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1907

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VOLUME II.

AUGUSTA
KENNEBEC JOURNAL PRINT
1907

MAINE FARMER PRESS, AUGUSTA

A forest fire

SIXTH REPORT

OF THE

FOREST COMMISSIONER

OF THE

STATE OF MAINE

1906.

AUGUSTA
KENNEBEC JOURNAL PRINT
1906

STATE OF MAINE.

To His Excellency, William T. Cobb, Governor of Maine:

I herewith submit my third report as Forest Commissioner for the year ending November 30, 1906, as required by the act for 1891, chapter 100, creating a Forest Commission.

EDGAR E. RING,

Forest Commissioner.

PLANTING A TREE.

AUTHOR UNKNOWN.

What does he plant who plants a tree?
He plants a friend of sun and sky;
He plants the flag of breezes free;
The shaft of beauty towering high;
He plants a home to heaven anigh
For song and mother-croon of bird,
In hushed and happy twilight heard—
In treble of heaven's harmony—
These things he plants who plants a tree.

What does he plant who plants a tree?
He plants cool shade and tender rain,
And seed and bud of days to be,
And years that fade and flush again;
He plants the glory of the plain;
He plants the forest's heritage;
The harvest of the coming age;
The joy that unborn eyes shall see—
These things he plants who plants a tree.

What does he plant who plants a tree?
He plants, in sap and leaves and wood,
In love of home and loyalty,
And far-cast thought of civil good—
His blessings on the neighborhood,
Who in the hollow of his hand
Holds all the growth of all our land—
A nation's growth from sea to sea
Stirs in his heart who plants a tree.

REPORT OF THE FOREST COMMISSIONER.

In submitting this, my third report as Forest Commissioner of the State of Maine, which is really the sixth in the series of Forestry Reports of this State, I wish to call attention to the fact that it has been my purpose and endeavor to touch upon and discuss such subjects as will be of practical benefit to the forestry interests of this State.

The report of 1902 was devoted largely to our river systems in relation to the estimated stand of spruce, and what could be reasonably expected in the future, by judicious management of the forests.

From observations made since 1902, having kept a very careful watch of lumbering operations in all sections of the State, I am of the opinion that my estimates made in 1902 were fully warranted by the facts; and it gives me pleasure to add that my recommendations as to careful and intelligent cutting have been, in the main, adopted.

There is nothing discoverable from present indications to lead me to believe that our forests are being devastated, or that in a comparatively few years Maine will become a barren waste. On the contrary, however, the owners of large tracts of timberland are becoming more and more careful in their lumbering operations and seem to be conducting these operations with reference to the present supply and future growth. Large sums of money have been expended by the owners of wild lands in the study of the proper management of these holdings so as to guarantee a perpetual supply of lumber.

A commendable practice adopted by the timberland owners is of having inserted in their permits for cutting lumber a provision that no trees measuring less than twelve to fourteen inches on the stump shall be cut. Thus all the trees under

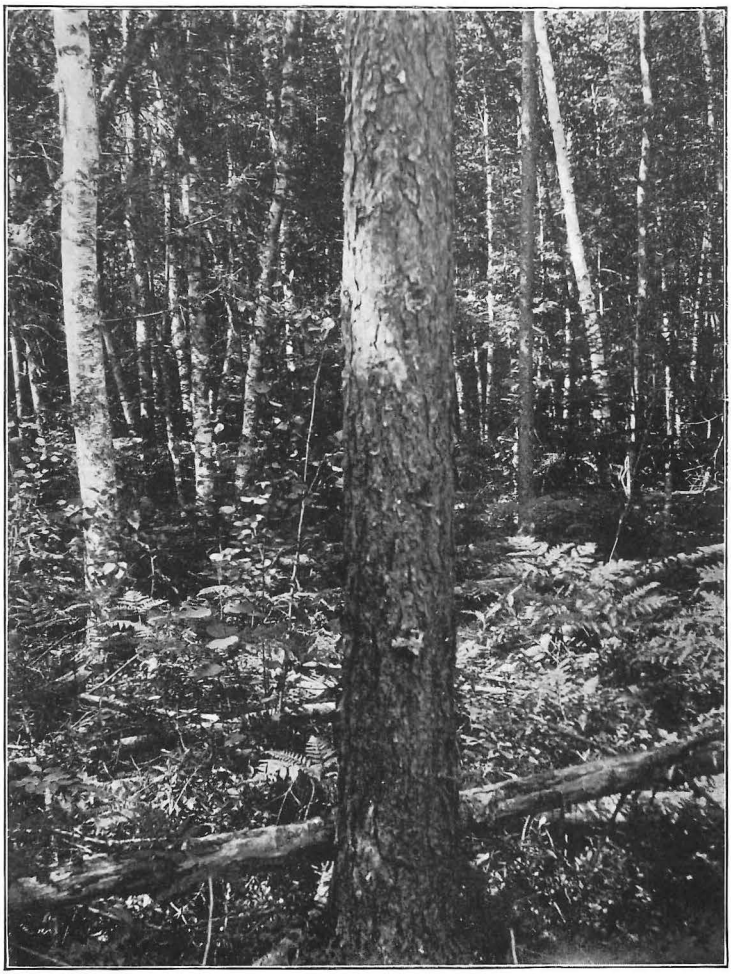
this limit are given more light and space to grow and develop, and by the law of Nature will in a few years take the place of the trees cut and be ready for another cutting. This is the secret of the future supply of timber in this State, and I believe it is being recognized and lived up to to a greater extent each year.

Another feature of saving in the great lumbering interests of the State, and distinct from the selection of trees of suitable dimensions, is the method of cutting.

In my first report I tried to make it plain and point out the great waste which prevailed in the leaving of high stumps from three to six feet, containing much of the best timber in the tree. Such wasteful cutting has, in a great measure, been stopped. The saving that is now made over the old way is partly due to the cutting being done before the fall of the deep snows of winter; but more particularly to sawing instead of chopping down the trees. The same force of men with an outfit of saws can accomplish much more, both in economy and the number of trees felled, than when axes were used.

The report of 1904 was devoted largely to the forest fire question, the great loss to the State from forest fires during the dry year of 1903, and to the study and betterment of the forestry system so admirably started.

Indulging the hope that the previous reports issued under my supervision have contributed somewhat towards awakening an interest in the judicious management of our great forest wealth, I have striven to make this, my third report, sufficiently interesting to the end that it will lead to still greater reform in that direction.



