7-1916

The Keene Forest: A Preliminary Report

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Issued July, 1916

YALE UNIVERSITY
SCHOOL OF FORESTRY-Bulletin 4

THE KEENE FOREST

A PRELIMINARY REPORT

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New Haven
Yale University Press
1916

A Note to Readers
2012

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THE KEENE FOREST-A PRELIMINARY REPORT

INTRODUCTION

In 1913 the Yale School of Forestry came into possession of certain parcels of land located near Keene, New Hampshire. This land amounting to 629.4 acres was presented to the School as a nucleus for a school forest to be used for purposes of instruction and research. Subsequently in March, 1915, additional lots comprising 270.9 acres were purchased with funds contributed by the original donor. The present area totals 900.3 acres and is known as the "Keene Forest."

Keene is the county seat of Cheshire County. It is one of the largest towns of southern New Hampshire, having a population of about 11,000. It is easily accessible by through train service from Boston, 92 miles away, and New Haven, 143 miles away. Morning trains from New Haven enable the faculty and students to reach the forest shortly after noon, so that it is better located for School purposes than less accessible tracts much nearer New Haven. Cheshire County, and particularly the region tributary to Keene, forms one of the best parts of the white pine belt of New England.

The ownership of accessible and suitable forest areas by schools of forestry is now recognized as not only desirable but also essential. Adequately developed demonstration forests serve as fields for research on the part of the student and also as practical object lessons enabling him to see the results of the different methods of treatment which he may be called upon to apply after he begins his professional career. From the standpoint of both teaching and research it is essential that experiments be initiated and maintained for long periods of time and work undertaken which cannot be justified under a purely commercial management. When such work is under way, therefore, it is advisable that ownership of the land be vested in public institutions, particularly those of educational character. The Keene forest serves as a forest experiment station where various problems affecting the economic development and utilization of forest crops are under

investigation. Sample plots have been established and pine plantations made to show the effect of different intervals of spacing.

Demonstration forests furnish one of the most effective means of interesting forest owners and thus spreading the practice of forestry. For the next few decades the combined efforts of educational institutions, states, and municipalities will scarcely suffice to create enough of these demonstration areas. The Keene forest is ideally located for a demonstration forest as it is near an unusually good market and is easily accessible. For about two miles it fronts on the Winchester highway (Fig. 1), one of the main automobile routes from the south to the White Mountains. Over this road the traffic is heavy throughout the year, and in the summer is greatly augmented by the summer tourist.

Plans for extension and development

At the present time the Keene forest is composed of five noncontiguous areas. These tracts, in area 200, 122, and 86.5 acres respectively, lie from 6 to 8 miles northwest of Keene within 2½ miles of one another. The other two tracts composed of three lots each and comprising 275.5 and 216.3 acres respectively are situated on the Winchester highway 2 or 3 miles southwest of Keene and only ¼ mile apart. The map facing this page shows the location of the various lots in reference to Keene, their topographic features, and their relative size and form. Table 1 gives the acreage by lots and tracts.

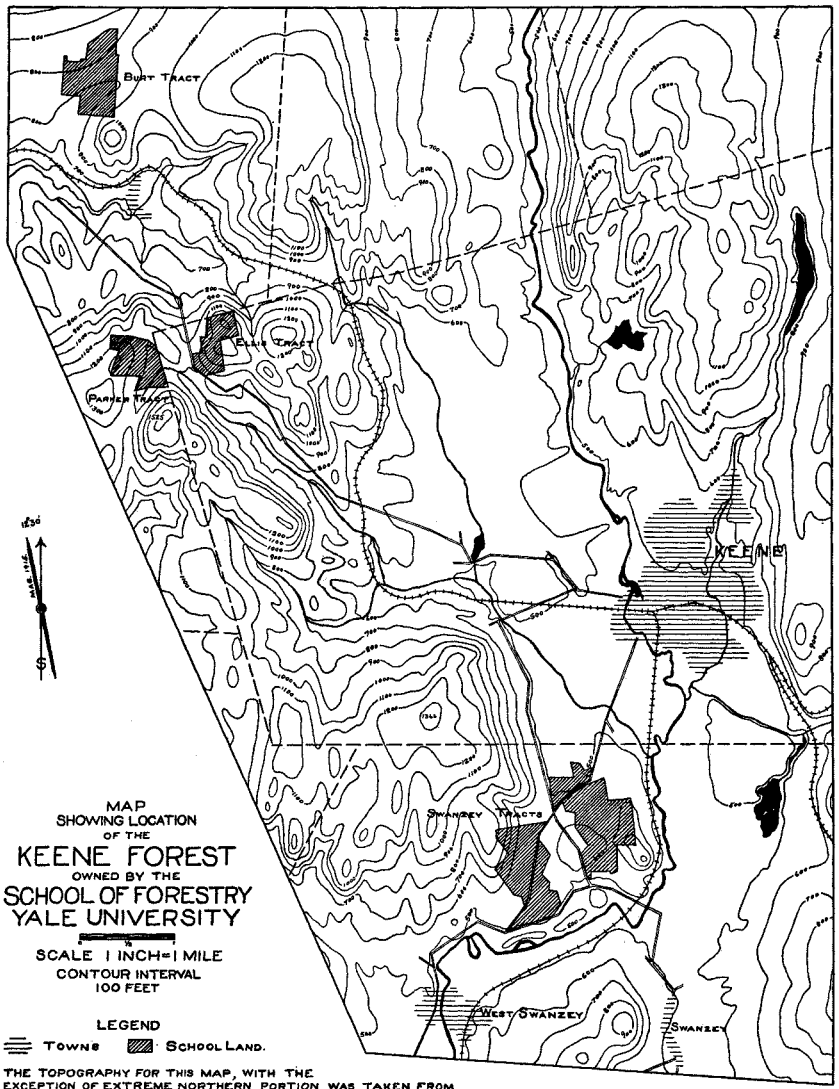
TABLE 1—LAND CLASSIFICATION BY LOTS AND TRACTS

Southwest of Keene (Swanzey lots)

