1190 were hemlock, 288 white pine, 85 red maple, 85 red oak, 75 red spruce, 24 paper birch, and 17 beech. Stand 44 to 58 feet high. Average height, 51 feet.

Discussion: This tract is not primeval in any sense, but rather illustrates the long record of disturbances in an area never fully cleared for farming. The predominance of the hemlock is due in part to the lightness of these disturbances, both cutting and windfall, and to the site -- for it is on such low, sheltered, moist slopes that this species attains its optimum development. S.H.S.

PONDEROSA PINE

29-year-old Plantation from Southern California Seed

PH III, 15-B
0.4 Acre

June 6, 1944

Soil:

Brookfield stony fine sandy loam.

Site:

Well drained knoll. Elevation 1200 feet.

Land-use History:

Old pasture. At time of planting, this area was a clearing in a pasture growing up to scrubby white pine. The sod was unusually tough.

Silvicultural History:

Planting, 1915. 530 ponderosa pine 1-2, grown in Petersham from Southern California seed. Spacing 6 x 6.

Inspection, 1918. 71% survival, the highest of any of the six ponderosa pine plantings of 1915.

Thinning, 1944. Trees in poor condition and heavily diseased (Cronartium Comptoniae, Arth.). 47% of trees removed. About 200 trees per acre left. Average dbh, 5.5". Average height, 26'. Stand also contains 20 volunteer white pine and 3 hardwoods in dominant position.

Discussion:

Although poor, this is the best ponderosa pine planting on the Forest. Because of the space-demanding character of the species, the stand was thinned heavily to try to save the planting.

WHITE PINE
29-year-old Plantation

PH VI, 15-F(2)
5.5 Acres

June 20, 1944

Soil:

Brookfield stony fine sandy loam.

Site:

High slope, well drained. Elevation 1310 feet.

Land-use History:

Pasture from before 1830 to time of planting.

Silvicultural History:

Planting, 1915. 3500 white pine 1-2 from Harvard Forest nursery. Spacing 6 x 6. Side hole method.

Inspection, 1919. 70% of trees healthy, 24% weak, and 6% dead.

Inspection, 1932. 840 trees per acre. Average dbh, 3.8". Average height, 17'. Heavily weeviled.

Weeding, 1934. Occasional overtopping paper birch cut back.

Pruning, 1935. About 200 trees per acre pruned to height of about 12'.
6 man-hours per acre.

Thinning, 1944. 21% of trees removed (14% of free trees). 680 trees per acre left. Average dbh of free trees, 5.78". Average height, 30'.
Control plot established. Much of stand destroyed by hurricane.
About 2 acres left.

Discussion:

Despite heavy weeviling, enough good stems are left to make a satisfactory stand. Growth is adequate, but inferior to adjoining red pine (now mostly blown down). Little treatment was necessary.

RED AND WHITE PINE

29-year-old Alternate Row Plantation

PH VI, 15-G
0.5 Acre

June 16, 1944

Soil:

Brookfield stony fine sandy loam.

Site:

High slope, well drained. Elevation 1310 feet.

Land-use History:

Pasture from before 1830 to time of planting.

Silvicultural History:

Planting, 1915. 302 red pine 1-2, 334 white pine 2-1, and 22 jack pine 1-2 from Harvard Forest nursery. Spacing 6 x 6. Red and jack pine in alternate rows with white pine. Four planting methods: A. Careful mattock center hole; B. Mattock side hole; C. Slit sod off; and D. Slit sod on.

Inspection, 1923.	A	B	C	D
Height - white pine	7.1'	7.0'	6.6'	6.5'
- red pine	9.5'	9.2'	9.1'	8.6'
- jack pine	-	11.1'	-	-
Survival - white pine	91%	94%	89%	78%
- red pine	100%	85%	90%	90%

Weeding, 1934. Two overtopping hardwoods removed. 1 man-hour per acre.

Hurricane damage, 1938. East half of stand blown down. Salvage operation yielded logs.

Thinning, 1944. 30% of red pine, 1 white pine, and 2 jack pine removed. RED PINE: 488 trees per acre. Average dbh of free trees, 6.8". Average height, 36'. WHITE PINE: 300 trees per acre. Average dbh of free trees, 5.1". Average height, 28'.