MAINE FARMER PRESS, AUGUSTA

Characteristic bark of Norway pine

DESCRIPTION OF SOME OF OUR NATIVE TREES.

With a little study it should not be difficult to distinguish trees, one from another, and properly name them. No reference is made here to the Latin specific and sub-specific designations, but to the proper English names. In these descriptions it is thought best to give the distinguishing marks and peculiarities of each tree as will enable the young forestry student to recognize with a little practice the different trees and to designate them properly.

To the lover of Nature there is no form of recreation more enchanting than time spent wandering in our forests, to witness the varied forms of life as it there exists. Its stillness, its majestic strength and extent, its extreme slowness of growth and change make it seem the emblem of peace. But in reality it is the scene of the fiercest and most relentless struggle in nature. The warfare of the trees is constant, and lasts for centuries without a moment's let-up. It makes a fatal weapon of the most trivial advantage or accident, and tallies hundreds of victims for every survivor. Every tree that reaches maturity is hero of many duels and veterans of a continuous free fight. But the greatest struggle for existence in the forest is usually the struggle for light. Sometimes there is not enough water or nourishment to supply all, and the struggle for them complicates the struggle for light; the result is almost always a forest of peculiar type, the "open forest" like that of the Rocky Mountains, where water is scarce, or of some sections of our own State, where the soil is poor, so that one tree drains the resource of many yards of ground. Such trees stand far apart, with little underbrush, as if in a park. In general the forests of our own State have plenty of food and water, the principal struggle for existence being for sunlight. Generally speaking, our Maine forest is a community of trees, by standing together they

protect themselves against high winds, one of their worst enemies. They shade the ground and keep it moist and cool, not merely for the benefit of their own roots, but for the protection and nourishment of their delicate young. The young seedlings are sensitive to heat and drought and excessive moisture, and even when the parent trees, between which they spring up, give them just the right amount of shade and coolness, they grow but slowly at first, often only an inch or two a year for four or five years.

WHITE PINE.

The white pine, next to spruce the most valuable timber tree of Northeastern America, has played a conspicuous part in the natural development of the United States and Canada. Great fleets of vessels and long railroads have been built to transport the lumber sawed from the mighty trunks; and men have grown rich by destroying it, building towns to supply the needs of their traffic, and seeing them languish as the forests disappear.

Sixty years ago the pineries of Maine and lower Canada contained stores of white pine which were believed to be practically inexhaustible; but the larger part has already been cut and the great trees which were once the pride of the northern forest no longer exist. The white pine, however, is a tree of strong vitality and under favorable conditions reproduces itself freely, especially on New England hills, where agriculture, weary of a hopeless struggle against difficult conditions, have gone back to the forest; and although it may be said that practically all of the old or original growth of white pine has been cut, there are many million feet standing in our State today, of a size suitable for lumber. This stand, however, being of a more rapid growth, is less valuable than that which preceded it, and while the best of lumber for finish and other purposes was obtained from the older and larger growth, the second growth yields a grade of lumber suitable only for boxes and ordinary building purposes. It stands today second only to spruce in its value to the State. The white pine will, under favorable conditions, grow to a height of one hundred and twenty-five feet, with a trunk from three to four feet in diameter, although specimens have been cut which were upward of two hundred feet high with a trunk diameter of six feet, four

feet above the ground. The so-called pumpkin pine is the close-grained wood of large trees which have grown to a great age in rich, well-drained soil and have been favored with abundant air. They were usually found scattered through forests of deciduous trees and were nowhere abundant. Although the white pine does not quickly or abundantly reproduce itself where fires have been allowed to consume the surface soil of the forest, it succeeds itself on land which has not suffered from fire, if sufficient shade is left to protect the young and tender seedlings. In Maine it now occupies large tracts of abandoned farm lands, and these vigorous young forests, which have sprung up on land worthless for the production of other crops, promise prosperity to these rural regions. During the past year (1905) there were upwards of 100,000,000 feet of second growth white pine manufactured in Maine, and the supply in the southern part of the State appears to be increasing. A few successful attempts have been made to cultivate the white pine in New England on a comparatively large scale, and it will no doubt play an important part in the silvicultural operations which may be undertaken in the Northeastern part of the United States.

As the article by Prof. Spring, found in this report, deals with all the characteristics of this tree, no further description will be necessary here.

PITCH PINE.

The pitch pine occurs chiefly in the southern part of the State. Its northern limits may be said to be the Androscoggin river, little being found above that latitude. It is most plentiful in York and Cumberland counties, large quantities being found along the Saco river. It grows to a height of fifty or sixty feet with a short trunk. It is frequently fruitful when only a few feet high, and often produces freely from the stump. After singeing by fire many vigorous shoots clothed with primary leaves from an inch to an inch and a quarter in length and about a sixteenth of an inch wide, of a pale green, spring up. It is an inhabitant of sandy plains and dry uplands, less frequently of cold, deep swamps. The wood is light, soft, brittle, coarse-grained, and very durable but not strong; it is light brown or red with yellow or nearly white sapwood and contains broad, small summer cells and many conspicuous resin passages.

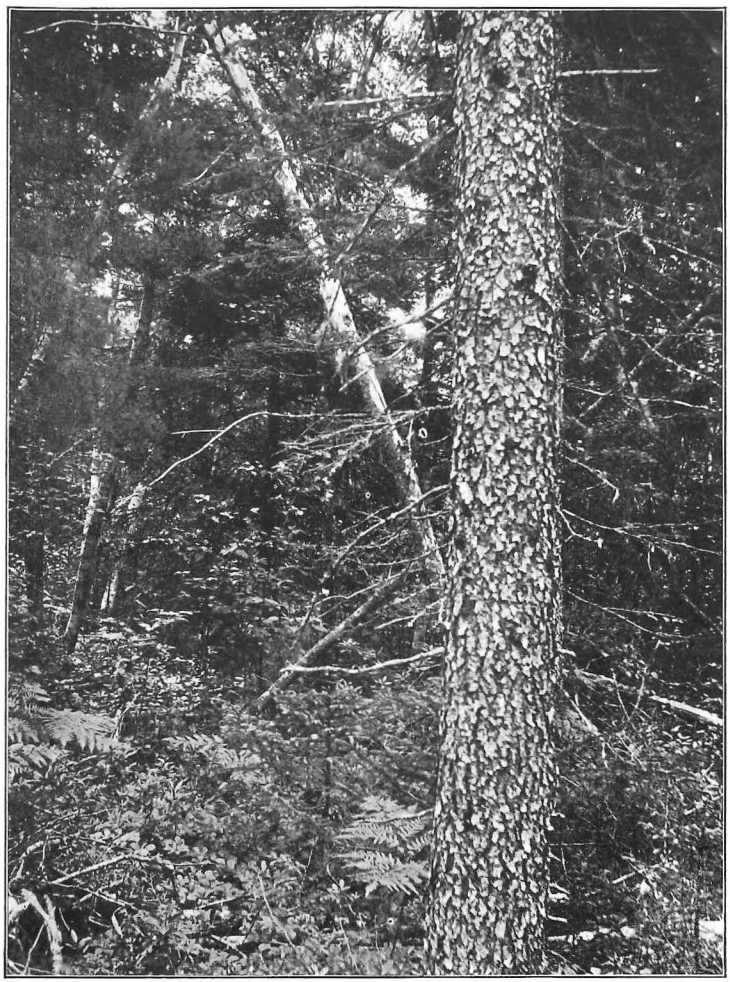
It is largely used for fuel and in the manufacture of charcoal. It has but little value for lumber.

