

THE BLACK ROCK FOREST

BULLETIN NO. 3

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A STUDY OF SEVERAL CONIFEROUS UNDER- PLANTINGS IN THE UPPER HUDSON HIGHLANDS

BY

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WITH AN INTRODUCTION BY A. B. RECKNAGEL



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INTRODUCTION

SINCE earliest childhood I have been familiar with the Hudson Highlands. When I first became acquainted with the region, it was still one where timber cutting was going on at a rather rapid rate. Since then the blocking up of private estates and the change in economic conditions have made it a region primarily of value for constructive development of the area in respect to recreation and the maintenance of a forest cover.

This is naturally a hardwood region, and the attempts which the Bulletin sets forth to introduce a coniferous admixture by underplanting have met with the usual results attendant upon such efforts. The shade of hardwoods is so dominant as to make the life of even the hardiest conifers one of continuous attrition. Only by severely cutting into the hardwood overstory can the coniferous plantation be brought to vigorous growth. I have watched these plantations for the past fifteen years and am aware of the constant struggle which these two conflicting elements wage. It is not surprising that the growth of hardwoods must be held in check, since they are after all the native trees and the conifers are the intruders.

Once the decision is reached to raise conifers, the success depends entirely upon such cultural operations as the cleanings, thinnings and important cuttings with which the Bulletin deals.

The Black Rock Forest is doing a real service, not only to the forest owners of the Hudson Highlands but to all others as well who are interested in similar problems. It is the practical work which this Bulletin sets forth that can point the way to successful development of forests.

It is too much to hope for the immediate application of intensive forest practice to all areas in the Hudson Highlands. However, we have Nature fighting on our side, and with the increasing precaution against loss from fires, from insects, from fungi and, last but not least, from the depredations of the human animal, it remains only to point out the way to improvement and to follow this way if best results are to be attained. This Bulletin will help the owner to apply the best measures to his own land and it has the strong advantage of being based not upon theory but upon hard-headed facts and actual measurements of conditions as they occur in the field. The Black Rock Forest deserves high commendation of professional foresters and of forest owners for the progressive and helpful work which it is doing.

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FOREWORD

DURING the last quarter century, in portions of the upper Highlands of the Hudson River, underplanting of local hardwoods with various coniferous species has been not infrequently practiced. Outside of fire protection, the great majority of these plantings have received no attention or care since the day they were set. In some areas the overwood has been thinned lightly once or twice under the German system. In one case the brush and hardwood sprouts have been occasionally cut back; and in two areas a well-defined release cutting has been made. To-day there appears such a marked difference in the growth of the tended and some of the untended plantations that we deem it timely to set forth what now seem to be obvious and helpful conclusions regarding the establishment of such plantings.

We wish to express here our appreciation of the kindness of Mr. Rudolf Pagenstecher, Dr. E. G. Stillman, Mr. Thomas Smidt, the Estate of Dr. E. L. Partridge, the Estate of Mr. C. C. Stillman, Mr. L. V. Ledoux and the United States Military Academy in permitting us to measure and to photograph their various plantings and in supplying us with the essential data covering the establishment of these settings. We desire also to acknowledge the many helpful suggestions supplied by Professor Richard T. Fisher, Director of the Harvard Forest, Petersham, Mass.

REASONS FOR THIS STUDY

THIS paper is intended primarily for the non-technical owner of forest land. It was suggested in part by the considerable number of instances observed in the northeastern states where high hardwood forests had been underplanted to conifers without later cultural treatment and with consequent failure of the plantation; and also in part by the number of inquiries received at the Forest headquarters regarding the advisability of establishing close-set, coniferous plantations under the high shade of the local hardwoods, using the two or four-year old stock furnished by the State Conservation Commission. Such inquiries, when analysed, have invariably shown no plans whatever for any subsequent treatment or tending of either the plantation or the main hardwood stand.

Many foresters now agree that in these northeastern states there has been much unintelligent reforestation and afforestation, especially along the lines of underplanting.

In view of the above mentioned inquiries, coupled with the fact that the Forest headquarters lie in a region where a number of such unsuccessful efforts are available for detailed examination, this brief study has been made with the idea of demonstrating to the layman the impossibility of obtaining satisfactory results by the methods often used.

LOCATION AND GENERAL DESCRIPTION OF THE AREAS EXAMINED

ALL of the planted areas examined in this study were in the towns of Cornwall and Highlands, and in the reser-

vation of the United States Military Academy, West Point, Orange County, New York. In no case were they commercial plantings. The work was done chiefly as an experiment, the hope being to improve the appearance of the forest. In some cases an extremely close spacing was used, the intent having been the ultimate complete conversion of the indigenous hardwood cover to a pure coniferous stand. In other cases, probably with the idea of producing a mixed cover, a much wider spacing was adopted.