Inspection, 1944.	A	B	C	D
Dbh free trees - white pine	5.39"	5.75"	4.61"	4.42"
- red pine	6.54"	6.75"	6.24"	7.21"

Discussion:

Red pine has outdistanced white pine on this rather poor site, and now occupies about 35% of the canopy. The jack pine too has done well, but is of poor form. Hole planting definitely resulted in better growth and survival than did slit planting, at least for white pine, and quite possibly also for red pine.

RED PINE

25-year-old Plantation on Cut-over Gray Birch Land

FH II, 19-B
1.7 Acres

June 1, 1944

Soil:

Charlton loam.

Site:

Gradual slope southeast of spruce bog. Elevation 1200 feet. Soil rich with fair drainage.

Land-use History:

Under cultivation to about 1885, followed by pure gray birch.

Silvicultural History:

Clearcutting, 1918-19. 30-year-old gray birch yielded 14 cords per acre. Advance growth mowed. Brush piled and burned.

Planting, 1919. 2200 red pine, 2-3 stock. Seed from Champlain Valley. 6 x 6 spacing. Mattock hole method. 12 man-hours per acre.

Weeding, 1921. Gray birch, red maple, and paper birch removed. 2 man-hours per acre.

Weeding, 1923. 2 man-hours per acre.

man hours? Replanting, 1926. 58 red pine, 2-2 stock, from Harvard Forest nursery.

Weeding, 1930. Heavy. 5 man-hours per acre.

Inspection, 1932. 860 trees per acre. Average dbh, 3.5". Average height, 16'. Lowest branches beginning to die. No podzolization.

Pruning, 1936. 180 trees per acre pruned to average height of 10 feet. Pruning removed collar except in 17 controls. 19 man-hours per acre.

Thinning, 1938. Of 612 trees per acre, 116, or 19%, removed. Crown thinning. Pruned crop trees favored. 10 man-hours per acre.

1942-Pruning? Post-hurricane cleanup, 1939. Three small spots of blowdown and scattered leaners were felled. About 15% of stand affected. 28 man-hours per acre. 107 white ash, 3-0 stock, planted in clearings, 1941 (41-N).

man hours? Thinning, 1944. Of 660 trees per acre, 60, or 9%, removed. Yield, 90 board feet and 1.2 cords per acre. Average dbh, 6.9". Average height, 37'.

Discussion:

Gray birch competition was not sufficient to prevent the successful establishment of this red pine plantation. The cost, however, was about 100 man-hours per acre, including 28 hours of hurricane cleanup. Growth is good, and the last thinning yielded merchantable products.

Trees pruned through the branch collar are 75% to 100% healed over. Trees pruned outside the collar are less than 25% healed. (Exp. 36-5).

RED PINE

22-year-old Plantation on Peach Orchard

PH III, 22-B
1.7 Acres

June 27, 1944

Soil:

Gloucester stony fine sandy loam.

Site:

Well-drained mid-slope. Elevation 1180 feet.

Land-use History:

Successively a cultivated field, a mowing, and a peach orchard. At time of planting, an abandoned field with very light sod, a light grass cover, and a few pin cherries.

Silvicultural History:

Planting, 1922. 1644 red pine, 2-3 stock. 6 x 6 spacing, rows staggered. Slit method, sod removed. 13 man-hours per acre.

Inspection, 1932. 920 trees per acre. Average height, 12.0'. Average crown width, 2.5'. Very good plantation.

Weeding, 1934. Borders only. 3 man-hours per acre.

Hurricane salvage, 1940. About 25% of stand affected, mainly a strip along the south border. Trees felled and lopped.

Thinning and pruning, 1944. 14% of trees removed. Left were 530 trees per acre. Average dbh of free trees, 5.7". Average height, 36'. 200 crop trees per acre pruned to 17'.

Discussion:

This is a highly successful plantation. Time required has been about 25 man-hours per acre exclusive of hurricane salvage.

WHITE PINE

21-year-old Plantation on Peach Orchard

PH III, 23-A
0.9 Acre

June 27, 1944.

Soil:

Gloucester stony fine sandy loam.

Site:

Mid-slope. Practically level. Medium drainage.

Land-use History:

Successively a cultivated field, a mowing, and a peach orchard. At time of planting, the northern portion had seeded in very heavily to gray birch, and the southern portion had been cultivated in 1922 as a vegetable garden.