NORWAY OR RED PINE.

The red or Norway pine is a tree usually seventy or eighty feet high, with a tall, straight trunk two or three feet in diameter, but occasionally attaining a height of one hundred and twenty-five feet with a trunk five feet through. The bark of the trunk is from three-quarters of an inch to an inch and a quarter in thickness and is slightly divided by shallow fissures into broad flat ridges covered with thin, loose, light reddish brown scales. The Norway pine is said to be the only American representative of a peculiar Old World group of pine trees. It grows on light sandy loam or dry rocky ridges, usually forming forests of other pines and of deciduous-leaved trees. It is distributed throughout Maine but is not abundant. The wood is hard and rather close-grained; in color it is pale red, with thin yellow or often nearly white sapwood. Used chiefly for lumber, for construction purposes, timber, and piles.

SPRUCE.

In the State of Maine the spruce easily takes first rank in commercial importance. The climate and soil conditions of this State seem to be peculiarly adapted for its growth, and the many uses for which it can be put, together with its great abundance in all the wooded sections, make it a source of wealth to Maine which should be recognized by wise legislation to prevent its extermination. Until within recent years its great value was but little known and as a result but little attention was paid to its perpetuation. Its greatest enemies are fire and wasteful cutting. The State forest fire laws are doing much to save it from destruction by fire, and self-interest is causing the wild land owners to give more attention to the prevention of careless and indiscriminate cutting. By careful estimate made in 1902, taking each town by itself, it was shown that 21,239,000,000 feet of spruce trees large enough to cut for lumber stood in our Maine forests. Forestry experts, from studies made of the growth, believe that the spruce forests of this State



MAINE FARMER PRESS, AUGUSTA

Characteristic bark of red spruce

will stand a cutting of 600,000,000 feet and hold its own, or in other words they will increase that amount in a year under a system of careful management. There is no wood that equals spruce for building purposes, and in the manufacture of paper it is unexcelled. It is found on all types and in a variety of mixtures, occurring most frequently on a sandy loam soil, content with fair moisture. It will not grow on very sandy soil as the white pine does, but will grow on soil of scarcely any depth, and in every variety of situation, from the swamps to the tops of mountains. It thrives best on loamy soils, on which specimens have been found with a diameter of four feet on the stump, and a height of one hundred feet, although the average mature tree is about eighteen inches in diameter and eighty feet in height.

Spruce produces some seed every year, but seeds very abundantly about once in eight years. The seeds do not germinate nearly so rapidly as those of some other trees, and are more particular in regard to the condition of the seed bed. It requires a suitable degree of moisture and sufficient soil, either organic or mineral. There is no special light requirement. The best spruce reproduction is found where the above conditions are best fulfilled, and this is old decayed log covered with moisture-gathering moss. It reproduces very poorly on hardwood land, when the soil is covered with a thick matting of hardwood litter. On spruce flats and slopes the reproduction is generally good, as the ground is covered more or less with moss and there is considerable organic soil exposed. On the moist mineral soil near streams there is often excellent reproduction. The seed, being light and winged, is easily carried considerable distances from the tree by wind.

Spruce is one of the most tolerant of the coniferous species; that is, it can continue to exist with little sunlight, although it requires abundant light for rapid development. Germinating in the dense shade of the forest it often continues to grow as a suppressed seedling for fifty years or more without reaching a height of five feet. As soon as light is admitted, however, its rate of growth rapidly increases. It is this great tolerance and tenacity of the spruce in youth which makes up for its slow growth and causes it to be so generally distributed. Until recent years, according to Sargent's Sylva of North America,

botanists referred all our spruces to two species, the black spruce and the white spruce, but Prof. Lambert, from material obtained in Newfoundland, recognized a third species which he called the red spruce. This species, however, has generally been neglected by botanists, who have either overlooked it entirely or have considered it a variety of the black spruce, although the late Dr. Lawson of Halifax and other eminent botanists have insisted that the red and black spruce were distinct trees, and their views will certainly be shared by everyone who sees them alive and understands their distributions and peculiarities.

THE RED SPRUCE.

The red spruce is a tree usually seventy or eighty and occasionally from one hundred to one hundred and ten feet in height, with a trunk from eighteen to thirty-six inches in diameter; short, slender, slightly pendulous branches which form a narrow, compact, pyramidical head; short branchlets clothed with rusty pubescence and dark green lustrous leaves. The cones are oblong and from one and one-half to two inches long, with thin, rigid, entire or obscurely erose scales, and are straight at the base, light green, sometimes slightly tinged or streaked with purple, and fall within a year after ripening. The seeds are very dark brown and about an eighth of an inch long, with short, broad wings full and rounded above the middle.

The red spruce is distributed from the valley of the St. Lawrence river and the northern shores of Prince Edward Island southward through Quebec, the Maritime Provinces and along the Atlantic coast to southern Maine and Cape Ann, Massachusetts, and through the hilly interior and mountainous parts of New England and New York and along the Alleghany Mountains to the high peaks of western North Carolina, comparatively rare and of small size north of the boundary of the United States and in the neighborhood of the coast. The red spruce, which is an inhabitant of high, well-drained, gravelly slopes, is most abundant and attains its greatest dimension in the elevated regions of northern New England and New York. It thrives well in Maine and constitutes probably eighty per cent. of the stand of spruce in the State today.

