HARVARD FOREST

BULLETIN No. 9

RICHARD T. FISHER, *Director*

RED PINE IN CENTRAL NEW ENGLAND

A Preliminary Study with Volume and Yield Tables

BY

PAUL M. REED

HARVARD FOREST, PETERSHAM, MASS.

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PREFACE

THIS brief report on red or Norway pine seems justified by the recent large increase in the popularity of the species for forest planting. The U. S. Forest Service has published a bulletin on "Norway Pine in the Lake States" (Bulletin No. 139, by H. H. Chapman and T. S. Woolsey, Jr.), but so far there is nothing in print about the species as it occurs in New England. Admittedly preliminary in character, the present study was largely reconnaissance. It may claim, however, to have located and to have examined most, if not all, the available stands in the region. Some of the material relating to planting and to the uses and market for the lumber was obtained from sources outside New England.

Acknowledgments are due, for information on marketing in the Lake States, to S. L. Coy of the Cloquet Lumber Company, St. Paul; for information on the cost of seed collection, to A. H. Richardson of the Provincial Forest Service, Ontario; for information about adaptability for pulpwood, to the U. S. Forest Products Laboratory, Madison, Wisconsin.

R. T. FISHER.

PETERSHAM, MASS.

RED PINE IN CENTRAL NEW ENGLAND

A PRELIMINARY STUDY WITH VOLUME AND YIELD TABLES

DISTRIBUTION AND ASSOCIATED SPECIES

THE general range of red pine (*Pinus resinosa*) extends from Minnesota and the Lake States south to Pennsylvania and eastward through southern Canada, New York, and New England. Among lumbermen and farmers it is generally known as Norway pine, hard pine, and occasionally yellow pine. Many people do not distinguish it from the native pitch pine. Red pine has needles in bunches of two, 4 inches to 6 inches long, and light reddish-brown bark, divided by shallow furrows into flat plates. On the other hand, pitch pine (*Pinus rigida*) has needles in bunches of three, 3 inches to 5 inches long, and a dark gray-black bark, rough and deeply furrowed. Pitch pine is in every respect inferior to red pine.

The region covered by this study probably represents the soils and climate where red pine is capable of its best development. This is indicated by the rate of growth and hardiness that it displays both in plantations and in natural stands. On the other hand, speaking in terms of area, there is extremely little red pine in the region. It occurs only in patches or scattered groups on the poorer, sandier soils and at points often many miles apart. All of the stands found in this survey were in the towns of Warwick, Petersham, Baldwinsville, Winchendon, Ashburnham and Groton, in north-central Massachusetts, and in Rindge, Jaffrey, Wilton, Newport, Sunapee and New London, in southern New Hampshire, between the elevations of 700 feet and 1300 feet. Above and below these limits the species is extremely rare.

In view of the history and past treatment of forest lands in the region, it is probable that most of the types in which red pine occurs are in a state of transition. The following classification covers the principal associations in which it is found:

1. Pure Red Pine. Red pine in pure stands is found chiefly on sand plains or gravelly knolls where the soil is relatively dry and unfertile. (Fig. 1.) Like white pine it forms a permanent type only on the lighter soils where hardwoods do not offer effective competition. Being less exacting in soil requirements than white pine, it is able to flourish on even poorer soils. In such cases the stands are usually uneven-aged.

Like white pine it also forms at times a temporary type on old fields, but here again it usually is found on the lighter or more gravelly soils.

2. Mixed Red and White Pine. Red pine is most commonly found associated with white pine in more or less even-aged stands on abandoned farm lands. Such sites are at present of poor to medium quality, although they were undoubtedly better under the original forest conditions and are capable of being restored in time to their former fertility.

3. Red Pine and Mixed Hardwoods. Red pine sometimes occurs in old-field stands with white pine and mixed hardwoods. Such stands are roughly even-aged and for the most part occur on medium soils. The hardwoods include paper birch, gray birch, black cherry and red maple, species that come in on open land under conditions of exposure which do not favor the better hardwoods.