Silvicultural History:

Planting, 1923. 1120 white pine, 2-1 stock, and 322 white pine, 2-0 stock.
Spacing 5 x 5. Slit method, sod removed. 24 man-hours per acre.

Weeding, 1923. Gray birch seedlings bent over about each planted pine.
7 man-hours per acre.

Replanting, 1925. 213 red pine, 2-2 stock, from Harvard Forest nursery.
Mainly in the south portion of the stand. 5 man-hours per acre.

Weeding, 1927. Overtopping gray birch seedlings cut out. 5 man-hours per acre.

Weeding, 1930. Hole weeding to free pine from birch. 11 man-hours per acre.

Inspection, 1932. 1020 trees per acre. Average height, 6.3'. Average crown width, 3.7'.

Hurricane salvage, 1940. About 15% of trees, leaning or down, mostly in south portion, were felled and lopped.

Thinning, 1944. 19% of trees removed. Left were 880 trees per acre.
Average dbh of free trees, 4.9". Average height, 25'.

Discussion:

Although this is one of the better white pine plantations on the Forest, both from the standpoint of growth and freedom from weeviling, it is inferior to the adjoining red pine plantations (22-A and 25-L). The red pine filled into the stand in 1925 are considerably larger than the older white pine.

WHITE SPRUCE AND WHITE PINE

20-year-old Plantation on Old Apple Orchard

PH II, 24-A
1.4 Acres

June 1, 1944

6/26/47

Soil:

Brookfield stony fine sandy loam.

Site:

Mid-slope. Well drained. Elevation 1150 feet.

Land-use History:

Under cultivation for at least 100 years. Was combined apple orchard and mowing at time of planting.

Silvicultural History:

Site preparation, 1924. Apple trees and fuelwood removed. Brush piled along field borders. Grass consumed by broadcast burning. 28 man-hours per acre.

Planting, 1924. 1800 white spruce and 900 white pine. Both 2-1 stock from Harvard Forest nursery. Spacing 5 x 5 feet. Mattock slit method. Sod removed. TWO ROWS OF SPRUCE ALTERNATED WITH ONE OF PINE. 54 man-hours per acre.

Replanting, 1927. 270 white spruce and 120 white pine, both 2-2 stock. Harvard tool. 8 man-hours per acre.

Weeding, 1929. Borders only. Machete. $1\frac{1}{2}$ man-hours per acre.

Inspection, 1932. WHITE SPRUCE: 1240 trees per acre. Average height, 4.4'. WHITE PINE: 480 trees per acre. Average height, 4.4'. 60% weeviled. White pine crowns wider than white spruce (3.3' as against 2.5').

Weeding, 1935. Entire stand. Machete. 3 man-hours per acre.

Improvement cutting, 1944. All pines cut. No wood removed. These were poor quality scrubby trees, 95% weeviled. No spruce removed. Control plot established. WHITE SPRUCE: Average dbh free trees 4.0"; all trees 3.8". Average height 26'. WHITE PINE: Average dbh free trees 3.8"; all trees 3.4". Average height 21'.

Discussion:

White spruce and white pine are incompatible because of extensive weeviling to white pine during juvenile period when white pine is the taller tree. This stand should be a high quality one, nevertheless, as the white spruce has done exceptionally well.

WHITE SPRUCE AND WHITE PINE
20-year-old Plantation on Brushy Pasture

PH II, 24-B
1.3 Acres

June 1, 1944

Soil:

Brookfield stony fine sandy loam.

Site:

Low slope with moderate to poor drainage. Elevation 1120 feet.

Land-use History:

Cultivated at one time, then a pasture. At time of planting, abandoned pasture was rapidly growing up to white pine, scrub apple, and alder.

Silvicultural History:

Site preparation, 1924. Area cut over and broadcast burned to dispose of dead grass. 3 man-hours per acre.

Planting, 1924. 1200 white spruce 3-0 and 400 white pine 2-1 from Harvard Forest nursery. Spacing 5 x 5. Harvard tool. THREE ROWS OF SPRUCE ALTERNATED WITH ONE OF PINE. 29 man-hours per acre.

Weeding, 1926. Heavy growth of alder, gray birch, and apple cut to ground. 3 man-hours per acre.

Replanting, 1927. 787 white spruce 2-2 and 110 white pine 2-2. Portion near Locust Opening Road overgrown with alders. 17 man-hours per acre.