Practically all of these plantings were made in rough, stony land having a well-drained, gravelly, porous soil of no great degree of fertility. Owing to the character of the ownerships, these holdings have been more or less broken up by open fields and dirt roads. What few woods fires have occurred have not travelled far. During the past fifty years such damage has been rare, and consequently soil conditions are somewhat better than those found in the outlying wooded areas where picknicking and hunting, with attendant fire injury, are more frequent.

THE FOREST COVER

In former years, before the tracts in question were excluded from commercial exploitation chiefly by becoming private estates for summer occupancy, there prevailed hereabouts much indiscriminate clear cutting. This practice, coupled with the frequent fires which formerly occurred, has left these areas in a somewhat sub-normal condition, although, comparatively speaking, in better shape than the outlying lands. Most of the trees are of sprout origin; the soils are none too fertile. Additional concrete evidence of many fires still persists in the form of cat-faces and infected butts. Further, the natural reproduction is somewhat less abundant than might be expected under stands where the cover is mostly



PLATE I. NORWAY SPRUCE; PLANTED IN 1912 IN AN OLD FIELD AND UNDER THE LARGE, SPREADING, OPEN-GROWN WHITE OAK IN THE BACKGROUND. NO CULTURAL TREATMENT GIVEN. THIS INDIVIDUAL, WHILE THRIFTY AND STURDY IS YET ABLE TO RESPOND TO RELEASE DESPITE ITS HAVING BEEN SHADED DURING ITS ENTIRE LIFETIME. HEIGHT, 44 INCHES.



PLATE II. NORWAY SPRUCE; 2 TO 3 YEAR OLD STOCK FROM THE N. Y. STATE CONSERVATION DEPT.; PLANTED IN 1917 IN THE OPEN IN AN OLD FIELD. NO CULTURAL TREATMENT, BUT NEVER SHADED. AVERAGE HEIGHT 15 FEET. CONTRAST THE GROWTH OF THESE TREES, APPROXIMATELY 15 YEARS OLD, WITH THE SHADED 20-YEAR OLD INDIVIDUAL SHOWN IN PLATE I.

composed of species possessing in general a good degree of tolerance of shade.

The overwood was the mixed hardwood forest typical of the Upper Hudson Highlands. Red, Chestnut, and White Oak were the dominant species, with Hard Maple, Red Maple, White Ash, Black Birch, Yellow Birch, and an occasional Gray Birch, Ironwood, Hornbeam, and Dogwood. Much of this hardwood cover was of fair fuelwood size. Only here and there had the trees reached sawlog dimensions.

THE SOILS AND SITES

All of the planted areas examined showed a rather heavy, occasionally gravelly, brown silty clay loam, not infrequently compacted, especially in the deeper layers and with no convincing evidence of erosion. The present humus content is moderate, yet not abnormally low.

The sites are all sloping, with a generally northeast to northwest aspect.

THE SPECIES PLANTED

PLANTATIONS of the following nine species were examined:—

Norway Spruce	<i>Picea excelsa</i>
Norway Pine (Red Pine)	<i>Pinus resinosa</i>
American Larch	<i>Larix americana</i>
Balsam Fir	<i>Abies balsamea</i>
Scotch Pine	<i>Pinus sylvestris</i>
White Pine	<i>Pinus strobus</i>
Douglas Fir	<i>Pseudotsuga taxifolia</i>
Sitka Spruce	<i>Picea sitchensis</i>
Silver Fir	<i>Abies pectinata</i>

METHOD OF EXAMINATION

UNDERPLANTINGS on six different holdings were inspected. Each area was studied with reference to spacing, species, soil conditions, slope and aspect, and the forest cover both at the time of planting and at present. Numerous total heights were taken. We have tabulated, as accurately as the available information affords, all alterations that have been effected both in the plantation and in the main forest cover since the planting. We have also secured, so far as is possible, detailed data covering the age and source of the nursery stock used, together with the planting method employed.

DETAILS OF THE AREAS EXAMINED

TWENTY-SEVEN planted areas were examined. In several cases it was not possible to determine exactly either the source or the age of the stock used, or the planting method. In Table I is shown, the respective ages and sources of supply.