4. Red Pine and Other Conifers. On moist flats, particularly in the northern part of the region, stands of mixed conifers form a relatively permanent type which promises to yield a high grade of timber owing to the admixture of such

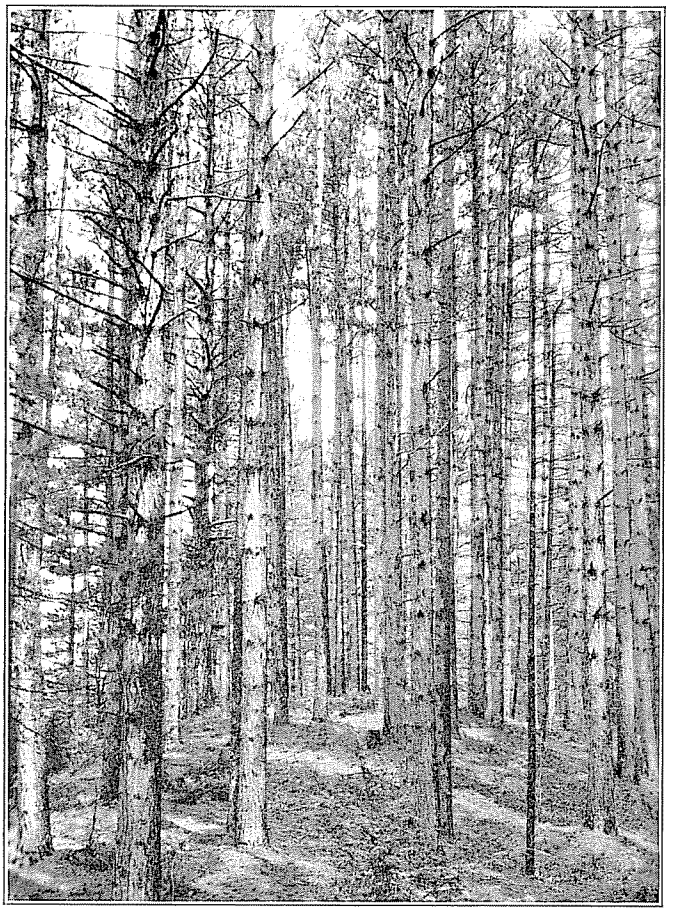

FIG. 1. STAND OF PURE RED PINE 80 YEARS OLD ON OLD PASTURE

Diameters breast high of dominant trees 9–15 inches; average height 77 feet. Volume per acre 68,540 board feet.

Photographed by A. C. Cline

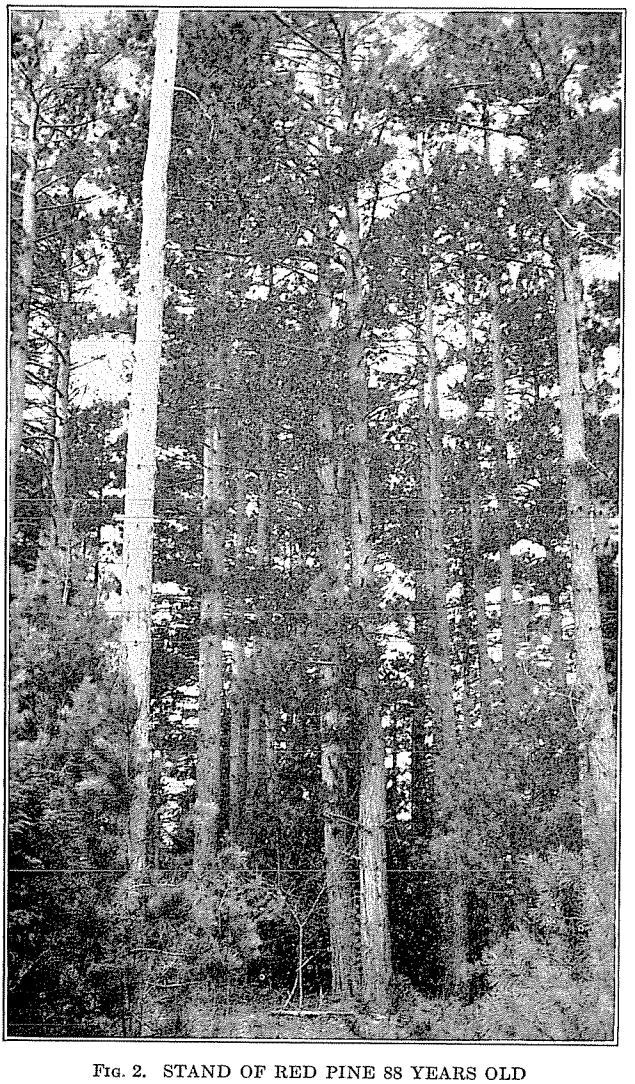

FIG. 2. STAND OF RED PINE 88 YEARS OLD
Average diameter breast high 16 inches; average height 91 feet.
Photographed by A. C. Cline

shade-tolerant species as hemlock and spruce, both excellent pruners of pine. Balsam fir and red pine complete the usual composition of the type.