Weeding, 1929. Heavy sprout growth of alders in south part of stand cut back. 3 man-hours per acre.

Weeding, 1931. Same. 10-man-hours per acre.

Inspection, 1932. WHITE SPRUCE: 1220 trees per acre. Average height 2.7'. WHITE PINE: 420 trees per acre. Average height 4.8'. White pine crowns wider than spruce (3.3' as against 1.5').

Weeding, 1932. Alders in south portion of stand. 1 man-hour per acre.

Weeding, 1935. 6 man-hours per acre.

Weeding, 1943. South portion. 2 man-hours per acre.

Improvement cutting, 1944. North portion. 31% of free pine and 12% of free spruce removed. WHITE SPRUCE: 890 trees per acre. Average dbh free trees, 3.46"; all trees, 3.20". Trees in inside row average 0.42" larger than trees bordering pine. Average height 22'. WHITE PINE: 230 trees per acre. Average dbh free trees, 5.05"; all trees, 4.78". Average height 24'.

Discussion:

South part of plantation a failure despite six weedings because of poor drainage and alder competition. Spruce throughout smaller than in similar stands (24-A, 24-C) because of seedling stock rather than transplants. White pine and white spruce incompatible (See 24-A). This is the first plantation established with the Harvard tool.

WHITE SPRUCE AND WHITE PINE
20-year-old Plantation on Mowing

PH II, 24-C
1.7 Acres

June 1, 1944

Soil:

Brookfield stony fine sandy loam.

Site:

Mid-slope. Medium drainage. Elevation 1140 feet.

Land-use History:

Once under cultivation, then a mowing. Hay cut annually until time of planting.

Silvicultural History:

Site preparation, 1924. Broadcast burned to remove dead grass.

Planting, 1924. 1700 white pine 2-1; 1500 white spruce 3-0; and 200 white spruce 2-1, all from Harvard Forest nursery. Spacing 5 x 5. Harvard tool. CHECKERBOARD SQUARES, EACH COMPOSED OF 16 TREES OF ONE SPECIES. 53 man-hours per acre.

Replanting, 1927. 425 white spruce 2-2 and 155 white pine 2-2. 9 man-hours per acre.

Inspection, 1932. WHITE SPRUCE: 860 trees per acre. Average height, 3.6'. WHITE PINE: 800 trees per acre. Average height, 6.4'. White pine crowns wider than spruce (4.4' as against 2.0'). Pine 80% weeviled.

Weeding, 1934. Gray birch, pin cherry, and aspen removed. Cutting heavy in spruce groups, light in pines to minimize weevil injury. 5 man-hours per acre.

Weeding, 1935. 4 man-hours per acre.

Thinning, 1943. NORTH PORTION heavily thinned. 44% of pine and 21% of spruce removed. CENTRAL PORTION left as control. SOUTH PORTION lightly thinned, mainly by girdling scrubby pines. 29% of pine and 8% of spruce removed.

Inspection, 1944. WHITE SPRUCE: Average dbh of inside trees, 3.6"; of outside trees, 3.3". Average dbh of all trees, 3.5". Average height, 26'. WHITE PINE: Average dbh of inside trees, 4.0"; of outside trees, 4.7". Average dbh of all trees, 4.5". Average height, 24'.

Discussion:

White spruce and white pine incompatible because of extensive weeviling to white pine during period when white pine is the taller tree. Spruce is of excellent quality and is being favored.

WHITE SPRUCE AND SCOTCH PINE
20-year-old Plantation on Pasture

PH I, 24-F
1.0 Acre

June 6, 1944

Soil:

Brookfield stony fine sandy loam. Sutton stony fine sandy loam.

Site:

Low slope. Rather poor drainage. Elevation 1140 feet.

Land-use History:

Successively a cultivated field, an apple orchard, and a pasture. At time of planting, apple trees, red oak, and red maple were present on the area.

Silvicultural History:

Site preparation, 1924. Apple trees and hardwood advance growth cut out. Grass broadcast burned. 17 man-hours per acre.

Planting, 1924. 990 white spruce, 3-0 stock, and 400 Scotch pine, 2-0 stock (Riga strain). Spacing 5 x 5. Harvard tool. Three rows of spruce alternated with one of pine. 30 man-hours per acre.