TABLE No. I

SPECIES, SOURCE AND AGE OF STOCK

<i>Species</i>	<i>Source</i>	<i>Total Age at Planting (years)</i>
Norway Spruce	N. Y. Conservation Department.....	2-3
Norway Pine	“ “ “	2-3
American Larch	“ “ “	2
White Pine	“ “ “	2-3
Balsam Fir	Hamburg, Germany	3
Scotch Pine	“ “	3
Silver Fir	“ “	3
Sitka Spruce	Unknown	3
Douglas Fir	“	3



PLATE III. NORWAY SPRUCE; AGE AT PLANTING UNKNOWN. PLANTED CIRCA 1880 AS A SCREEN FOR A RESIDENCE. NO CULTURAL TREATMENT. THESE TREES ARE BETWEEN 50 AND 60 YEARS OLD; THE CENTER ONE IS 60 FEET HIGH. THIS PLANTING IS ONLY THREE TIMES AS OLD, YET SEVENTEEN TIMES AS HIGH AS THE TREE IN PLATE I.



PLATE IV. NORWAY PINE; 2 OR 3 YEAR OLD STOCK FROM THE N. Y. STATE CONSERVATION DEPT., PLANTED IN 1918 UNDER HIGH RED, CHESTNUT, AND WHITE OAK. NO CULTURAL TREATMENT. THE SADDLE BAG IN THE FOREGROUND STANDS 12 INCHES HIGH. THE AVERAGE TOTAL HEIGHT OF THIS PLANTATION IS 39 INCHES.

In Table No. II according to species and whether tended, untended, or open grown, are listed the numbers of planted areas studied.

TABLE No. II
THE NUMBER OF PLANTED AREAS EXAMINED

<i>Species</i>	<i>Untended</i>	<i>Tended</i>	<i>Open Grown</i>
Norway Spruce	6	3	2
Norway Pine	1	—	2
American Larch	—	—	2
Balsam Fir	3	—	—
Scotch Pine	2	—	1
White Pine	2	—	—
Douglas Fir	—	—	1
Sitka Spruce	1	—	—
Silver Fir	—	1	—
Totals	15	4	8

A spacing of four to six feet was generally used. So far as we could learn, practically all of the planting work was done with a mattock, and in a careful, thorough fashion.

Except in the case of three of the Norway Spruce areas, and one of the Silver Fir plantings, no evidence was found of any subsequent treatment following setting. In two instances the underbrush and sprouts had been cut back at successive irregular intervals with little apparent effect on the underplanted conifers. In this case the trees were of no greater average height than the Norway Spruce which had had no attention at all. The other two Spruce areas had been given a complete release cutting fifteen years after planting, which entirely removed the hardwood overstory. This was a cutting by groups, each group being only a few rods in diameter.

The suppressed stands showed an average height of 42 inches against an average of 17 feet in the liberated areas.

INSECT DAMAGE

THE spruce gall louse (*Adelges abietis* Linn.) was frequently found on the areas of Norway Spruce mentioned here. Occasional infestations were seen on Spruce plantations located in the open and enjoying full sunlight, but by far the majority of infested trees were found where this species had been set under shade.

It is difficult to account for this apparent choice of suppressed individuals. We suspect that it is possibly a taste of the louse itself for shade rather than a distinct plant preference.

DISCUSSION

IN Table III are shown the detailed data gathered from the twenty-seven plantings. These are given by species, total age of the plantation, the number of plantations actually measured, the average height in tended, untended, and open grown stands, the plate reference and such additional remarks as seem necessary for clarity. In addition, in Text Figure I is given a set of ten age-height curves derived from the data in Table III.



PLATE V. NORWAY PINE; 3 OR 4 YEAR OLD STOCK FROM THE N. Y. STATE CONSERVATION DEPT., PLANTED IN 1913 IN THE OPEN. NO CULTURAL TREATMENT, BUT NEVER SHADED. TOTAL HEIGHT 32 FEET. WHILE THESE TREES ARE ABOUT 5 YEARS OLDER THAN THOSE SHOWN IN PLATE IV, THE DIFFERENCE IN HEALTH AND THE MUCH GREATER ANNUAL HEIGHT GROWTH IS OBVIOUS.



PLATE VI. BALSAM FIR; 2 TO 4 YEAR OLD STOCK, SOURCE UNKNOWN, PLANTED IN 1912 UNDER HIGH RED OAK AND HARD MAPLE. NO CULTURAL TREATMENT. TREES IN BACKGROUND AVERAGE 30 INCHES HIGH; THE ONE IN THE FOREGROUND BY THE HAT IS 54 INCHES HIGH. THIS TREE STANDS NEAR THE ROAD WHERE THE LIGHT SUPPLY IS SOMEWHAT BETTER.