	Area of lots in acres	Area of tracts in acres	Total area in acres
Carey	97.4		
Hills	78.0		
Perham	40.9	216.3	
Swamp	52.0		
Whitcomb	173.5		
Worcester	50.0	275.5	491.8

Northwest of Keene (Keene, Westmoreland and Walpole lots)

Burt		200.0	
Ellis		86.5	
Parker		122.0	408.5
Total			900.3


BURT TRACT
ELLIS TRACT
PARKER TRACT
KEENE
SWANZEY TRACTS
WEST SWANZEY
SWANZEY
MAP
SHOWING LOCATION
OF THE
KEENE FOREST
OWNED BY THE
SCHOOL OF FORESTRY
YALE UNIVERSITY
SCALE 1 INCH=1 MILE
CONTOUR INTERVAL
100 FEET
LEGEND
TOWNS
SCHOOL LAND.
THE TOPOGRAPHY FOR THIS MAP, WITH THE
EXCEPTION OF EXTREME NORTHERN PORTION, WAS TAKEN FROM
THE KEENE, NEW HAMPSHIRE QUADRANGLE OF THE U.S.GEOLOGICAL SURVEY.

From the standpoint of effective administration and protection it is unfortunate that the Keene forest is composed of so many non-contiguous tracts. The consolidation of the present holdings southwest of Keene known as the Swanzey lots will be undertaken as rapidly as circumstances permit. This will be attained by the purchase of connecting lots. The forest in this locality will also be increased by the purchase of adjacent woodland as funds are available and desirable lots are placed on the market. It will probably take a number of years to consolidate the Swanzey holdings and add sufficient acreage to their present area to give the School from 1,200 to 1,500 acres in one solid block. The School should own the above acreage in Swanzey and retain its present holdings of 408.5 acres northwest of Keene in order to justify the permanent employment of a resident forester.

Permanent improvements

The more important permanent improvements needed immediately are:

a. A building to serve as living quarters for students and faculty when on the forest. A suitable building can be erected for $500.

b. A shed in which to store and season gray birch cordwood. This is necessary in order to sell the birch in the most profitable manner. It will cost about $300.

c. The planting of all areas that are not already adequately stocked.

The Director was fortunate during the past year in receiving $900 in contributions from friends of the School to be expended for planting and other permanent improvements on the Keene forest. This has enabled the School to begin the planting of the 174 acres of open land which will probably be completed within the next three years. Approximately 40 acres were planted in April, 1916, at a cost of $187.86 exclusive of the stock which was grown by the School at New Haven and supplied to the Keene forest without charge. Assuming that the work can be completed at the same rate of expense it is estimated that approximately $700 would be needed to finish the planting.

Plans are under way for the construction of living quarters for the faculty and students when engaged in work on the forest. It is expected that the building will be completed during the autumn. Further contributions of $1,100 would complete the essential permanent improvements required at the present time.

General maintenance

The only special funds for the maintenance of the Keene forest are the income from the Graduates' Fund, approximately $200 per year, and the receipts from the sale of wood and timber. These receipts have netted only a few dollars a year since the property was acquired and should not be counted as a source of income for the next decade. Further expenditures draw directly upon the general funds of the School, which are needed for other purposes.

Due to the lack of funds the policy of the School has been to pay the taxes, to omit much experimental work which should be undertaken, and to spend as little as possible on traveling expenses, administration, protection, and silvicultural operations. This policy is hindering the desirable development of the property as a demonstration forest and as a factor in the teaching and research work of the School.

The annual charges which should be met for some years, or until the income from the forest balances all expenditures, are approximately as follows:

Taxes	$250
Traveling expenses	150
Administration and protection	100
Silvicultural operations	100
Experimental work	200
Total	$800

Eventually the Keene forest, accessible as it is to excellent wood markets, should return a large net revenue. How soon the annual charges can be met through sales of timber cannot be definitely predicted, but possibly this can be done at the end of the next ten years.

PART I—DESCRIPTION

Climate

The climate of central New England is favorable for the development of forests. Moderately cold winters with sufficient snow to protect the soil from excessive freezing are followed by growing seasons four or five months in length. Since records have been kept at Keene by the Weather Bureau the precipitation

has averaged nearly 41 inches a year. A large proportion of the rainfall comes in the growing season; and droughts serious enough to hinder tree growth are of infrequent occurrence.

Topography

The city of Keene is located on the sand plain of the Ashuelot River which broadens out west and south of the city to a width of about two miles. From the sides of this plain 500 feet above sea level, ranges of low hills rise, reaching on the western side elevations of 1,200 to 1,400 feet. The southern section of the school forest (the Swanzey lots) lies 2½ miles southwest of Keene on the sand plain and on the lower slopes of the western range. The northern section of the forest (the Keene, Westmoreland and Walpole lots) lies northwest of Keene on hills near the divide between the Ashuelot and Connecticut rivers. These lots are approximately 700 feet above Keene and in relative elevation have a range of 500 feet. Except over small portions the ground is sufficiently level for economic logging.

Soils

The underlying rock formation is granite and it appears frequently on the tops of the hills and in ledges on the slopes. Rock outcrop and loose stones are more abundant throughout the lots on the hills northwest of Keene than on the property southwest of the city. In the latter region a heavy mantle of sand quite free from stones covers the rock except in a few places. The soils are of a light, sandy character except in the swamps where finer and heavier soils prevail. Only about 65 acres of swamp occur and nearly all of this is found on the Swanzey lots.