Weeding, 1927. Mostly along borders. 10 man-hours per acre.

Replanting, 1927. 740 white spruce, 2-2 stock and 200 white pine, 2-2 stock. Earlier low survival due to small stock used. 18 man-hours per acre.

Weeding, 1930. Mostly along borders. Scotch pine heavily weeviled. Also budded by squirrels. 13 man-hours per acre.

Weeding, 1934. Borders. 2 man-hours per acre.

Inspection, 1932. WHITE SPRUCE: 1380 trees per acre. Average height, 2.3'. Average crown width, 1.4'. SCOTCH PINE: 600 trees per acre. Average height, 4.5'. Average crown width, 3.3'.

Improvement cutting, 1944. Scotch pine scrubby. All pines removed except in control plot. WHITE SPRUCE: 1280 trees per acre. Average dbh of free trees, 3.6"; all trees, 3.0". Average height, 22'. SCOTCH PINE: 200 trees per acre in control plot. Average dbh of free trees, 5.7"; all trees, 5.2". Average height, 22'.

Discussion:

The spruce is in excellent condition except in the wetter portions of the stand. Removal of the Scotch pine in 1944 was probably not necessary, but should result in better soil conditions. The only value of Scotch pine in this and similar plantations is that of a nurse tree. Its use may avoid early thinnings and may result in better form of other species with which it is planted.

WHITE PINE

20-year-old Seed Source Experiment

PH I, 24-G
0.5 Acre

June 27, 1944

Soil:

Brookfield stony fine sandy loam.

Site:

Mid-slope. Moderate drainage. Elevation 1140 feet.

Land-use History:

Formerly cultivated. At time of planting, a mowing with moderately heavy sod.

Silvicultural History:

Planting, 1924. 924 white pine, 3-0 stock, from Harvard Forest nursery. Seed of 6 lots, each collected from a single mother tree in Petersham. Spacing 5 x 5. Lots in east-west rows. Harvard tool.

Lot	Mother tree	Site	Dbh	Ht	Mean seed weight
1	Open grown	I	16"	35'	21 mg.
2	Dominant in old field stand	II	15"	75'	16 mg.
3	Open grown	II-	12"	30'	22 mg.
4	Co-dominant. Same as 2.	II	12"	70'	18 mg.
5	Old growth. Boulder site.	II	28"	100'	15 mg.
6	Stagnant old field stand	II-	10"	50'	14 mg.

Picking weevils, 1930. 425 weevils collected in 6 man-hours.

Inspection, 1932. 1260 trees per acre. Average height, 7.2'. Average crown width, 4.5'. Weeviling severe.

Thinning, 1944. 17% of trees removed. Left were 990 trees per acre. Average dbh of free trees, 5.2". Average height, 28'. 16 man-hours per acre.

Experimental measurements:

Lot	1929 Height	1939 Height	1944 Height	1939 Dbh	1944 Dbh
1	3.2'	18'	26.4'	3.7"	4.85"
2	4.4'	19'	27.5'	3.5"	4.95"
3	5.0'	20'	28.2'	4.3"	5.00"
4	4.3'	20'	26.4'	4.2"	4.89"
5	3.8'	19'	27.7'	3.7"	5.14"
6	4.1'	18'	25.6'	3.9"	5.05"
Basis	All trees	5 each	10 each	5 each	All trees

Discussion:

This experiment was poorly designed in that the lots were not randomized but were planted systematically from north to south. Weeviling disrupted height growth and reduced the value of the experiment. Although inconclusive, there are indications that growth differences between the lots do exist, lot 3 either being the fastest growing or being the largest because of the heavy seed from which it originated.

WHITE AND ASIATIC SPRUCE

20-year-old Plantation on Old Field

PH I, 24-H
2.6 Acres

June 28, 1944

Soil:

Brookfield stony fine sandy loam. Sutton stony fine sandy loam.

Site:

Low slope. Medium to poor drainage. Elevation 1120 feet.

Land-use History:

Cultivated field at one time. At time of planting, old mowing and pasture with scattering of white pine, gray birch, and pin cherry.

Silvicultural History:

Planting, 1924. 3826 white spruce, 3-0 stock, and 550 Asiatic spruce (*Picea shrenkiana*), 2-2 stock. Spacing 5 x 5. Harvard tool. Asiatic spruce planted pure west of white pine (24-G). 25 man-hours per acre.