The most striking fact with regard to local distribution is that a species of such general vigor should be on the whole so scarce.

SOIL REQUIREMENTS

Red pine was found only sporadically on the heavier soils. Normally it is confined to the sandy sites, in which respect it is plainly less exacting than white pine. Wherever red and white pine are found occurring together on sandy soils, the red pine for its age is always the larger, often strikingly so. A particularly sterile site, for example, after two attempts had been made at planting it to white pine, was finally planted to red pine, which not only survived, but made vigorous growth. No local softwood, except pitch pine, will thrive on such poor soils. In the natural forest red pine is apparently unable to compete successfully for the better class of soils.

HABIT OF GROWTH

Mature red pine growing in a forest presents an appearance unexcelled by any other native conifer. The nearly cylindrical boles with their light reddish-brown bark are clean of dead branches and often extend up fifty feet to the first live limb. (Fig. 2.) The crown is very regular and uniform, resembling a broad-based cone whose sides are slightly rounded outward. Young trees are limby, but the lower branches soon die and fall off in well-stocked stands so that the average knot size in red-pine lumber seldom exceeds one inch. The branches leave the bole at about the same angle as those of white pine, but near the tip they abruptly turn upward, while white-pine branches hold their original direc-

tion. Very rarely is a forked stem found. In the present survey the oldest tree was 123 years old. For the last thirty years growth had been practically at a standstill, not for lack of growing space, as the crown was free from neighboring trees, but apparently due entirely to age. Cores taken with an increment borer from trees on the sample plots showed that from sixty years on there was a marked slowing up. The largest trees found had a maximum height of 95 feet with diameters ranging from fifteen to eighteen inches in from eighty to ninety years. In shade the degree of taper is noticeably less than when the tree grows in the open. During the first twenty-five years of its growth red pine characteristically has more taper than white pine; but the form of white pine is altered by shading more easily than that of red pine.

EFFECT OF PARTIAL SHADING ON HEIGHT GROWTH

Red pine is ordinarily classed as a species intolerant of shade. Since much of the present and prospective planting of the species involves competition with various kinds of broad-leaved vegetation, a study of height growth in relation to available light was made in a plantation on the Harvard Forest. The history of the plantation was as follows:

A mature stand of white pine was clearcut during the winter of 1916–17. The advance-growth hardwood was cut to the ground and all slash piled and burned. The land slopes gently to the west and north. The soil is a light, sandy loam, the surface of which is very rocky, large boulders being plentiful. An examination of this area at the end of the second growing season (September 1918) showed that the ground cover was scanty, being composed of club moss, occasional clumps of grass, and other herbaceous vegetation. The reproduction consisted of mixed hardwoods four to five feet in height, and scattered white-pine seedlings four years

old. A clearer idea of the species and their distribution may be obtained from the following tabulation:

AMOUNT AND CHARACTER OF REPRODUCTION ON THE AREA AT THE END OF THE SECOND GROWING SEASON AFTER CUTTING, REDUCED TO NUMBER OF TREES PER ACRE. SEPTEMBER 1918

TABULATION BY SPECIES AND ORIGIN

Species	Seedlings	Seedling Sprouts	Stump Sprouts	Total
White ash	...	1440	20	1460
White pine	350	...	..	350
Red oak	...	250	..	250
Hard maple	...	170	..	170
Chestnut	...	110	5	115
Poplar	25	60	..	85
Black cherry	10	50	..	60
Birch	20	30	5	55
Red maple	...	50	20	70
White oak	...	20	..	20
Basswood	5	20	..	25
Hickory	...	10	..	10

During the following spring (April 1919), this area was planted with red-pine transplants which were five years old and averaged fifteen inches in height. The trees were spaced 6 feet by 6 feet in openings and in poorly stocked places. No further operations had taken place at the time the present study was made (September 1923).