The soils are better adapted for forestry than for agriculture. On the Swanzey lots this is due primarily to the light, sandy nature of the soil, and on the other lots to rock outcrop, abundance of loose surface stones, and lack of depth.

Drainage from the northernmost or Burt lot is westward directly into the Connecticut, elsewhere it is into the Ashuelot river which flows through Keene. This river flows within half a mile of the Swanzey lots and affords water transportation for logs to points downstream.

Social and industrial conditions

Keene is the eighth largest city in New Hampshire and is the only large center of population near the school forest. The people in Keene as well as those in the surrounding country are

largely of native descent. The country people are engaged principally in agricultural pursuits in the summer and often in logging in the winter. In Keene there is a large amount of manufacturing, mainly of wood products.

Wood-using industries

The volume of wood consumed by the wood-using industries and the variety of products[1] manufactured make Keene an important center for woodworking industries.

White pine is the chief species used and is made into boxes, buckets and pails, kegs, kits, and lumber. It is estimated that approximately 30,000 cords of second growth pine and 15,000 M feet of lumber are annually used in Keene; while at West Swanzey 3,000 cords and 6,000 M feet of lumber are annually consumed. The material comes both from the forests around Keene and from more northern regions.

The best local demand for white pine is in the log in 12-foot lengths, although other lengths have a sale value. Logs with a minimum top diameter of from 3 to 4 inches are accepted.

Among the largest consumers of white pine are the pail and kit manufacturers who can use "joints" (intervals between branch whorls) of from 9 to 24 inches with 14 inches as the best length. One concern can take shorter than 9-inch joints for use in the manufacture of small buckets. The box factories can utilize a somewhat poorer quality of lumber than the bucket and kit factories, since the latter demand material comparatively free from knots.

Prices paid range from $9 to $10.50 per cord for logs delivered at the factories, depending on quality and on the time of year.[2] When the greater part of the cut is of small diameter the price ranges from $9 to $9.50 per cord. Some pine is delivered on the bank of the Ashuelot River, at which point from $8.50 to $9 per cord is paid. The logs are driven by buyers to mills below Keene. Logs are ordinarily bought on the cord basis using the Humphrey decimal scale. Quantities of sawn lumber, chiefly 2⅛-inch stock, are purchased by the factories at an average price of $20 per thousand feet mill run.

A small amount of Norway pine is offered in the local markets.

[1] Among the wood products manufactured in Keene are the following: boxes, brush backs, buckets and pails, chairs, hoops and rims, kegs, kits, ladders, lumber, shoe heels, spokes (baby carriage, etc.), wheels (spinning wheels, wheel heads, etc.).

[2] One concern pays 50 cents per cord more for logs hauled on wagons than for those hauled on sleds. This covers the extra cost of wagon transport.

It is said to work excellently and, if used alone, would be well received by box and bucket men. In small quantities it is not so desirable because it differs in color from white pine with which it is mixed and also because when used in a bucket with white pine staves the two kinds of wood do not turn evenly. Norway pine now brings from $8 to $9 per cord; if large quantities were available, probably the price would be the same as for white pine. It has a future for practically all purposes for which white pine is now used.

Tamarack in limited quantities is cut but is not in much demand owing to its inferior quality. The largest logs are cut into framing timbers, and some plants use small quantities for crates and boxes at a price of $7 per cord delivered.

Hemlock and spruce are bought in small quantities for framing timbers and for crating. The price paid is $7 to $8 per cord delivered.

Approximately three-fourths of the hardwoods used in Keene are shipped in by rail from points outside of Cheshire County. The local hardwoods are bought either in the logs delivered or standing. In the latter case they are logged and milled by the purchaser. It has been impossible to secure a reliable estimate of the amount of hardwood used annually in Keene, but it is much less than that of pine.

Oak and elm are most in demand at prices of $12 to $14 per cord delivered. Rock maple, yellow birch, paper birch, and beech in 12-foot lengths bring from $10 to $12 per cord when free from knots and redheart. Poplar is used to a small extent for crating and for boxes and sells for $7 per cord delivered.

Cordwood

There is a good demand in Keene for 16-inch wood in stove lengths and also for 4-£00t lengths. The wood is used in the brick yard and also for domestic purposes. Four-foot lengths delivered bring from $3.75 per cord for gray and white birch to $4.50 per cord for mixed hardwoods. The best prices can be realized by selling 16-inch lengths to householders who pay as much as $6 per cord.

Logging methods and costs

For the ordinary owner who is not interested in a woodworking plant the best procedure is to sell logs or sell stumpage. In the following table average costs of the various items entering into the cutting and delivering of lots and cordwood are estimated.

TABLE 2.—AVERAGE COST OF LOGGING

ITEMS	LOGS COST PER CORD	CORDWOOD COST PER CORD
Cutting	$1.00	$1.00 to $1.25 (includes piling)
Hauling (price depends on lot from which hauled). 1½ to 2 cords per two-horse sled load	$1.50 to $3.50 (add $.50 per cord if hauled on wheels)	$1.50 to $3.00
Sawing into 16-inch lengths		$.60
Logging, milling and piling lumber by contract	$5.00	

September to March inclusive are the months during which logging is most actively prosecuted. This is due to the lower cost of hauling on snow and also to the fact that on April 1 property is re-assessed for the coming year and so the taxable value of cut-over tracts is reduced.

In scaling logs with the Humphrey decimal scale the logs are calipered at the middle outside the bark. The scale is usually read to the nearest $\frac{1}{100}$th of a cord.[1] The cord is usually considered as equivalent to 600 board feet.

The Forest

The original forest which once covered the Ashuelot valley and the bordering hills has disappeared. No trace of the virgin forest remains on the property owned by the School of Forestry. Repeated cuttings, fires and clearings for agricultural use are the agencies responsible for this condition.