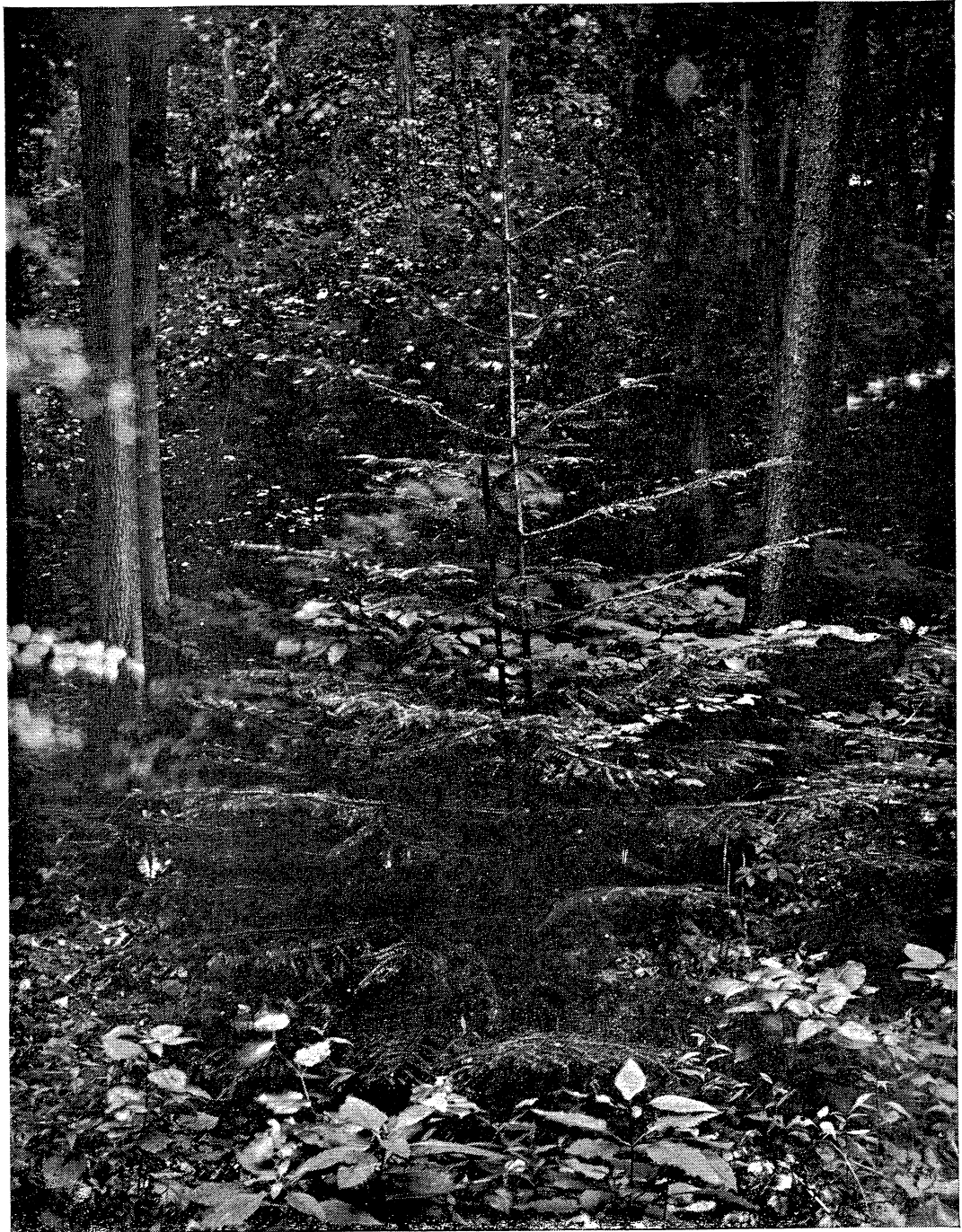


PLATE VII. BALSAM FIR; THE SAME PLANTATION AS IN PLATE VI. THIS TREE STANDS CLOSE TO THE ROAD AND HAS ALWAYS HAD A FAIR AMOUNT OF SUNLIGHT. THE TOTAL HEIGHT OF 108 INCHES IS IN SHARP CONTRAST TO THE STUNTED FIRS OF EQUAL AGE SHOWN IN PLATE VI.