An instrument was constructed to measure the "weighted hours" of sunlight which the trees in the plantation received during a day. Credit is given to P. R. Gast for this idea and for his help in perfecting the apparatus. A piece of cardboard was cut in the form of a half circle, having a radius of $8\frac{1}{2}$ inches. The half circle was then divided into twelve equal segments, representing the hours of sunlight from 6 A.M. to 6 P.M. and were numbered accordingly. Since the sun furnishes two of the factors necessary to the physiological processes of trees, that is, heat and light, and since it has been proved that one hour of sunlight near the middle of

the day is of more relative importance to a tree than one hour of sunlight in the early morning or late afternoon,[1] it is at once obvious that each hour must be given a proportionate value. Hence the term "weighted hours." A weighted hour as used in this work means the relative value of each individual hour of sunlight that a tree receives expressed in gram-calories of heat. The "Monthly Weather Review" for August 1914 contains a table giving solar and sky radiation expressed in gram-calories.[2] By averaging the results given in that table, a value was found for each hour of sunlight from 6 A.M. to 6 P.M. After these values had been placed in their respective positions on the cardboard half circle, the latter was fastened on the surface of a board carrying a compass to insure correct orientation in the field.

In use, this instrument was held horizontally at the tip of the tree whose hours of light were to be measured. The board was then turned in its plane until the point on the circumference of the half circle indicating noon pointed due south. When this was done, the hours during which the tree received its light were recorded by noting the position of the surrounding trees and during which hours of the day their shade was cast on the tree being measured, the value of each hour being indicated on the instrument.

By this method observations were made on 180 red pines. On the area covered there were two fairly distinct topographical sites, a small summit or plateau, and a stretch of bench or terrace with somewhat less rapid drainage. The trees on these two sites were dealt with in separate groups. Other than this, differences in general drainage conditions, the soil, and the distribution of associated hardwood reproduction were uniform. The two graphs presented in Fig. 3

[1] Zon, Raphael, and Graves, Henry S., Light in Relation to Tree Growth. *U. S. D. A. Forest Service* Bulletin 92.

[2] Monthly Weather Review, Volume 42, No. 8, Table 9. *U.S.D.A. Weather Bureau.*

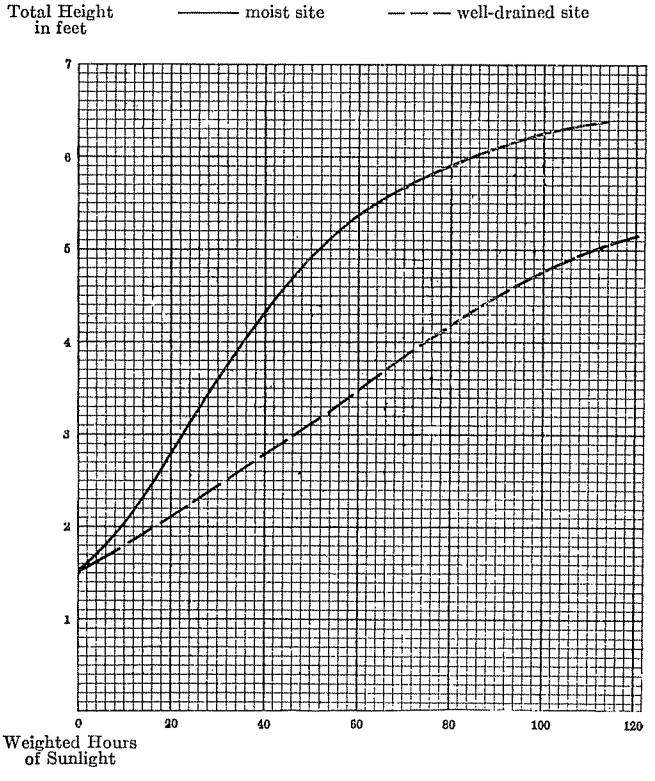

FIG. 3. GRAPH SHOWING RELATION OF HEIGHT GROWTH TO SHADE

Red pine ten years from seed planted in young hardwoods.