BLACK SPRUCE.

The black spruce is an inhabitant of cold, wet swamps, where it rarely grows sixty feet high or lives a hundred years. It is a tree of open habit, with rather remote branches, which sweep downward in slender, graceful curves. The leaves are blueish green and very glaucous. The cones are broadly ovate, and from three-quarters of an inch to an inch and a quarter in length, with rigid scales conspicuously erose on the margins; they are strongly incurved at the base, dark purple when fully grown, and remain on the branches for many years. Trees stunted by wet and cold often begin to produce cones when only four or five feet high. It is common in the Maritime Provinces of Canada, following down the Atlantic coast to New Jersey, although south of Cape Ann it is not common in the coast region, being confined to a few isolated swamps. It is not common in Maine, comprising probably five per cent. of our spruce growths.

WHITE SPRUCE.

The white spruce differs from the red and black in its stouter, pale and glabrous branchlets and larger buds, in its bluer and more glaucous foliage, although on some black spruces the leaves are as glaucous as those of the white spruce, and in the thin, entire cone scales, which are so flexible that a dry cone is easily compressed between the fingers, while the cones of other species break under slight pressure. The strong, disagreeable odor of the bruised leaves of the white spruce distinguishes it from all other conifers, making it easy to recognize this tree at all seasons of the year. It is most common in the northern part of the State and represents probably fifteen per cent. of our spruce forest.

BALSAM FIR.

Balsam fir grows to a height of fifty or sixty feet with a trunk usually twelve to eighteen inches in diameter. The bark of the trunk of young trees is thin, smooth, pale gray, and conspicuously marked by the swollen resin chambers; on older trees it becomes, especially near the ground, sometimes nearly half an inch in thickness, and is reddish brown and much broken

into small irregular plates separating on the surface into thin scales. The wood is very light, soft, not strong, coarse-grained and not durable. In color it is pale brown, often streaked with yellow, with thick and lighter colored sapwood and containing narrow bands of small summer cells. It occurs in mixture with spruce throughout the State but is more common in the northern part. It is not found to any extent on hardwood land but grows chiefly on the spruce flats and in swamps often occurring nearly pure.

Fir trees seed, as a rule, every third year. This is, however, varied in some cases by seeding in alternate years, and even in successive years. The more vigorous the tree, the more frequent the seeding. It prefers a mossy ground cover for a seed bed. Seedlings are usually very plentiful on old moss-covered logs and on the upper slopes. They are able to endure rather heavy shade and will live for years in a suppressed condition, ready to start into active growth on the removal of the old forest.

Fir is a short-lived tree; few individuals are found over one hundred years old. It is easily thrown by the wind, and, growing as it does on very shallow soil at high elevations, the constant swaying of the tree in the wind may sever the connection of the rootlets, breaking and tearing them and thus causing the tree gradually to dry out and die for no apparent reason. Often large areas of such dead and dying trees are found on the upper slopes.

The market value of fir is considerably less than that of spruce for various reasons, one in particular being its deceptive nature in regard to soundness. Often a fir tree on being felled will show an absolutely sound butt and also a sound top, giving the impression that the tree is sound throughout, but when it is manufactured the defects appear in the way of red and decayed portions. This characteristic, which is found more in the fir than in any other tree, is due to water getting in at knots or where a limb may have been broken off at any distance above the stump, the tree still retaining its soundness of top above the spot where the water may have gotten in. As a pulp product the fir is considered of much less value than the spruce as it makes lighter pulp and not as good a grade. However, a small percentage, mixed with spruce, can be and is used in the manu-

facture of pulp. Knowing the uncertainty of the soundness of the fir and realizing its lesser value, the operator generally leaves the fir in his operations, to the detriment of the land; the trees thus left furnishing an abundance of seed which is blown about in large quantities, thus re-seeding the land with fir in place of the more marketable spruce. Owing to its small commercial value and its prolific seeding propensity, it should be considered as a weed in our forest garden and eradicated as soon as possible.

HEMLOCK.

A tree usually from fifty to seventy feet in height, with a trunk from sixteen to twenty-four inches, although specimens are found of three and occasionally four feet in diameter. It attains its best development on the lowlands along the streams and on the lower slopes, when it grows in mixture with hardwoods and spruce. It was formerly very abundant in the central part of the State, but has been almost entirely taken out for the bark and lumber, so that it is now comparatively scarce. Its growth is slow, and although it is able to withstand very dense shade, the reproduction is very poor. It reproduces best along streams and in low, moist situations.

The wood is light, soft, not strong, brittle, coarse, difficult to work, liable to wind-shake and splinter, and not durable when exposed to the air. It is largely manufactured into coarse lumber and is used sometimes for railway ties.

The astringent inner bark affords the largest part of the material used in the Northeastern states and Canada in tanning leather, and from it is prepared a fluid extract sometimes employed medicinally as an astringent.

Two varieties, red and white hemlock, which, however, appear to be produced under precisely similar conditions, are recognized by lumbermen.

The seeds of the hemlock, although they are produced in great abundance, do not germinate freely in open situations or on ground which has been recently burned over, and the young seedlings grow slowly, plants under favorable conditions being not more than three or four inches high at the end of the fourth season. The young plants are easily destroyed by fire, and the prospects for the natural restoration of the hemlock

forests are not promising. Even under most favorable conditions the hemlock increases slowly, both in height and trunk diameter. A specimen in the American Museum of Natural History, New York, obtained in Northern New York, is thirteen and a half inches in diameter inside the bark and one hundred and sixty-four years old, the sapwood being two inches in thickness with twenty-nine layers of annual growth.

WHITE CEDAR—ARBOR VITAE.

The white cedar is distributed throughout Maine but is found in greatest abundance in the northern part, particularly in Aroostook county. It is a tree usually growing to a height of fifty or sixty feet with a trunk diameter of two to three feet. The bark of the trunk is from one-quarter to one-third of an inch in thickness and is light red-brown, often tinged with orange color.

The flowers open in April and May and are liver-colored. The fruit ripens and discharges its seeds in the early autumn, but remains on the branch until after the appearance of the new growth in the following spring; it varies from one-third to nearly one-half of an inch in length. The seed is about an eighth of a inch long and nearly surrounded by thin wings as wide as its body.