The present forest is composed principally of white pine, which covers 400 acres in pure stands and is found mixed with other species on many other areas. This species dominates the forest both in area occupied and even more in commercial importance. Of the conifers hemlock is second in importance, while tamarack, balsam, Norway pine, and red spruce are rarely found. Gray birch and soft maple are the most abundant hardwood trees and form fully 60 per cent of the hardwoods. Hard maple, beech, red and white oak, elm, yellow and paper birch, white and black ash, aspen, and alder occur, many of these being abundant in certain restricted areas.

Due to heavy and frequent cuttings the forest as a whole is young. In places, due to fires and clearings, it is stocked too sparsely or else with inferior species.

The land has been classified into ten types, eight of them wooded and two not wooded. Further description of the forest

[1] The Humphrey decimal scale as now used is based on an arbitrary 100 cubic foot cord (91 cu. ft. solid) and the divisions read to $\frac{1}{100}$th of a cord.

FIGURE 1.

View along the Winchester road adjacent to the Perham lot showing a 40-year old pure stand of relatively even-aged white pine.

FIGURE 2.

A pure natural stand of white pine on the Ellis lot, 30 to 40 years old, thinned in 1908 when about 5 cords per acre were removed.

will be taken up under each type separately. Table 3 gives the areas in each type and age class.

Forest types

Pine. The pine type includes all stands containing 80 per cent or more of white pine, and in one case Norway pine. The stands are even-aged and have originated both on lands that have been clear-cut and on agricultural lands formerly used for pasture or crops (Fig. 2). In a few instances pure pine stands originated from plantations made during the last ten years (Fig. 3). This type is found on all qualities of soil and in all situations. In only one case does it occur on swampy land, and here the pine is very scattered. As a whole these stands are fully stocked and in good condition and are the most valuable portion of the forest. They embrace nearly 400 acres.

Hemlock. Only 17 acres are included in the hemlock type which comprises all pure stands of hemlock. While classed in Table 3 as even-aged, there is considerable range in age within a stand. The exact age of the hemlock stands is not easily determined. Pure hemlock stands are located mainly on the borders of swamps or on ledgy, third quality upland-situations which although logged over were probably never cleared for agricultural use. The stands are fully stocked and in healthy condition, but of small commercial value compared with similar stands of pine.

Pine and Hemlock. Mixed stands of pine and hemlock containing less than 80 per cent of either are classed in this type. The pine is even-aged and determines the age of the stands; the hemlock is rather irregular, some being older and some younger than the associated pine. It is doubtful whether any part of the 23 acres of this type was ever farmed, although it contains some fairly good land. First, second, and third quality sites are included. The pine in this type is among the best in the forest in quality and height, being pruned by the dense foliage of its slower growing associate.

Hardwood. All of the varieties of hardwoods occurring on the tract are found in this type. Gray birch occasionally is found pure, but usually the composition is a mixture of several species. The pure stands of gray birch originated either on burns or more rarely on cultivated fields. Some of the stands of wind-disseminated species such as poplar, soft maple, and yellow, paper and gray birch undoubtedly started on burns from seed carried by the wind, but the greater part of the present type has resulted from Clear-cutting hardwood stands. Thus a large proportion

TABLE 3.—LAND CLASSIFICATION BY TYPES AND AGE CLASSES—AREA IN ACRES

TYPES	AGE CLASSES						YEARS				
	1 to 10	11 to 20	21 to 30	31 to 40	41 to 50	51 to 60	1 to 40	11 to 60	Irregular	Open	Total
Pine	69.2	161.5	141.3	20.9	7.0	—	—	—	—	—	399.9
Hemlock	—	—	14.4	2.6	—	—	—	—	—	—	17.0
Pine and Hemlock	—	—	16.4	6.3	—	—	—	—	—	—	22.7
Hardwood	33.0	30.6	27.7	6.3	21.8	—	26.5	2.2	2.6	—	150.7
Hemlock and Hardwood	—	—	1.7	2.2	0.7	4.3	—	—	—	—	8.9
Pine under Hardwood	2.9	97.3	20.9	0.6	—	—	—	—	—	—	121.7
Alder	—	8.3	5.4	—	—	—	—	—	—	—	13.7
Open	—	—	—	—	—	—	—	—	—	68.3	68.3
Swamp	—	—	—	23.6	—	—	—	—	7.1	—	30.7
Cut-over	—	—	—	—	—	—	—	—	—	66.7	66.7
Totals	105.1	297.7	227.8	62.5	29.5	4.3	26.5	2.2	9.7	135.0	900.3

of the trees are of sprout origin. On account of their orIgIn the stands are regular in form. This type occurs on all situations from swamp to rocky, third quality sites. In the swamps, black ash, soft maple, yellow birch, and elm are the dominant species. The swamp stands and all stands of gray birch from 4 to 6 inches in diameter contain many diseased and stagheaded trees. On account of the abundance of inferior species such as gray birch and soft maple, the hardwood type, which embraces 150 acres, is less valuable than the coniferous types or the mixed types of conifers and hardwoods.

Hemlock and hardwood. Stands containing more than 50 per cent but less than 80 per cent of hemlock in mixture with hardwoods are included in the hemlock and hardwood type. It is the smallest of the ten types, comprising only 8.9 acres, and is found in and near swamps. It averages older than the other types. The chief hardwoods, yellow birch, maple, and black ash associated with the hemlock are usually of less value than the latter. The stands are fully stocked and in good condition.

Pine under hardwood. The pine under hardwood type of 122 acres comprises stands of hardwoods which contain an understory of pine. Some of the pine may be of equal height with the hardwoods but usually it is overtopped by the latter. The hardwoods are principally gray birch and soft maple; aspen, paper birch, hard maple, and other hardwoods occur less commonly. Burns, clear cuttings, and, to a lesser extent, abandoned agricultural lands are the places of origin of this type, which is distinctly even-aged in form. The type occurs exclusively on first and second quality soils. In most cases the pine is suffering from suppression; otherwise the stands are in good condition and fully stocked. The potential value of this type, due to the presence of the white pine, is sufficient to make it second in commercial importance.