with one exception, consisted of white pine more or less in groups. The exception was evidenced by a twenty-three-inch stump of red pine, which at the time of cutting was forty-eight years old. Thus it became clear that the present groups of red pine, ranging in age from twenty to thirty-five years, originated during the fifteen-year period prior to the cutting twenty years ago. During this period the old stand was interspersed with small openings on which there was apparently little, if any, ground cover other than scanty grass. Since the cutting practically no reproduction of red pine has taken place. Until some of the older trees in the present groups started to bear seed, no reproduction could have been expected; but certainly for the past ten years plenty of seed had been scattered. The lack of recent reproduction can be accounted for only by the thick mat of lichen and low-bush blueberry which came in as a result of the logging, and before the present red pines were old enough to bear seed. It was observed in several other places not far from this plot that wherever large holes existed in pine stands on sandy soils, whether caused by cutting or mere accident, a thick mat of ground cover very soon developed. Similar though more casual observations in many places in this region strengthen the belief that even though an area be completely exposed, red-pine seedlings are unable to persist where there is a heavy ground cover. Even a grass cover, which apparently is no hindrance to white pine, precludes the establishment of red pine.

INSECT ENEMIES

Red pine is relatively free from insect attack and probably has fewer serious insect enemies than any other eastern conifer. There is, however, some danger from insect attack to young-growth red pine, especially in nurseries, parks, and areas of reforestation, with lighter damage to the mature forest-grown trees.

The following list of insects injurious to red pine, together with a few notes regarding each one, has been prepared by H. B. Peirson, Forest Entomologist, Augusta, Maine:

I. Insects Attacking the Trunk or Bole

There are several species of round-headed and flat-headed borers which attack weakened or felled trees, but which are not a menace to green standing timber. Damage from these is best prevented by quick utilization of all logs cut in the spring or summer. The three species most commonly observed working in red pine are two species of Monochammus: *Monochammus notatus* (brown in color) and *Monochammus scutellatus* (black in color), both of which are robust, long-horned beetles; and *Chalcophora virginiensis*, a flat-headed borer, oblong-oval in shape and of a brassy or copper color.

The pitch-drop worm, *Nephoteryx zimmermanni*, and several species of bark beetle are commonly found in red pine, but there is no record of these assuming epidemic form. The bark beetles are purely secondary, attacking only dead or dying trees.

II. Insects Attacking the Bark

Considerable damage is done by the Pales weevil, *Hylobius pales*, to red-pine plantations which have been set out on recently cut-over white-pine land. The Pales weevil is a snout beetle which breeds in freshly cut white pine stumps or logs, and feeds on the bark of coniferous seedlings, girdling and killing them. It is unsafe to plant such an area until the third year after cutting.

III. Insects Attacking Buds and Shoots

The larvae of the European pine-shoot moth, *Evetria buoliana*, bore into and hollow out the terminal buds of pine, moving from one to another, and the second year hollow out

the entire shoot. At times they destroy a large number of buds and shoots, and injure many other shoots which normally would supplant the destroyed leaders, thus permanently disfiguring the tree. The injured shoots bend downward and outward, then curve upward in an attempt to continue the normal upward growth of the tree. The insect attacks principally trees between the ages of six and fifteen years, but is reported as at times being very destructive to younger plantings and seedlings. It is best controlled by pruning and destroying the infested buds and twigs. This can be done at any time except during the summer months. The most satisfactory time, however, is during the fall or winter. At this time the injury, although not so apparent as in the late spring, shows up as a slight exudation of pitch at the base of the infested buds. Pruning at this time allows the secondary buds to develop.

IV. Insects Attacking the Foliage

The larvae of Leconte's sawfly, *Neodiprion lecontei*, are at times very destructive to young pines, both nursery stock and natural reproduction. Defoliation of young pines is usually severe in its effects, either killing the trees outright, misshaping them, or weakening them to such an extent that they are easily susceptible to secondary enemies. When young, the larvae are pale white with brownish heads; but as they mature, the body becomes yellowish white with a number of rows of black spots. The head changes to a dark-brown or orange color. When full grown the larvae are three fourths of an inch in length. The most satisfactory control is to spray the young trees with arsenate of lead at the rate of six teaspoonfuls to a gallon of water immediately after the larvae are found.