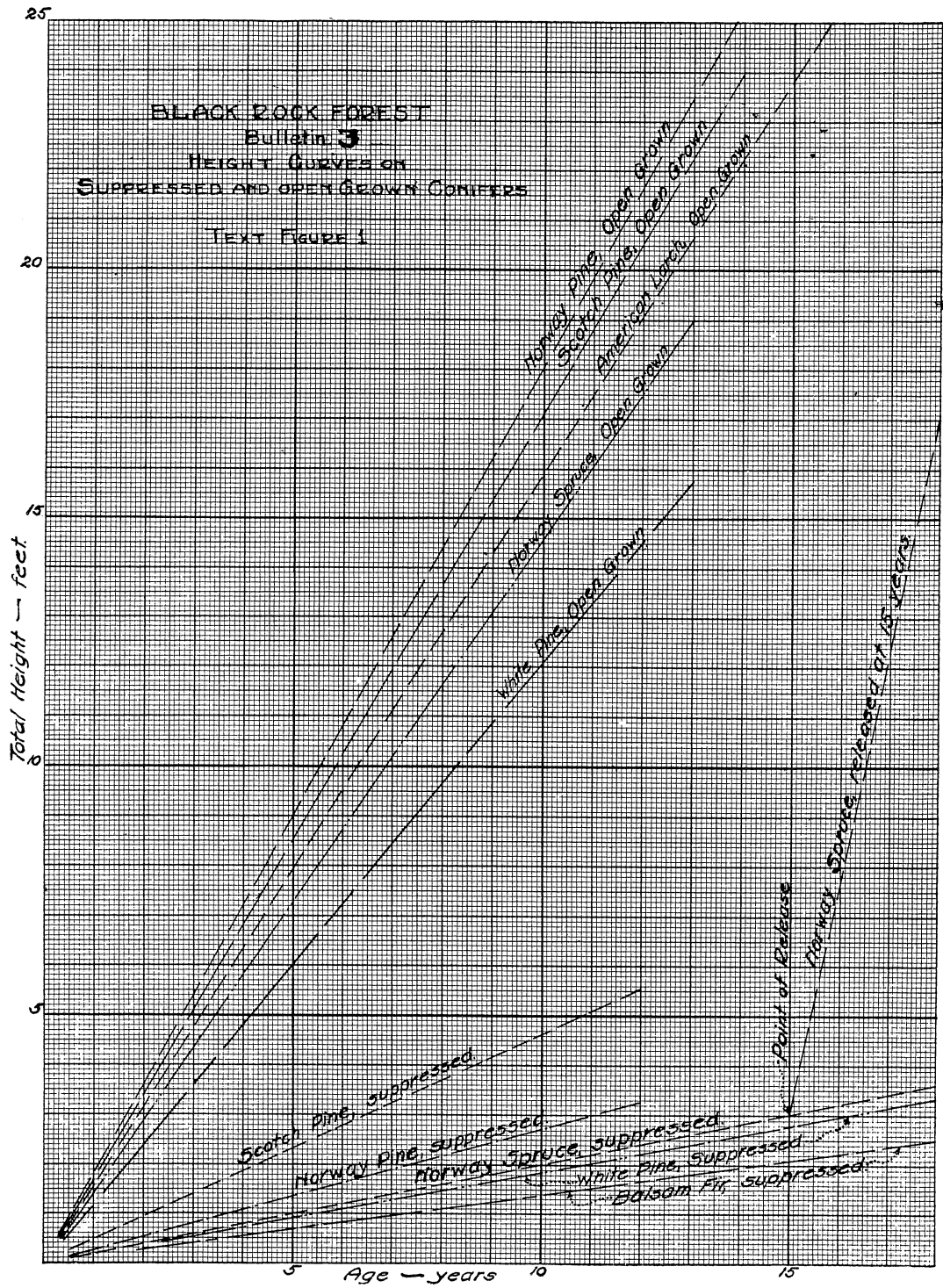


PLATE VIII. SCOTCH PINE; 2 TO 4 YEAR OLD STOCK FROM THE N. Y. STATE CONSERVATION DEPT., PLANTED IN 1918 UNDER HIGH RED OAK AND WHITE ASH. NO CULTURAL TREATMENT. THE ARROW MARKS THE TOP OF A 5-FOOT RANGE POLE. THE AVERAGE HEIGHT IS 46 INCHES. THE THREE OAK SPROUTS AT THE RIGHT INDICATE THE CHARACTER OF THE OVERWOOD.