The wood is light, soft, brittle and rather coarse-grained and very durable.

It inhabits swamp-land but thrives well on the banks of streams and reproduces well where the conditions are favorable.

Immense quantities are annually consumed in the manufacture of shingles, railway ties and telegraph poles, its great durability making it a very valuable wood for these purposes.

TAMARACK—LARCH.

The tamarack or larch is a tree which, when full grown, reaches a height of fifty or sixty feet with a trunk diameter of eighteen or twenty inches. The wood is heavy, hard, very strong, rather coarse-grained, compact and very durable in contact with the soil; it is light brown, with thin, nearly white sapwood. It is an inhabitant of lands saturated with water, when transplanted to uplands grows in good soil much more

rapidly than it does in its native swamps, attaining a large size and more picturesque habit, and of all the larch trees which have been tried in the Northern states it best deserves attention as an ornament of parks and gardens. It is extremely sensitive to fire. The wood is used chiefly for shipbuilding, posts, ties, and rough lumber.

Some twenty-five years ago the larch saw-fly destroyed practically all of the larch in Maine, but a new growth has sprung up and there is today a large, healthy growth of medium-sized trees distributed throughout the State. This tree is sometimes known as juniper among lumbermen, but the juniper is a small shrub with low drooping branches with leaves somewhat resembling those of a young cedar. It is of no value.

WHITE POPLAR—ASPEN.

The white poplar is an intolerant tree growing to a height of fifty or sixty feet, with a trunk diameter of one to two feet. The leaf is two to two and one-half inches wide, and usually one-half inch shorter than wide; dark green, smooth on both sides when mature, with slight down on the edge. Ribs distinct above and below and whitish. The tremulousness of its foliage, which the slightest breeze stirs, and which sometimes gives it the name of "quaking aspen," is due to the thinness of the sideways flattened leaf-stems. It is found from Hudson Bay and Newfoundland southward to northern Kentucky and Pennsylvania, and is the most widely distributed of North American trees. It will grow in almost any kind of soil, but does best on moist ground. It is extremely rapid growing but short lived. It shoots up like a weed, growing on the average eighteen feet in height in the first eleven years; they seldom get beyond forty or fifty years of age, by which time they reach a large size. Its extreme intolerance of shade is usually, however, the cause of their early death. Having a very light, winged seed that can be easily carried for long distances by the wind, any land is apt to be seeded up to a thick stand of this species wherever there is sufficient light, as on burns, or abandoned fields.

The wood, which is abundant throughout Maine, is used for soda pulp and excelsior, and the great demands that are now

made for these products make it a valuable tree. After fire, or lumbering, the aspens are a very desirable species to have come up, as they become merchantable in twenty years and yield a large stand to the acre.

The large-toothed aspen has practically the same silvicultural characteristics as the aspen and has the same commercial value. They differ somewhat in distribution, the large-toothed aspen being more confined to the southern part of the State.

BASSWOOD—LINDEN.

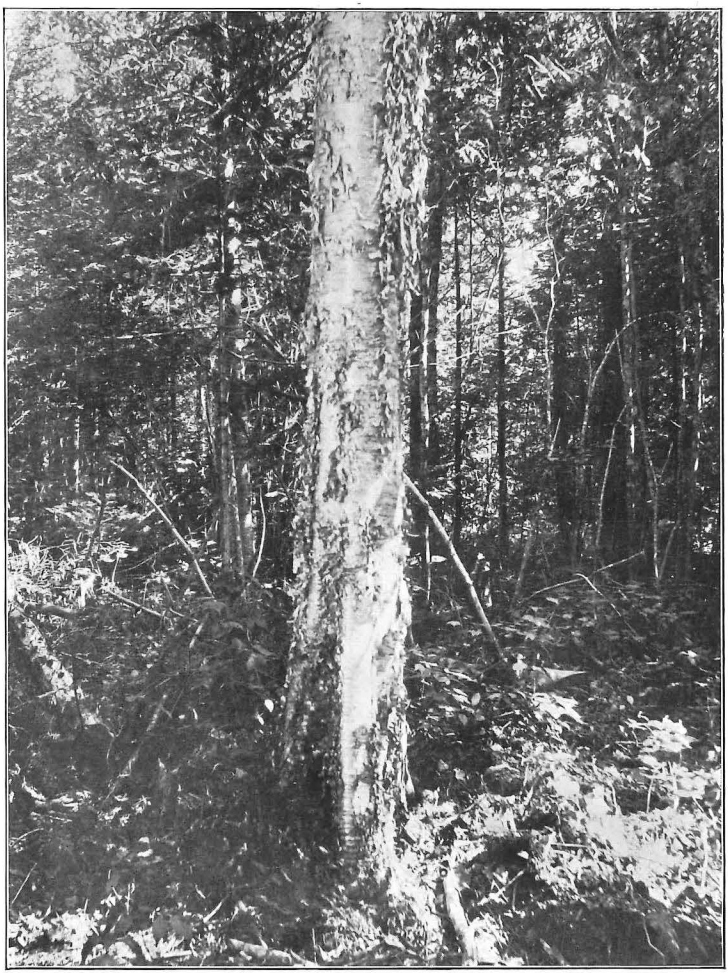
The basswood is a straight-trunked tree, sixty to eighty feet high, often unbranching to half its height and two to four feet in diameter. Seeds mature the first season. The wood is light, soft, tough, close-grained and easily worked. It is used in the manufacture of cheap furniture, boxes, tool handles, carriage boxes, veneer and for lumber. It is a hardy tree, resisting drought well. It is found in rich woods throughout the State. The large size which the basswood attains in good soil, its graceful habit, rapid growth, ample dark green foliage and fragrant flowers, make it one of the most desirable ornamental trees in the northern part of the United States.

WHITE BIRCH—PAPER BIRCH—CANOE BIRCH.

This birch is one of the most widely distributed trees of Maine, and found farther northward than any other non-evergreen tree of America, excepting the aspen. It grows to a height of forty to seventy feet. The wood is light, hard and very close-grained, but decays rapidly when exposed—more rapidly than the bark, which often remains as a shell long after the wood within has disappeared.

The bark of the trunk is very tough and durable; thick, snow-white on the outside; easily removed from the wood, and then itself very separable into paper-like sheets. The inner sheets are of a reddish tinge.

It is one of the most valuable trees in our forests; the wood being used in the manufacture of spools and novelties. It does well on any retentive moist soil, and although very hardy, it is comparatively short lived.