The larvae of the imported sawfly, *Diprion simile*, has been reported as feeding on red pine. This insect has recently made its appearance in nurseries and on estates in New England and is to be regarded as a serious enemy. The

five-needle pines, however, are its favorite host. So far the sawfly has shown a decided preference for young trees. The color of the larvae changes during its growth from a dull gray to a velvety black and yellow, the head remaining black. At present, control is limited to spraying as in the case of Leconte's sawfly.

FUNGUS, STORM AND FIRE

During the course of this study, 200 cores were taken with an increment borer and in not a single case was rot of any kind found. The stands where these borings were taken were widely distributed over two states, so it is probably safe to assume that standing red pine in this region is quite free from fungus enemies.

Wind and snow do very little damage. No uprooted trees were found, but this is no more than what might be expected after observing the strong wide-spreading root system. Injury caused by snow was found only once: in a 6 by 6 plantation where the side branches were just beginning to interlace, some of them were torn from the trunks as a result of the weight of the snow.

Red pine will stand a much more severe fire than white pine. In a mixed stand of red and white pine twenty years old, where a fire had burned over several acres, the white pine was all dead except for small groups which grew in low, sheltered places; while the red pine, although scorched well up the boles, showed no other ill effects. This area was burned over in 1922. In 1925 the white pine still had a badly blistered appearance, but the red-pine bark was merely scorched. It thus appears that red pine suffers relatively little damage from natural causes.

SILVICULTURAL TREATMENT

In the present status of silvicultural practice, no definite conclusions can be stated regarding methods of natural reproduction. Having regard to the habits of the species as noted above, direct planting seems to be considerably less expensive and more certain than natural seeding. Nevertheless, on sites more favorable to red pine than to other softwoods, that is to say, on the lighter soils, it is probable that natural reproduction will prove successful. However, no method of natural reproduction would be effective unless heavy ground cover were kept out and surface soil considerably broken up by the logging, or otherwise.

Although red pine bears seed every three years, a good crop of cones is not expected oftener than once in six years. 1923 was considered a good seed year in this region. Cones were collected at a price of from $2.00 to $8.00 a bushel. This cost is considered high, due to the scattered distribution of the stands and the necessary employment of inexperienced men. With a good crop and experienced men, it should not cost over $3.00 a bushel to collect cones here. There are about 1500 cones to the bushel, or approximately 60,000 seeds. It was found that the number of seeds per cone varied; large cones yielded fifty to sixty seeds while small cones contained only ten to fifteen seeds. Seed-extracting plants have averaged between .3 and .5 pounds of seed per bushel of cones, depending upon the seed year. The heaviest yield of seed always occurs when there is a large crop of cones. The extraction of seed costs from $3.50 to $5.50 per pound.

Red pine is one of the most satisfactory trees to raise, not only because the germination per cent is high, but also because it is easy to transplant and the percentage of loss from damping off and other causes is comparatively low. In selecting stock for planting, the first thing to consider is the condition of the area; and second, the size and vigor of the stock. In open fields and pastures where the ground cover

FIG. 4. PLANTATION OF RED PINE 38 YEARS OLD PLANTED 4′ x 4′

Diameter breast high of dominant trees 7–11 inches; average height 52.8 feet. Volume per acre 39,240 board feet.

Photographed by P. M. Reed

is scanty, two-year seedlings have given excellent results. Two-year seedlings cost much less than transplants and they are easier to handle. On areas where the underbrush is heavy or on cut-over land where hardwood competition is expected, thrifty three- or four-year old transplants should be used. In most of the plantations examined, the spacing was 6 by 6. In one plantation on the Harvard Forest, twelve years from the seed, the side branches were just beginning to interlace and the branches in the first six feet averaged three fourths of an inch in thickness. Fig. 4 shows a plantation thirty-eight years old in which the trees had been planted 4 by 4. The knot sizes in the first twelve feet averaged from .5 to .7 of an inch. Since the size and number of knots per board are the governing factors of quality in lumber grown on short rotations, it is evident at once that if knot sizes can be controlled, the quality of the lumber can be greatly improved. In Harvard Forest Bulletin No. 7 it has been shown that for a given site, the knot size is determined by the length of time it takes for the crowns of a stand of white pine to meet and form a complete crown canopy. As red pine is more shade-intolerant than white pine, the effect of a spacing closer than 6 by 6 is felt more quickly and results in an earlier cleaning of the boles and smaller knots. Field observations indicate that for high quality, 4 by 4 is the most desirable spacing to use in planting red pine.