Alder. About 14 acres of pure alder occupy certain swampy or moist soils. These areas were formerly used for agricultural purposes and when drained are among the best sites on the tract. At the present time the growth in this type is worthless.

Open. Areas formerly used for agriculture but now abandoned and still unforested are embraced in the 68 acres of open land. This type is confined to first and second quality sites that have been recently pastured. They are usually covered with grass and have little woody vegetation.

Swamp. The swamp type, as indicated by its name, is restricted to wet lands. Mixed conifers, such as balsam, tamarack, spruce, hemlock, and pine, and mixed hardwoods, such as soft

rnapIe, yellow and gray birch, black ash, and elm, are the species which form the stands on the 30 acres of this type. As some of these swamps are crossed by old drainage ditches, it is possible that they were once cleared for farms. . The present forest is rather irregular in form and in the distribution of the species represented. Some portions are pure conifers and others pure hardwoods. Quite a number of trees are diseased and there has been considerable windfall among the conifers.

Cut-over. Areas which were cut clear less than ten years ago and which have not yet been restocked are placed in the 66 acres of the cut-over type. Before cutting they belonged to the pine type. Considerable slash, though not enough to prevent planting, and occasional clumps of hardwood sprouts or young pine prevent the area from being entirely bare. The site is sandy and of first and second quality.

Present volume

An ocular estimate has been made of the cordwood and lumber on the different lots. This is shown in Table 4. No effort has been made to estimate the amount of hardwood lumber, which is less than the hemlock. It is scattered and located mainly on the lots northwest of Keene.

Present value

In Table 5 the estimate is summarized under two headings: (1) the Swanzey lots; (2) the Keene, Westmoreland and Walpole lots. Stumpage prices are applied to show the money value of the timber. The greatest value is seen to be in the Swanzey lots where stumpage prices are higher due to nearness to Keene. Out of the grand total of $8141 the value of the pine alone amounts to $6030.

Summary of work accomplished from Jwne 1, 1913, *to April 30,1916*

The property was turned over to the School of Forestry in June, 1913. Since then it has been visited every few months by one or more members of the faculty. As a result of these trips information necessary for the proper management of the property is gradually being acquired.

The work accomplished may be classified under the following headings:

I. Sales of stumpage. Small amounts of cordwood have been sold from time to time.

TABLE 4.—ESTIMATE OF LUMBER AND CORDWOOD BY LOTS AND TYPES

TYPE	SPECIES	LOTS																			
		Burt		Carey		Ellis		Hills		Parker		Perham		Swamp		Whitcomb		Worcester		Total	
		Cds.	Bd. ft.	Cds.	Bd. ft.	Cds.	Bd. ft.	Cds.	Bd. ft.	Cds.	Bd. ft.	Cds.	Bd. ft.	Cds.	Bd. ft.	Cds.	Bd. ft.	Cds.	Bd. ft.	Cds.	Bd. ft.
Pine	Hardwood...	—	—	65	—	—	—	—	—	5	—	—	—	20	—	55	—	—	—	145	—
	Hemlock....	—	15,000	—	10,000	—	—	—	—	—	—	—	—	—	—	—	—	—	10,000	—	35,000
	Pine.....	—	45,000	—	51,000	—	154,000	—	166,000	—	—	—	52,000	—	20,000	—	39,000	—	62,000	—	589,000
Hemlock	Hardwood..	50	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	—	55	—
	Hemlock....	—	—	—	—	—	10,000	—	—	—	—	—	—	—	3,000	—	—	—	12,000	—	25,000
	Pine.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pine and Hemlock	Hardwood..	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	—	5	—
	Hemlock....	—	—	—	—	—	12,000	—	—	—	—	—	—	—	—	—	—	—	10,000	—	22,000
	Pine.....	—	—	—	—	—	16,000	—	—	—	—	—	—	—	—	—	—	—	5,000	—	21,000
Hardwood	Hardwood..	10	—	40	—	55	—	—	—	660	—	50	—	—	—	15	—	—	—	830	—
	Hemlock....	—	—	—	10,000	—	5,000	—	—	—	—	—	—	—	—	—	—	—	—	—	15,000
	Pine.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hemlock and Hardwood	Hardwood...	—	—	20	—	15	—	—	—	—	—	—	—	—	—	25	—	—	—	60	—
	Hemlock....	—	—	—	25,000	—	5,000	—	—	—	—	—	—	—	—	—	3,000	—	—	—	33,000
	Pine.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pine under Hardwood	Hardwood...	—	—	15	—	—	—	—	—	30	—	—	—	15	—	225	—	20	—	305	—
	Hemlock....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Pine.....	—	—	—	—	—	—	—	—	—	—	—	—	—	1,000	—	—	—	10,000	—	11,000
Swamp	Hardwood...	—	—	—	—	—	—	—	—	—	—	—	—	240	—	—	—	—	—	240	—
	Hemlock....	—	—	—	—	—	—	—	—	—	—	—	—	—	40,000*	—	—	—	—	—	40,000
	Pine.....	—	—	—	—	—	—	—	—	—	—	—	—	—	25,000	—	—	—	—	—	25,000
Total	Hardwood...	60	—	140	—	70	—	—	—	695	—	50	—	275	—	320	—	30	—	1640	—
	Hemlock....	—	15,000	—	45,000	—	32,000	—	—	—	—	—	—	—	43,000	—	3,000	—	3,200	—	170,000
	Pine.....	—	45,000	—	51,000	—	170,000	—	166,000	—	—	—	52,000	—	46,000	—	39,000	—	77,000	—	646,000

*35,000 feet of this amount is tamarack and spruce.