MAINE FARMER PRESS, AUGUSTA

Characteristic bark of young yellow birch

YELLOW BIRCH.

The yellow birch is a tree forty to eighty feet or often more in height; one of the largest and most valuable non-evergreen trees of Maine. Its hard, close-grained wood is largely used for shipbuilding, fine furniture and wheel hubs. It takes a good polish.

The yellow birch is distributed from Newfoundland southward through the Northern states to northern Delaware, along the Alleghany Mountains to the high peaks of North Carolina and Tennessee and to northern Minnesota. It usually inhabits moist uplands, growing in rich soil, and is exceedingly abundant, and attains its largest size in northern New England and New York, and as it grows among the pines, maples and elms of the Northern forest, is often a magnificent tree with its great lustrous bark, and broad and graceful branches, but it requires low temperatures and abundant moisture to develop its greatest beauty.

"Silver birch" is merely a local name for second growth yellow birch. It is very valuable for wheel hubs and peg wood.

BLACK BIRCH—CHERRY BIRCH.

A tree forty to seventy feet high, with many slender branches. Bark of trunk, a dark chestnut brown; smoothish when young, but becoming rough in old trees. The smaller branches are smooth and dotted with white spots. The foilage and bark are very aromatic and sweet-tasting, sometimes known as "sweet birch."

The wood is heavy, hard, very strong, close-grained, and takes a beautiful polish. Used in the manufacture of furniture, shipbuilding and for fuel.

It is found from Newfoundland to northern Delaware, westward, and southward along the mountains. It is very common in northern Maine.

GRAY BIRCH.

The gray birch is a slender, short-lived tree, twenty to thirty feet high, with white, soft wood, not durable. The outer bark of the mature trunk is chalky-white and thin, but not, like the

bark of the paper birch, easily separable into layers. Usually it is marked with blackish dots and lines. Often the branchlets and twigs are blackish, and in very young trees the bark may be reddish-brown, and marked with white dots. It springs up abundantly over burned and abandoned lands and is quite common in Maine. Except for fuel, the wood is of but little value.

A cultivated species is the European Weeping Birch. Its branches are very drooping, with more slender leaves, and a spray that is exceedingly light and delicate.

BEECH.

The beech is a large, stately tree, with spreading branches and a delicate spray, growing to a height of sixty to eighty feet with a trunk two to three feet in diameter. When crowded by other trees in the forest the beech grows tall, with a long and comparatively slender trunk, free of branches for more than half its length and a narrow head. The bark of the trunk is compact and from one-quarter to one-half an inch in thickness, with a smooth, light, steel-gray surface.

The beech is one of the most widely distributed trees of eastern North America, inhabiting the rich soil of uplands and mountain slopes, when it often forms nearly pure forests of considerable extent. It is very abundant throughout Maine.

The wood is hard, strong, tough, very close-grained, and takes a beautiful polish. It is used in the manufacture of chairs, shoe-lasts, plane-stocks, and tool-handles. It is very abundant in Aroostook county but is utilized to but small extent.

WHITE ELM—AMERICAN ELM.

The white elm is one of the noblest of American trees, eighty feet or more in height, and of strong, graceful proportions. The trunk divides at a slight angle into two or three arching limbs, and these again into many smaller curving and drooping branches. It is common over the entire State but does not occur anywhere in great abundance. It is found on deep, alluvial soil along the streams and in meadows, but is not found to any extent in the forest, occurring only in low altitudes.

The wood is very hard, and very tough from the interlacing of its fibres. It is used in making saddle trees, wheel hubs and agricultural implements. The tree is widely cultivated, streets planted with it become columned and arched like the aisles of a Gothic cathedral.

ROCK MAPLE—SUGAR MAPLE.

The rock maple is a noble tree, eighty to one hundred feet high, with a trunk two to four feet in diameter rising sometimes in the forest to the height of fifty or sixty feet without a branch.

The wood is heavy, hard, strong, close-grained, and tough, with a fine, satiny surface susceptible of receiving a good polish; it is light brown, tinged with red, with thin sapwood. The wood of the sugar maple is more valuable and more generally used than that of any other American maple. It possesses a high fuel value, burning with a clear, steady flame. It is largely used for the interior finish of buildings, especially for floors, and in the manufacture of furniture. It is also valuable for shipbuilding. Accidental forms in which the grain is beautifully curled and contorted, known as "curled maple" and "bird's-eye maple," are common and highly prized in cabinet making.

It is especially valuable for its sap, which yields the "maple sugar" of commerce. A tree of average size will give in an ordinary season twenty to thirty gallons of sap, usually containing from two to three per cent. of sugar.

Sugar maple occurs over the entire State, and is one of the most common of hard woods. It prefers the deep, fresh soil of the hardwood slopes, never growing in swamps or wet flats. It is quite abundant along roadsides and cut-over land.

RED MAPLE.

The red maple is quite common throughout Maine. It prefers moist soil and is seldom found above an elevation of 2000 feet. Under favorable conditions it will sometimes grow to a height of 100 feet with a trunk diameter of three feet. The wood is heavy, close-grained, not very strong. Color light brown, tinged with red. It is largely used in the manufacture of furniture. It reproduces readily.

WHITE ASH.

The white ash is distributed throughout Maine but is found in greater abundance in the central and southern sections, where it sometimes reaches a height of 100 feet. It thrives best along streams, in rich, moist soil. The reproduction from soil is poor, although the tree sprouts freely from the stump.

It is a very valuable tree, the wood being very heavy, hard and tough and is used in the manufacture of agricultural implements, cabinet work, and is unequalled for the manufacture of oars.

BLACK ASH.

This species occurs in moist situations about the State, usually a small, medium-sized tree, and inhabits deep, cold swamps and low banks of streams and lakes.

The wood is heavy, rather soft, not strong, tough, coarse-grained; durable in contact with the soil. It is used in the manufacture of baskets, in cabinet making, for barrel-hoops, and interior finish of houses.

RED OAK.

The red oak is quite a common tree throughout Maine, but is found in greater abundance in the southern part, where it sometimes grows to a height of 100 feet with a trunk diameter of four feet. It thrives well on hillsides and sandy soil; a rapid grower and a vigorous sprouter from the stump; a very hardy tree.

The wood is hard, strong and coarse-grained. In color it is reddish brown. It is used in the manufacture of chairs, for lumber and interior finish. The bark is used for tanning.