VOLUME, YIELD, AND GROWTH

The following volume tables are based on measurements taken on 108 trees twenty to ninety years old, selected in well-stocked stands. The volumes include that portion of the tree between a one-foot stump and a four-inch top. As no red pine was being cut in the region, it was necessary to climb the trees for the required measurements. A cord was marked at intervals of twelve feet (the standard log length here) and weighted at one end. With this cord the climber

could tell when he was twelve, twenty-four, thirty-six, etc. feet from the ground. Diameters were taken at the stump, breast high, and at the end of each twelve-foot section to a four-inch top, this being considered the merchantable portion of the tree. Other measurements recorded for each individual tree were total height, height to first live limb, crown radius, bark thickness, and age. The merchantable volumes for individual trees were found by computing each log separately. In figuring the volumes of the individual sections, the formula for the frustrum of a cone was used for the butt and tip logs, and the formula for the frustrum of a paraboloid for the middle logs. The use of these formulae was indicated by the rates of taper as plotted on cross-section paper.

TABLE I. VOLUMES IN CUBIC FEET

D. B. H. (Inches)	Total Height (Feet) 30	40	50	60	70	80	90
5	2.2	...	...	...	...	...	...
6	3.2	4.2	5.0	...	...	...	...
7	4.3	5.7	7.0	8.3	...	...	...
8	...	7.4	9.2	11.0	12.8	...	...
9	...	9.5	11.7	14.0	16.2	...	...
10	...	11.7	14.5	17.2	20.0	22.7	...
11	...	14.2	17.5	20.8	24.2	27.5	30.7
12	...	16.8	20.7	24.7	28.8	32.7	36.7
13	...	19.5	24.2	28.8	33.5	38.2	42.7
14	...	...	28.0	33.4	38.9	44.2	49.5
15	...	...	32.0	38.3	44.5	50.7	56.7

This table shows that the cubic-foot volumes slightly exceed those for white pine of the same life history, height and diameter. (See Table 12 in "Forest Mensuration," published by the Commonwealth of Massachusetts.) In the absence of any data on red-pine logs for the actual board-foot yield in round-edge lumber, the volumes in Table II were computed by assuming that the ratio between the cubic-foot contents of trees of the two species would hold for board

feet. In fact, red-pine logs, showing less taper, would probably yield slightly more than the figures indicate.

TABLE II. VOLUMES IN BOARD FEET OF ROUND-EDGE LUMBER

D. B. H. (Inches)	Total Height. (Feet) 30	40	50	60	70	80	90
5	12	..	..	..	..	...	...
6	19	25	35	..	..	...	...
7	25	39	46	54	..	...	...
8	..	43	59	73	91	...	...
9	..	55	70	93	114	...	...
10	..	67	91	109	140	157	...
11	..	80	108	134	164	188	214
12	..	91	123	158	186	219	250
13	..	102	142	180	218	259	287
14	..	..	165	204	257	296	352
15	..	..	191	235	288	342	389

A thorough combing of the region covered by this study furnished only nine plots which were suitable for a statement of yield per acre. Most of the stands were either too open or not of sufficient area to be of use. Five of these plots were taken on medium soils containing some loam so that they approached site II conditions. The other four were plainly on a still poorer site, the soils being chiefly sand and gravel. Fortunately, when plotted, the volumes per acre furnished points falling into two groups, which justified the drawing of two very tentative curves. Thus Table III shows roughly what the yields of volunteer red-pine stands are on these two types of soil. Under the conditions no exact site classification was possible, so for convenience the terms "medium soils" and "poor soils" are used.

TABLE III. YIELD PER ACRE IN BOARD FEET OF ROUND-EDGE LUMBER

Age Years	Volume	
	Medium Soils	Poor Soils
20	7,000	4,500
25	14,500	7,500
30	25,000	11,500
35	35,000	15,500
40	42,500	20,000
45	48,000	24,700
50	52,500	29,000
55	56,000	33,000
60	58,800	36,500
65	61,000	39,200
70	63,000	41,500

The yields of red pine given above for the medium soils range from 15 per cent to 50 per cent higher than those given in any of the white-pine-yield tables for this region. It is true that these figures of yield are based upon insufficient data and that the nine sample plots represent exceptionally well-stocked stands. Nevertheless, the conclusion is fair that a greater volume of red pine than of white pine can be grown on an acre for a given (and short) rotation.