TABLE NO. III

AVERAGE HEIGHTS, BY SPECIES, OF THE AREAS EXAMINED

<i>Area No.</i>	<i>Species</i>	<i>Number of Plantings Measured</i>	<i>Age of Planting</i>	<i>Average Height, Untended</i>	<i>Average Height, Tended</i>	<i>Average Height, Open Grown</i>	<i>Plate Reference</i>	<i>Remarks</i>
1.	Norway Spruce .	7	18 yrs.	42"	—	—	1	High hardwood cover.
2.	Norway Spruce .	2	18	—	17.5'	—		Given a liberation cutting 15 years after planting.
3.	Norway Spruce .	1	13	—	—	19'	2	Planted in open pasture.
4.	Norway Spruce .	1	50	—	—	60'	3	Planted on open lawn.
5.	Norway Pine ...	1	12	39"	—	—	4	High hardwood cover.
6.	Norway Pine ...	1	17	—	—	32'	5	Planted in open, on well-drained, gravelly ridge. 6' x 6' spacing.
7.	Norway Pine ...	1	25	—	—	30'		Planted on open slope, in mixture with American Larch.
8.	American Larch .	1	17	—	—	27'		Transplanted to 4' spacing in nursery; never re-set.
9.	American Larch .	1	25	—	—	35'		Same area as No. 7.
10.	Balsam Fir	1	18	30"	—	—	6	High hardwood cover.
11.	Balsam Fir	1	18	54"	—	—		A portion of Area No. 10 lying close to the road.
12.	Balsam Fir	1	18	108"	—	—	7	Originally set in a hardwood clearing; since overtopped by sprouts.
13.	Scotch Pine	1	12	46"	—	—	8	High hardwood cover; full shade.
14.	Scotch Pine	1	12	85"	—	—		Same area as No. 13, but only about 25% shade.
15.	Scotch Pine	1	14	—	—	24'	9	4-year stock, set in open and never shaded.
16.	White Pine	1	16	72"	—	—		High hardwood cover and heavy shade. Shows weevil work.
17.	White Pine	1	24	50"	—	—	10	High hardwood cover; dense shade.
18.	Douglas Fir	1	32	—	—	36'		Set in open; never shaded.
19.	Sitka Spruce ...	1	18	30"	—	—	11	High hardwood cover; full shade.
20.	Silver Fir	1	18	—	42"	—	12	High hardwood cover; full shade, but underbrush periodically cut back.



TEXT FIGURE I



PLATE IX. SCOTCH PINE; 4 YEAR OLD STOCK FROM THE N. Y. STATE CONSERVATION DEPT., PLANTED IN 1916 IN THE OPEN. NO CULTURAL TREATMENT BUT NEVER SHADED. CONTRAST THESE PINES, APPROXIMATELY 18 YEARS OLD AND AVERAGING 24 FEET IN HEIGHT WITH THE 15-YEAR OLD, 46-INCH HIGH TREES SHOWN IN PLATE VIII.



PLATE X. WHITE PINE; AGE AT PLANTING AND SOURCE OF STOCK UNKNOWN. PLANTED CIRCA 1906 ON THE U. S. MILITARY RESERVATION AT WEST POINT, N. Y., UNDER HIGH MIXED HARDWOODS, CHIEFLY OAK, MAPLE, AND BIRCH. NO CULTURAL TREATMENT. AVERAGE HEIGHT 50 INCHES. THESE TREES SHOW MORE PLAINLY THAN THE OTHER SPECIES THE STUNTING EFFECT OF THEIR LONG PERIOD OF SUPPRESSION.

We believe that the chief point of this study—*i.e.*, the relative behavior of the underplanted conifers with and without liberation—is clearly shown in the Text Figure 1. The contrast between the growth of suppressed and open grown stands is immediately apparent; and the prompt and vigorous response of suppressed Norway Spruce to a release cutting is marked.

This ability to respond favorably to release should be thoroughly sensed. While the areas presented herein afford proof of this quality only in the case of Norway Spruce, it is common knowledge with foresters that the other species here discussed possess the same ability in varying degree, White Pine, for example, and Red Pine in particular, being in general perceptibly less tolerant than the Spruces and Firs, but still able to respond to release if not suppressed for too long a period.

It is not the purpose of this paper to prescribe regarding the proper duration of such periods. That, ordinarily, can best be determined by a careful study of the local factors governing a given plantation. Our chief exhortation to the layman contemplating such underplantings is that his plan should invariably include gradual removal of the overwood so as to afford, after perhaps not more than ten years, practically full sunlight to the coniferous understory. Lacking such subsequent care, it is unreasonable to expect underplantings to make more than a feeble growth either in height or diameter.