MAINE FARMER PRESS, AUGUSTA

Stand of small red spruce

FOREST FIRES.

All sorts of questions as to the length of time our forests can stand the present rate of cutting; as to the best methods of managing a forest, etc., etc., will continue to be argued by the land owner and the lumber user, but on one point nearly all agree, and that is that the greatest source of danger to our forests is from fire. What a dread comes upon the person who is in the least interested when it is learned that a forest fire is raging in the particular locality of his holdings and that his investment in the same is liable to be swept away in a few hours. It is not, however, altogether the owner of timber lands who shudders at the knowledge of a woods fire, but more and more our people are realizing what general devastation of our forests by fire would mean. It would mean that not merely the pulp, paper and lumber interests would suffer incalculable loss, but that the sources of our water supply would dry up, in time causing the crippling of many great enterprises in our State, which now depend upon the rivers and lakes to turn their wheels and operate their machinery.

To remedy and lessen the evil becomes the duty of not only the State Forest Department, but every individual with the welfare of the State at heart should do all within his power to promote the cause of forest preservation and aid in educating the public, who often are thoughtless, as to what our forests mean to the State. If it is a fishing party, a picnic gathering or a few strollers through the woods, they should be made to realize that too much caution cannot be exercised by them in refraining from carelessly building fires, throwing away lighted matches, stubs of cigars, etc. It would be well if each one could have instilled into his memory in capital letters PUT OUT YOUR FIRE, and if you find fire left by others put that out. If just such spirit could be manifest the danger would be greatly lessened and the losses sustained through carelessness reduced to a minimum.

CAUSES OF FOREST FIRES.

The causes of forest fires are varied and many, and really in a very small per cent. can the exact origin of a fire be traced. Suppositions of this and that cause are advanced, but when it is noted that in the reports of the wardens for unincorporated places and the selectmen of towns, the cause is often given as "unknown," it must be admitted that the tracing of many a fire to the exact cause is a matter of no small moment.

In Maine we are more likely to suffer from forest fires in the early spring, before the undergrowth starts up and puts on its green leaves, than later in the season, except under conditions of severe summer drought, when fires may rage in any of the summer months. In the fall when the grass is dry from the drought and much of the underbrush in the same condition, a fire may easily be set that will extend to the trees, because in most stretches of woodland the underbrush is from three to six or eight feet high, and while it is so dense as to make it nearly impassable, it is full of air spaces that feed a fire in it with oxygen, and send it whirling around the tree trunks, so that when the wind is strong we soon have the spectacle of a forest fire, with all the danger, the loss and suffering it carries with it.

The danger from damage to forests by fire where lumbering is carried on arises largely from the fact that the tops of the trees and large limbs which are left on the ground dry rapidly and give fuel for any running fire to catch in. The burning of these leavings by the lumbermen is expensive and by one who has made a study of the matter it has been suggested that the branches might be lopped, so that both they and the tops would fall to the ground. In this way the tops which are ordinarily braced up from the ground by the branches and kept as dry as tinder, would be likely to be kept moist from snow and rain and rot sooner. The tops and limbs of spruce trees left in the woods become too wet and sodden to burn easily in two or three seasons after cutting, and of course the closer they lie to the ground the sooner will the process of decay take place. In some of the foreign countries where fuel is scarce the tops and branches of the trees are bundled into firewood, but of course in this country anything of the kind would be impracticable under the existing conditions.

Forest fires come into existence by ignition of the combustible material which is scattered over the ground in natural, or wild woods. Should the ignition be confined to passing over the soil and consuming only the dead foliage and dried branches which always litter the ground, it is called a ground or soil fire. As soon as the fire attacks the branches of the trees and reaches the canopy formed by the tops of the trees, it is known as a crown or top fire. Besides these forms of fires, cases may be mentioned where single trunks or boles, when hollow, are ignited by men who smoke out a hive of bees, or dens of bear; and still more seldom are the cases where the soil itself, being of a peaty nature, is set on fire.

Woods fires are seldom caused by natural forces, although there is the admitted per cent. that are caused by lightning. In most cases they are due to imprudence or negligence of man by lighting fires in the woods or near by. Some are caused, only indirectly by human agency, from the sparks emitted by locomotives on railways which run through wooded tracts. The number of cases of forest fires in this State from incendiarism are fortunately very few.

As for the localities endangered principally by forest fires, the nature of the soil and the situation of the woods are the main factors which determine the extent of the injury, because on these the character of the soil covering and the species of trees growing there is dependent. Inferior soils, with their dry covering of coarse grasses and herbage, are of such deficiency in soil moisture that the scrubby growth soon becomes dried up in early summer and are much more threatened with danger from fire than fertile soils with strong growth of succulent plants and grasses.

As a rule, the areas with inferior quality of soil are mostly occupied by conifers, resinous trees, which of themselves are much more subject to danger from fire than the broad-leaved deciduous trees, more especially as regards the top or crown fires. From these, the latter suffer only during the earlier stages of growth, when they form thickets, and dead foliage is still hanging on the branches. The vast stretches covered with young conifers, where the soil and its covering are not only usually dry, but where the trees themselves are of an inflammable nature, invite forest fires in a most undesirable degree,

and as soon as these ground fires have originated, it will not take a long time before the lower branches and twigs of the young trees are attacked by the flames, and the entire forest will be devoured.

Old pineries where the trees have parted with their branches and keep only their canopy, suffer not so much from ground fires, but are exposed to crown fires. This danger diminishes with the increase in the growth of the trees, because the combustible material in the needles in the canopy is getting every year more isolated, and by the natural growth of the trees retires steadily more distant from the ground, the common place of the origin of forest fires. Large, compact natural reproduction of pineries enhance the danger of spreading of fires that may break out and at the same time make their extinction a matter of increased difficulty.

Settlers or farmers clearing land in the spring or fall are responsible for a larger per cent. than should be of the fires in this State. It is surprising the extent of ignorance and carelessness displayed in the matter of clearing land. Little precaution is taken and ofttimes a fire is started in the stump and brush piles when a heavy wind is blowing and it is almost certain that the flames and sparks will be swept to adjoining land, but the parties firing their dry piles of refuse do not seem to realize the danger until it is too late. They wake up to the fact when they see a nice tract of spruce or pine growth being eaten up by the flames. They may work ever so hard then to extinguish the fire, but a little more judgment would be the occasion for a great deal less work and loss. The laws in regard to the setting of fires are broad and threatening all kinds of trouble for the one who causes damage, but the fact to be instilled into the minds of such law-breakers is that they must not set fires on their clearings in dry times.