Weeding, 1927. 3 man-hours per acre.

Replanting, 1927. 1410 white spruce, 2-2 stock. Original planting had failed to a large extent because of the small stock and heavy ground cover. 12 man-hours per acre.

Weeding, 1930. Scattered birch, aspen, and red maple sprouts removed. Spruce 1' - 2' high. 2 man-hours per acre.

Inspection, 1932. WHITE SPRUCE (South portion of stand): 1700 trees per acre. Average height, 2.8'. Average crown width, 1.8'. ASIATIC SPRUCE: Average height, 2.1'. Average crown width, 1.7'. Some white spruce mixed in with the Asiatic. These averaged 2.0' in height.

Weeding, 1933. Sprouts along north-south stone wall and in south portion of stand removed. 3 man-hours per acre.

Inspection, 1944. WHITE SPRUCE (South portion of stand): 1250 trees per acre. Average dbh of free trees, 3.5". Average height, 21'. ASIATIC SPRUCE: 1420 trees per acre. Average dbh of free trees, 2.8". Average height, 19'. In same area, 130 trees per acre of white spruce averaged 4.1" dbh and 21' in height.

Discussion:

Failure of the first planting points to the inadvisability of planting seedling stock on sites with a heavy sod cover. Both spruces have done well, but are inferior to the white and Norway spruce grown in mixture with red and white pine in nearby stands.

RED PINE AND WHITE SPRUCE

19-year-old Plantation on Mowing

PH I, 25-K
5.0 Acres

June 26, 1944

Soil:

Brookfield stony fine sandy loam.

Site:

Low slope with fair to poor drainage. Elevation 1150 feet.

Land-use History:

Alternately a cultivated field and a mowing for more than 100 years. At time of planting, a good mowing with heavy grass.

Silvicultural History:

Planting, 1925. 3225 red pine and 3300 white spruce, both 2-2 stock. Spacing 5 x 5. Harvard tool. Alternate rows of spruce planted 3 weeks after pine. Unusual care was taken to keep rows straight. 28 man-hours per acre.

Replanting, 1927. $\frac{3}{4}$ red pine and 225 white spruce, both 2-2 stock. $2\frac{1}{2}$ man-hours per acre.

Weeding, 1929-30. Hardwood weeds around edges removed. 1 man-hour per acre.

Weeding, 1932. Hardwood weeds around edges removed; also patch of older weeds near northeast corner. $\frac{1}{2}$ man-hour per acre.

Inspection, 1932. RED PINE: 740 trees per acre. Average height, 5.3'. Average crown width, 3.9'. WHITE SPRUCE: 840 trees per acre. Average height, 4.1'. Average crown width, 2.3'.

Weeding, 1935. Gray birch and red oak cut around edges. $\frac{1}{2}$ man-hour per acre.

Pruning, 1937. About 200 red pine crop trees per acre pruned to height of 8' - 10'. Area east of road only. 16 man-hours per acre.

Hurricane salvage, 1940. About 15% of trees leaning. These were removed wherever interfering with rest of stand.

Thinning and pruning, 1944. 18% of red pine and 40% of spruce removed. RED PINE: ~~570~~ trees per acre. Average dbh of free trees, 6.1". Average height, 31'. 200 crop trees per acre pruned to height of 17'. WHITE SPRUCE: 380 trees per acre, of which 270 are free to grow. Average dbh of free trees, 3.8"; all trees, 3.2". Average height, 27'.

Discussion:

A highly successful plantation. Both species are taller than those in pure plantations on similar sites. The mixture of red pine and white spruce results in the accelerated growth of the spruce, due to side pressure by the red pine. The pine, too, grows faster than in pure stands because of the greater amount of crown space which results from the slower growth of the spruce during the first 15 years.

RED PINE

19-year-old Plantation on Peach Orchard

PH III, 25-L
0.5 Acre

June 26, 1944

Soil:

Gloucester stony fine sandy loam.

Site:

Mid-slope. Well drained except along southern border. Elevation 1160 feet.

Land-use History:

Successively a cultivated field, a peach orchard, and a mowing. Heavy grass cover at time of planting.

Silvicultural History:

Planting, 1925. 737 red pine, 2-2 stock, from Harvard Forest nursery. Spacing 6 x 6. Harvard tool. 18 man-hours per acre.