To furnish an idea of the height growth on the two classes of soils mentioned, 232 trees were measured. After maximum and minimum curves had been plotted, the range was divided by two average height curves and the results recorded in Table IV.

TABLE IV. TOTAL HEIGHT ON BASIS OF AGE

Age Years	Height	
	Medium Soils	Poor Soils
20	22	15
25	31	22
30	39	28
35	46	34
40	53	39
45	58	44
50	63	48
55	67	52
60	70	55
65	73	58
70	76	61
75	78	64
80	80	66

Measurements of diameter growth at breast height were similarly plotted. Table V gives the average diameters on the two types of soil previously described.

TABLE V. DIAMETER BREAST HIGH ON BASIS OF AGE

Age Years	D. B. H. (Inches) Medium Scils	Poor Soils
20	3.5	2.8
25	5.6	3.8
30	7.9	5.0
35	9.6	6.2
40	11.0	7.3
45	12.1	8.5
50	13.0	9.5
55	13.8	10.4
60	14.5	11.2
65	15.2	12.0
70	15.7	12.6
75	16.3	13.2
80	16.7	13.8

Based on 217 trees

Properties and Uses

Red pine has always held an important position among the timber trees of this country. If large quantities had not been marketed as white pine, red pine would have been much oftener heard of during the years when the Lake States were sending their billions of feet of lumber to the markets. At an early date red pine from Canada and northern New York was popular ship timber in this country and England. Slender, straight trees were selected as masts, or were sawed for decking planks thirty or forty feet long. The British navy was still using some red-pine masts as late as 1875. For many years Chicago was the center of the red-pine trade, but the scarcity of this timber has retired it from some of the uses which it once filled, and southern yellow pine has been substituted. Lumber companies in Minnesota are sawing large quantities of red pine into dimension stock. On the market it is considered as second only to white pine. It

is much desired for car building. In 1909 the state of Illinois used 24,794,000 feet for all purposes and 14,783,000 feet in car construction. As we come to rely more on trees which will produce merchantable timber rapidly on the poorer soils, the importance of red pine should continue to increase.

A comparison of white pine and red shows that red pine is considerably heavier, harder, stiffer, and higher in shock-resisting ability and in strength as a beam or post. It is also about 50 per cent higher in shrinkage and consequently will not stay in place as well as white pine. Where there is an excessive amount of steam and moisture, red pine will not last as long as white pine. Red pine takes preservative treatment readily, especially in the round form, and small trees, such as might come from thinnings, should make excellent fence posts if creosoted. It is not a very satisfactory wood for the manufacture of paper pulp by either the groundwood or the sulphite processes. It is capable of reduction, however, by the sulphate process to a very satisfactory grade of kraft pulp and is equal to any species for this purpose. The greater specific gravity of red pine renders the yield of sulphate pulp per cord of wood higher than that obtained from any of the northern coniferous pulpwoods, and it compares very favorably with the southern pines in this respect.

Within the region of this study, the uses of red pine have been very limited, due partly to its scarcity, and partly to its relative inferiority to the plentiful white pine. Red pine has been used to some extent in the manufacture of boxes and pails. When used for pails it is never mixed with white pine, but always is sorted out and used alone to offset the difference in shrinkage of the two species. Red pine has not been used for match blocks. When used for boxes with white pine, red-pine shooks are placed with a shook of white on either side so as to correct the tendency to warp. Some mill owners select red pine in preference to white for timber in their mills. It is more durable than white pine where no steam or moisture is present. Mill men agree that red pine

is harder to work than white pine, but it is being put into dimension stock in New England and when cut from mature trees and when properly dried, makes good building material. Dimension stock from the younger trees, particularly if piled in loose piles, does not hold its shape. It is probable that much of the present objection to the red pine as lumber is because there has not recently been enough of it for users to learn how it should be handled. The species has many desirable qualities and unquestionably as it becomes more plentiful, satisfactory uses for it will be found.