A LOOK TO THE FUTURE

DURING the winter of 1930-1931 a portion of Compartment VI of Black Rock Forest was cleaned and thinned under the German system. In this cutting (File Record No. 4a) there was laid off a strip 100' x 1200', extending southeast from a brook bed and crossing the contours to a ridge summit. The lower half of this strip was planted with 4-year old White Spruce (*Picea canadensis*); the

upper half with 4-year old Norway Pine (*Pinus resinosa*). The Harvard Planting Tool was used. The spacing was as close to 6' x 6' as could be obtained. Our plan is to harvest the remaining hardwood overstory at commercial maturity, and thereafter, by careful and intensive weeding of the hardwood sprouts, to determine the possibility of producing a thrifty stand of hardwoods with conifers in mixture. If our existing market continues, this maturity may be looked for in from twelve to eighteen years, following the recent thinning. Judging from the response shown in the liberated Norway Spruce areas described above, we hope to carry through a fairly conclusive test of the practicability of such coniferous underplantings coupled with adequate, subsequent cultural work. We also plan to make intensive observations of the soil changes which may follow the projected alteration in the forest cover.

CONCLUSIONS

1. Since the factors of age of stock, soil quality, site, precipitation and care in planting were about equal in all cases, it is evident that the height growth of coniferous underplantings of the species listed herein is in direct inverse ratio to the amount of overhead shade, coupled with the soil conditions and root competition involved thereby.

2. Even after fifteen years of suppression under a heavy hardwood overstory, Norway Spruce has displayed a vigorous response to release cuttings.

3. But little mortality has occurred in this species following such release cuttings.

4. Insect damage by the Spruce gall louse is confined chiefly to Spruce plantations which have been grown under heavy shade.

5. Coniferous underplantings of the species discussed in this study cannot, in the Hudson Highlands, be success-



PLATE XI. SITKA SPRUCE; 2 TO 4 YEAR OLD STOCK, SOURCE UNKNOWN. PLANTED IN 1912 UNDER HIGH RED AND CHESTNUT OAK AND HARD MAPLE. NO CULTURAL TREATMENT. AVERAGE HEIGHT 30 INCHES. THESE TREES SHOW EVIDENCE OF GOOD HEALTH AND HIGH POTENTIAL RESPONSE TO RELEASE DESPITE THEIR PRESENT DWARFED CONDITION.