TABLE 5.—ESTIMATE OF LUMBER AND CORDWOOD SUMMARIZED

	Swanzey Lots		Keene, Westmoreland and Walpole lots		Total		Swanzey Lots		Keene, Westmoreland and Walpole lots		Total
	Cds.	Bd. ft.	Cds.	Bd. ft.	Cds.	Bd. ft.	Unit price	Value	Unit price	Value	Value
Hardwood.....	815	———	825	———	1640	———	$1 per cd.	$815.00	$0.50 per cd.	$412.50	$1227.50
Hemlock.....	——	123,000	——	47,000	——	170,000	$5.75 per M.	$707.25	$3.75 per M.	$176.25	$ 883.50
Pine.....	——	431,000	——	215,000	——	646,000	$10 per M.	$4310.00	$8.00 per M.	$1720.00	$6030.00
Total.....	——	———	——	———	——	———	———	$5832.25	———	$2308.75	$8141.00

FIGURE 3.

A 9-year old white pine plantation on the Ellis lot showing the early rapid growth of the pine on this tract.

FIGURE 4

A relatively even-aged stand of white pine, 20 to 30 years old, at the south end of the Hills lot on the Winchester road.

2. Freeing of the pine from overtopping hardwoods. A number of stands in the pine under hardwood type have been converted into the pine type by the removal of the hardwoods. Two methods have been practiced in this work: viz.:

a. Each year during the Christmas holidays a crew of students has been taken to Keene and has spent the time making cleanings (disengagement cuttings). This costs fully as much or more than it would if men were hired at Keene to do the work, but it has the advantage of giving the students practical experience in silvicultural operations.

b. Free use permits have been granted to remove the hardwoods on certain areas provided the pines are preserved. This has been satisfactory wherever employed.

8. An experiment was made in the winter of 1913-14 of cutting cordwood on the Swamp lot and retailing the product in Keene. It was not a complete success due principally to the man in charge in the woods rather than to the plan itself.

4. In the spring of 1916 about 40 acres on the Whitcomb lot were planted, approximately 40,000 white and red pine transplants and seedlings being used. Three experimental areas, spaced 4 x 4, 6 x 6, and 8 x 8 feet, respectively, were included in this plantation.

5. Type maps have been made for all the lots. Each lot has been divided into sub-compartments of stands containing only one age class and type. A description of each sub-compartment has been entered on special cards and filed for future reference.

6. A study of the wood-using industries in Keene and West Swanzey has been made.

7. Men have been employed at a nominal wage to have general oversight of the property and to protect it against fire and trespass. One man has charge of the Swanzey lots, another of the Keene, Westmoreland and Walpole lots. This is recognized as a haphazard and weak system of protection, but due to lack of funds it has been impossible to do more. There have been no fires on the property since it has been owned by the School of Forestry.

8. An equipment of tools for fighting fire was placed in the shack on the Swamp lot in 1913. This shack was broken into and the tools together with a camp outfit removed.

9. An account has been opened with each lot.

Expenditures and receipts

The expenditures and receipts summarized by main headings have been as follows:

TABLE 6.—EXPENDITURES AND RECEIPTS.
June, 1913, to May, 1916.

	Expenditures	Receipts
Labor	$711.50	—
Lawyer's fees	42.11	—
Rangers	75.34	—
Taxes	643.04	—
Tools and materials	15.77	—
Travel	160.57	—
Wood	—	$287.63
Gravel	—	9.87
Total	$1648.33	$297.50

The expenditures over receipts have been only partially met by the income from the Graduates Fund. Total contributions toward permanent improvements received prior to May, 1916, amount to $900.

PART II—MANAGEMENT

Except for the experimental features of management incidental to ownership by a university, the object is to secure the best financial returns from the forest. Silviculturally this means increasing the percentage of pine in proportion to other species. The presence of the white pine blister rust in New England, however, makes it questionable as to whether white pine should be favored. Norway pine is the only substitute worth considering. By the time the existing stands of white pine are ready for cutting more definite information regarding the effects of the blister rust on white pine will be available and should be used in determining the policy then adopted.

General policy for treatment of each type

Even where forest management is in its inception, as is the case on the Keene forest, it is advisable to outline a policy for the treatment of each type based on available knowledge. Although such a policy will need to be changed from time to time, it will prove useful in planning the detailed work for the immediate future.

Pine. Most of the stands of pine are less than twenty years old, hence questions of rotation and methods of reproduction may be left for the future to determine (Fig. 4). Some system which maintains the existing pure, even-aged form of stand will be used. During the next decade the principal work will consist in:

a. The removal of the few overtopping hardwoods in mixture with the pine.

b. Thinnings in dense stands over twenty years old wherever merchantable material can be taken out to improve the stand.

c. The cutting of occasional clumps of older pine from young stands. There are very few such clumps and these should not be cut except where actually interfering with the younger trees.

d. Experimentally at least, pruning selected trees, i.e., those which will form the final crop. It is believed that the production of clear twelve-foot butt logs will be worth while. Pruning can be done to the best advantage when the trees are about four inches in diameter.

Hemlock. Hemlock as compared with pine is too slow growing and low priced to be favored. All hemlock outside of the swamps should be cut as it reaches merchantable size and the type turned over to pine either by natural seeding or by planting. Ditching will render all swampy land now in this type dry enough for pine.

Pine and Hemlock. In the pine and hemlock type the hemlock can be removed gradually as the pine develops and shows ability to occupy the space now held by its associate. Where the hemlock occurs as an understory it should be retained throughout the rotation on account of its excellent silvicultural effect on the pine.