Inspection, 1932. 1200 trees per acre. Average height, 5.7'. Average crown width, 4.7'.

Hurricane salvage, 1940. Stand badly damaged. Trees cut and lopped. About 35% of stand (near south border) in good condition.

Thinning, 1944. 12% of trees removed. Left were 900 trees per acre. Average dbh of free trees, 4.9". Average height, 27'.

Discussion:

Although this stand is 2 years younger than the adjoining white pine plantation, the trees are larger and in better condition. On less fertile soils, red pine outstrips white pine. Heavy snow in November 1943 caused considerable top breakage.

RED PINE AND NORWAY SPRUCE

18-year-old Plantations on Little Prospect

PH IV, 26-I, 26-J, 26-K
14.5 Acres

Soil:

Brookfield stony fine sandy loam.

Site:

Well-drained hilltop. Elevation 1250 feet.

Land-use History:

High pasture and apple orchard. About 1900, began seeding in to scattered scrubby white pine, gray birch, pin cherry, and red maple.

Silvicultural History:

Site preparation, 1924-25. Scattered pine and hardwoods cut. Slash burned.

Planting, 1926. Three areas. 2-2 stock. Spacing 6 x 6. Harvard tool. 22 man-hours per acre.

	Area	Species	No.
26-I	6.1	Red pine	6,425
26-J	3.6	Red pine Norway spruce	1,825 1,842
26-K	4.8	Norway spruce	5,726

Replanting, 1927. Pure spruce area only (26-K). 300 white spruce, 2-2 stock. 2 man-hours per acre.

Weedings, 1927, 1928, 1930, 1932, and 1938. Persistent hardwood competition removed, particularly in spruce stand. Total of 8 man-hours per acre.

Inspection, 1932.	Species	Trees/A	Ave. height	Average crown width
26-I	Red pine	1840	3.5'	2.6'
26-J	Red pine Norway spruce	580 600	3.5' 2.9'	2.3' 1.9'
26-K	Norway spruce	1100	3.1'	2.2'

Inspection, 1944.	Species	Trees/A	Ave. dbh free trees	Ave. height
26-I	Red pine	1110	4.3"	21'
26-J	Red pine Norway spruce	510 530	5.2" 3.3"	25' 25'
26-K	Norway spruce White spruce	1130 133	3.3" 3.1"	22'

Discussion:

Both species have done better in the mixed plantation than in pure stands. When grown with spruce in alternate rows, red pine does not stagnate readily but spreads out into crown space above the spruce, which is slower growing in early life. The spruce itself has greater height and less taper when grown in close competition with pine.

RED PINE, NORWAY AND WHITE SPRUCE
18-year-old Plantation on Mowing

PH I, 26-N
1.5 Acres

June 27, 1944

Soil:

Brookfield stony fine sandy loam.

Site:

Mid-slope. Well drained. Elevation 1140 feet.

Land-use History:

Formerly cultivated. At time of planting, the area was a mowing in good condition with a heavy grass cover.

Silvicultural History:

Planting, 1926. 950 red pine and 780 Norway spruce, both 2-2 stock. The spruce was poor stock, yellow in color, and was planted too deep. Spacing 4.5 x 5. Harvard tool. 23 man-hours per acre.

Replanting, 1927. 500 white spruce, 2-2 stock, to replace Norway spruce which appeared to be failing. 7 man-hours per acre.

Weeding, 1930. Borders only. 1 man-hour per acre.

Inspection, 1932.

	Trees/A	Ave. height	Average crown width
Red pine	960	5.1'	3.6'
Norway spruce	400	3.3'	2.2'
White spruce	290	2.4'	1.3'

Pruning, 1937. 200 selected crop trees per acre of all species were pruned to height of 5' - 8'. 14 man-hours per acre.

Thinning and pruning, 1944. 18% of the pine and 48% of the spruce removed. Red pine crop trees pruned to 17'. Control plot left.

Inspection, 1944.

	Trees /A	Ave. dbh free trees	Ave. height free trees
Red pine	690	5.8"	29'
Norway spruce	310	3.3"	26'
White spruce	20	2.7"	

Discussion:

The pine is in excellent condition because of the natural thinning resulting from the early slow growth of the spruce. The replanting with white spruce was not justified. Despite a poor start, the Norway spruce has come through much better than the white and will form a small part of the final stand.