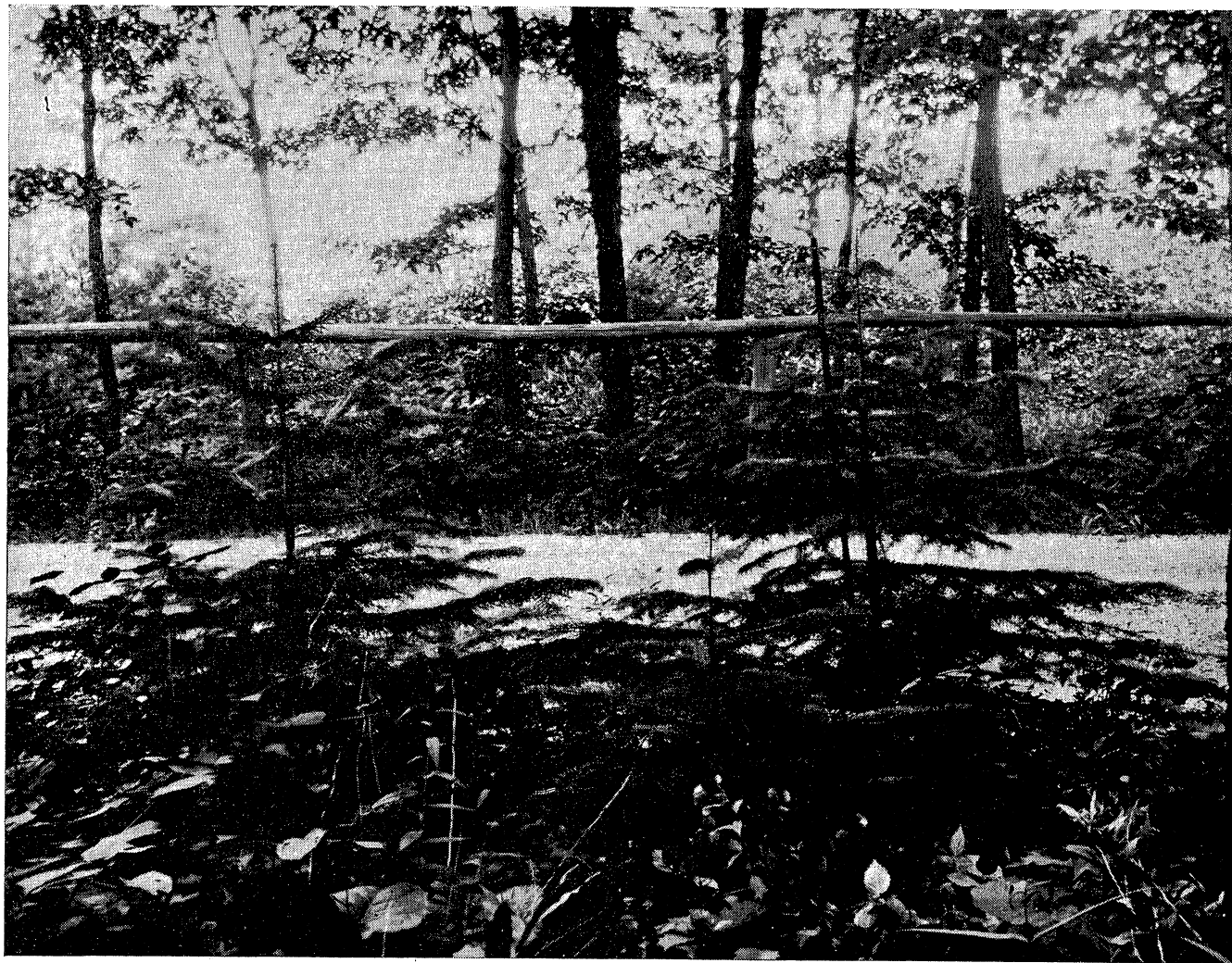


PLATE XII. SILVER FIR; 4 YEAR OLD STOCK FROM HAMBURG, GERMANY. PLANTED IN 1912 UNDER HIGH RED AND CHESTNUT OAK. ONLY SUBSEQUENT CULTURAL TREATMENT HAS BEEN THE OCCASIONAL CUTTING BACK OF THE INTERMIXED HARDWOOD SPROUTS. THE TREE IN THE FOREGROUND MEASURES BARELY 32 INCHES; THOSE TO THE REAR BY THE RAILING MARKING THE ROAD WHERE THE LIGHT SUPPLY IS SOMEWHAT GREATER, ARE 54 INCHES HIGH.

fully brought to maturity without subsequent cultural treatment which will in due time admit sufficient sunlight to the plantation.

GLOSSARY

- AFFORESTATION:** the establishment of a forest, naturally or artificially, where it is at present absent or insufficient.
- CANOPY:** the cover or canopy formed by all the trees in a forest, or, in an uneven-aged forest, by the crowns of all trees in a specified crown class.
- CATFACE:** a partly healed fire scar on the stem of a tree.
- COMMERCIAL MATURITY:** the age at which a forest crop may be harvested with the maximum financial return.
- CONIFER:** those species of trees (not necessarily evergreens) which bear their fruits in a cone.
- CROWN CLASS:** all trees in a stand occupying a similar position in the crown cover or canopy.
- GERMAN SYSTEM:** a method of thinning a stand of trees. Based on the principle of removing the poorest crown class first, and proceeding upwards through the better crown classes in consecutive order, increasing the number of crown classes removed with the degree of severity of the thinning.
- GROUP LIBERATION CUTTING:** a cutting or felling (usually over a restricted area) whereby valuable young growth is set free from crowding and suppression by the larger trees.
- HUMUS:** that portion of the forest floor in which decomposition of the leaf litter is so far advanced that its original form is not distinguishable.
- OVERSTORY:** see Overwood.
- OVERTOPPED:** trees with crowns entirely below the general forest canopy and receiving no direct light either from above or from the sides.
- OVERWOOD:** that portion of the forest forming the upper stratum of the forest canopy.
- REFORESTATION:** the natural or artificial restocking of an area with forest trees. Commonly applied to the latter.
- RELEASE CUTTING:** see Group Liberation Cutting.
- SUPPRESSED:** a subdivision of the Overtopped class, denoting trees either dying or dead.
- TENDED:** a forest or woodland treated for improvement in growth or composition as by thinning, release cutting, etc.
- TOLERANCE:** the capacity of a tree to grow under shade.
- UNDERPLANTING:** to set out young trees or sow seed under an existing stand of trees.
- UNEVEN-AGED FOREST:** applied to a stand or forest wherein occur considerable differences in the ages of the trees.