Hardwood. The hardwood stands which form this type cannot be changed quickly to pine without undue expense. The present growth on the third quality sites and in the poorest swamps is probably not worth transforming, but on the better: sites it will ultimately pay to replace the hardwoods with pine. This can be done by clear-cutting the older stands as they become merchantable for cordwood or timber and planting the cut-over areas. One or two cleanings will free the planted pine sufficiently to assure a satisfactory stand. On the best soils the mixture of a small percentage of hardwoods with the pine is desirable and can easily be secured by leaving seedlings or sprouts of the desired species when cleanings are made. The hardwood stands on the poorest and wettest sites should be handled by clear-cutting, securing reproduction from sprouts and from such seedlings as have started under the old stand. Under present conditions it is doubtful whether thinnings can be profitably made in the hardwood stands.

Pine under Hardwood. In most cases all that is necessary to convert the pine under hardwood type to pine is the removal of the overtopping hardwoods, thus freeing the understory (Fig. 5). Where there are large open spaces in the understory it may be

necessary to complete the stand by planting. The product obtained in the removal of the overtopping hardwoods, while sometimes large enough for cordwood, is usually so scattered as to be of little or no value. On the most favorable sites it may net as much as $1 per cord on the stump, but on the average the returns will scarcely pay the expense of removal.

Alder. Nearly all of the land now covered with alder is suitable for the production of pine. The present stands of alder are worthless and can be changed to pine by cutting the alder and planting pine. It will be necessary to drain the overwet areas.

Open. All of the open areas are suitable for planting and should be so treated within the next few years. Both Norway and white pine should be used, preference being given to the former species on account of the uncertainty of future damage to the white pine by the blister rust.

Swamp. The mature trees that occur as scattered individuals and in small groups in the irregular stands which comprise the swamp type should be cut. Some mature timber has been thrown by the wind, and that which is merchantable should be removed not later than the spring of 1917. The remaining hardwoods, except those in the wettest places, should be taken out as rapidly as the product will pay the cost of removal in order to increase the percentage of conifers through natural seeding and planting. The present stands in this type are composed for the most part of slow growing, inferior species. This is due to unfavorable conditions that cannot be remedied without considerable expense for drainage, which is not contemplated in the immediate future.

Cut-over. All recently cut-over land should be planted. While these areas are not as free from brush and hardwood sprouts as those classed as "open," the planting can be done without special preparation of the site. The use of both Norway and white pine is advised (Fig. 6).

Silvicultural work recommended for the next five years

With few exceptions the work here outlined may be classed as improvement in contrast with the harvesting of the final crop. Owing to the fact that the forest is young and several of the types are in process of transformation, no effort has been made to determine the annual growth. It is impossible to secure an equal annual cut for many years to come. The improvements suggested should be carried out as promptly as possible and completed during the next five years.

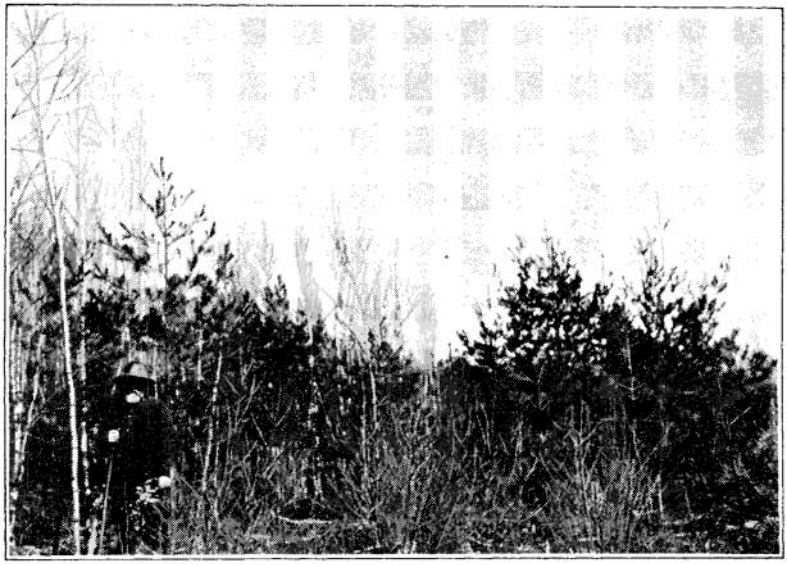


FIGURE 5.

A 5 to 20 year old white pine stand at the south end of the Hills Jot freed from overstanding birch in 191.5-1916.

FIGURE 6.

Planting white pine (2-1) in April, 1916, on the Whitcomb lot recently cut-over and burned.

SWANZEY LOTS

LOT	Sub-compartment	KIND OF WORK	REMARKS
Carey	a	Cut the merchantable hemlock and plant white pine. Make a cleaning in strips along the main road where there are some pine seedlings overtopped by hardwoods.	The sale of the hemlock should approximately cover the cost of the other work. 9 acres to be planted.
Carey	c	Cut the hardwoods.	The returns should pay the cost of the operation.
Carey	d	Cut the hardwoods.	The returns should pay the cost of the operation.
Carey	e	Free the pine.	
Carey	f	Cut the hardwoods.	Good cordwood will be secured and a profit can be made on the operation.
Carey	k	Plant portions not swampy with pine.	3 acres to be planted.
Carey	m	Plant with pine.	1.0 acres to be planted.
Carey	o	Plant with pine.	0.8 acres to be planted.
Carey	p	Plant larger openings with pine.	5.0 acres to be planted.
Carey	q	Plant with pine.	0.5 acres to be planted.
Carey	s	Plant with pine.	7.5 acres to be planted.
Carey	t	Plant with pine.	0.3 acres to be planted.
Carey	u	Plant the numerous openings with pine,	14.0 acres to be planted.
Hills	b	Free the pine.	Only a few trees need removing to free the pine.
Hills	h	Free the pine.	Wood can be given away standing.
Hills	i	Complete the freeing of the pine.	Fully half the area was treated in December, 1915.
Hills	j	The few hardwoods should be cut.	The returns should pay the cost of the operation.
Hills	l	Complete the freeing of the pine.	Wood can be given away standing.
Hills	p	Free the pine.	
Perham	c	Cut the large pitch pine and plant the openings.	0.7 acres to be planted.
Perham	d	Complete the freeing of the pine.	Northeastern end needs most attention.
Perham	e	Complete the freeing of the pine.	
Perham	g	Cut clear. Haul the cordwood to the main road and sell in the pile.	Should return a profit.
Perham	h	Cut the hardwoods.	The hardwoods are scattered but of fair size and should pay for cutting.
Swamp	a	Cut the hardwoods.	Should return a profit.
Swamp	b	Complete the freeing of the pine.	Wood can be given away standing.
Swamp	c	Plant with pine.	0.5 acres to be planted.
Swamp	e	Cut the hardwoods.	Should return a profit.
Swamp	g	Remove all merchantable windfalls and cut all merchantable conifers except the pine. Cut the hardwoods.	Should return a profit.
Swamp	j	Cut the hardwoods and all the conifers except the pine. Pick up all windfalls.	Should return a profit.
Swamp	k	Cut the large hemlock and pine.	Should return a profit.
Swamp	l	Free the pine.	Wood can be given away standing.
Whitcomb	c	Free the pine.	The returns should pay the cost of the operation.
Whitcomb	d	Plant with pine	0.3 acres to be planted.
Whitcomb	e	Plant the openings.	5.0 acres to be planted.
Whitcomb	g	Complete the planting.	15.0 acres to be planted.
Whitcomb	i	Complete the removal of the hardwoods.	Should return a profit.
Whitcomb	k	Plant with pine.	0.2 acres to be planted.
Whitcomb	n	Cut the hardwoods.	The returns should pay the cost of the operation.

SWANZEY LOTS (Continued)

LOT	Sub-compartment	KIND OF WORK	REMARKS
Whitcomb.....	p	Cut the hardwoods.	The returns should pay the cost of the operation.
Whitcomb.....	r	Cut the hardwoods.	The returns should pay the cost of the operation.
Whitcomb.....	s	Cut the hardwoods.	The returns should pay the cost of the operation.
Whitcomb.....	u		The returns should pay the cost of the operation.
Worcester.....	b	Free the pine.	Wood can probably be given away standing.
Worcester.....	d	Free the pine.	Wood can probably be given away standing.
Worcester.....	j	Sell the largest hemlock and possibly thin the pine.	Should return a profit.

KEENE, WESTMORELAND AND WALPOLE LOTS

LOT	Sub-compartment	KIND OF WORK	REMARKS
Burt.....	a	Plant with pine.	5.3 acres to be planted.
Burt.....	c	Cut the large hemlock and pine.	Estimated volume: Pine, 45,000 bd. ft.; hemlock, 15,000 bd. ft.
Burt.....	g	Fill the blanks with pine.	2 acres to be planted.
Burt.....	h	Plant with pine.	31.1 acres to be planted.
Burt.....	n	Plant with pine.	8.6 acres to be planted.
Ellis.....	b	Plant with pine.	2.9 acres to be planted.
Ellis.....	c	Plant with pine.	2.3 acres to be planted.
Ellis.....	d	Thin the pine.	Should return a profit.
Ellis.....	e	Cut the wolf maple trees and plant.	2.2 acres to be planted.
Ellis.....	i	Thin the densest portions.	Should return a profit.
Ellis.....	k	Plant with pine.	0.6 acres to be planted.
Parker.....	h	Thin if the operation can be made to pay expenses.	1.8 acres to be planted.
Parker.....	k	Plant with pine.	1.8 acres to be planted.
Parker.....	m	Free the pine.	
Parker.....	n	Plant with pine.	1.8 acres to be planted.
Parker.....	s	Plant with pine.	1.7 acres to be planted.

Administration and protection

The present system of administration must be continued for the present. Under this plan members of the faculty visit the forest from time to time to supervise specific operations. The results cannot be so satisfactory as would be the case with a reliable administrative officer always on the ground. It is believed that eventually the services of such a man will be warranted.

The two local men who in the past have been retained as agents at a small annual fee will in future be paid only for time actually employed on the forest. Their principal service is in protecting the forest against fire and trespass. The forest was thoroughly posted with fire notices in the spring of 1916. This method of fire protection is better than none but it should be greatly improved. A study of the fire problem in the region around Keene

should be made. The storage of tools at convenient points, the making of arrangements in advance for securing fire fighters when needed, and the employment of a patrol for definite periods or for days of exceptional danger would add materially to the protection of the forest.

At Christmas time trespassers steal a large number of balsam trees from the Swanzey lots. This is very difficult to prevent and, in fact, cannot be stopped at a cost commensurate with the slight damage done.

The boundary fences are in fair condition. In order to secure protection from grazing, it is only a matter of maintaining fences in the few places where cattle range on tracts adjacent to the forest.

It will be necessary to cut the leaders infested by weevil in the plantations on the Ellis lot. This work will probably be needed in all the plantations but appears unnecessary in young, naturally reproduced stands.

The gipsy and brown tail moths have already been found in Cheshire County. Increasing the amount of pine in the forest will have the effect of minimizing possible damage by these insects in the future.

The white pine blister rust, although assuming threatening proportions in Massachusetts, has not yet been found on the school forest or in that locality. Close watch, however, should be kept for any indication of its appearance.

Estimated receipts and expenditures

Receipts and expenditures have been discussed in the Introduction, and a detailed statement is presented at the end of Part I. The average annual receipts will not increase appreciably during the next five years, while the expenditures will necessarily be more due to the expense of enlarged operations in freeing the pine from overtopping hardwoods and in planting the open and poorly-stocked areas.

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