"Blueberry burns" are also a source of danger and the cause of more or less damage to the forests of Maine. It is the custom to burn over such lands giving promise of a good blueberry crop to increase the "pick," and in doing this ofttimes the fire spreads into adjoining growth, burning over many acres of valuable timber, and all for the sake of a few more blueberries, and this is said with all due regard for the canning industry and the men interested therein.

MAINE FARMER PRESS, AUGUSTA

Coniferous forest balsam fir in the foreground

In my last report I had occasion to call attention to the pernicious law allowing the shooting of porcupines and the placing a bounty on the heads of each animal of that kind shot. The hunting of these little animals and using all sorts of ammunition, particularly the use by boys of the old-fashioned muzzle-loader, occasioned many forest fires, doing damage many times greater than any direct damage ever caused by the animals in "girdling" the tree, besides the enormous cost to the State. This law was promptly repealed by the Legislature of 1905 and thus removed one of the frequent causes of fire which existed while the law remained on the statute books.

It is hard to estimate just what per cent. of forest fires to attribute to campers, fishermen and hunters, but unquestionably they do in no small degree add considerable to the number of fires carelessly started. Although warned in all directions by the innumerable "fire notices," a spirit of thoughtlessness seems to go with this class and say what we may, they will build fires and in many cases take no pains to put them out. It is not reasonable or fair to accuse all of being thus careless, as among the thousands who go into our woods for one reason and another, a great many are cautious in regard to fire, but of the other unthinking class we have little patience and our experience teaches us they are hard to get at and deal with.

A small per cent. of the fires can be attributed to river-drivers, but this percentage is growing smaller each year as those in charges of the drives are taking more care to see that their men leave no fires burning in places where harm might result. To some crews of river-drivers our wardens are indebted for the timely assistance given in fighting fires that otherwise would have gained great headway and caused much damage.

DANGER

—— FROM ——

Setting Fires on Forest and Timber Land

The Revised Statutes of Maine Provide as Follows:

Chap. 7, Sec. 55. Whoever by himself, or by his servant, agent or guide, or as the servant, agent or guide of any other person, shall build a camp, cooking or other fire, or use an abandoned camp, cooking or other fire in or adjacent to any woods in this State, shall, before leaving such fire, totally extinguish the same, and upon failure to do so such person shall be punished by a fine of fifty dollars. * * * * * * One-half of any fine imposed and collected under this section shall be paid to the complainant.

Chap. 7, Sec. 56. Camp fires must be totally extinguished before breaking camp, under penalty of not to exceed one month's imprisonment or one hundred dollars fine, or both, as provided by law.

Chap. 28, Sec. 15. Whoever kindles a fire, on land not his own without consent of the owner; * * * * * if such fire spreads and damages the property of others, he forfeits not less than ten, nor more than five hundred dollars; and, in either case, he shall stand committed until fine and costs are paid, or he shall be imprisoned not more than three years.

Chap. 28, Sec. 16. Whoever with intent to injure another, causes a fire to be kindled on his, or another's land, whereby the property of any other person is injured or destroyed, shall be fined not less than twenty nor more than one thousand dollars, or imprisoned not less than three months, nor more than three years.

Chap. 28, Sec. 17. Whoever for a lawful purpose kindles a fire on his own land shall do so at a suitable time and in a careful and prudent manner; and is liable in an action on the case, to any person injured by his failure to comply with this provision.

Chap. 28, Sec. 18. Persons engaged in driving lumber may kindle fires when necessary, but shall use the utmost caution to prevent them from spreading and doing damage, and if they fail so to do, they are subject to all the foregoing liabilities and penalties, as if said privilege had not been allowed.

Chap. 7, Sec. 67. Any person viciously or wantonly tearing down, destroying or defacing this notice, shall on conviction thereof, be punished by a fine of five dollars.

In addition to the above stated fines and penalties all persons are liable in civil suits for all damages caused by fires set by them or by their direction.

EDGAR E. RING, Forest Commissioner.

Undeniably some fires are caused by railroads where the right of way passes through the heart of the wooded sections. We find, however, the railroad managers in this State not only willing but anxious to do all in their power to reduce to a minimum the number of fires thus caused and to do all they can to extinguish fires once started. In some of the most exposed places patrols are kept at the expense of the railroads and the line gone over after the passage of each train. The dry season gives the men thus employed plenty to do but it saves a great many large conflagrations. Looking to the still better protection and aid from the railroads, the Forestry Department had neatly framed in wood and glass some 400 copies of the "Danger" notices. (See page 28.)

Early in the spring of 1906 letters were sent to the managers of all the railroads in the State asking them if such notices neatly framed, would, if furnished by the State, be distributed and put up on the outside of the station buildings at the railroad's expense. In every case a prompt response was made by the managers, heartily endorsing the plan and agreeing to instruct their agents to see that the same were posted as soon as received. Lists of stations, from which it was usual for tourists and hunters to depart, were made by the Forest Commissioner and furnished the railroads, and in each case so far as we know these notices were hung, and we believe had due effect in cautioning and causing hunters and campers to be more careful.

A good illustration of thoughtlessness in the origin of forest fires is contained in the following narrative. A hunter after wandering through the woods sat down beside a hollow tree which presented an inviting appearance. He had not been there long when there was a great commotion in the stump and several good-sized hornets landed on the hunter's neck and began to work. He moved out so hurriedly that he forgot his rifle and had to go back for it. His inclination then was to get even with the hornets and he gathered some grass and dried leaves and heaping them about the base of the stump set the pile on fire. Then he stood off gloating at the satisfaction of seeing the hornets smoked and burned out. The stump burned merrily for a few minutes before the man saw there might be trouble if he did not put the fire out. He made an attempt but it had gotten too far for him and from the old stump the

fire spread over several acres before it was extinguished. He learned his lesson but his lesson should be a warning to others tempted to do similar acts.

Some are inclined to lay the cause of many fires to guides, but it has been my observation that guides usually are very careful about leaving fires in the woods. They recognize that too many conflagrations would hurt their business, and they do not propose to help destroy the forest. On the other hand they are ever watchful and extinguish many small fires which they find in going about the woods.

PREVENTION AND EXTINGUISHMENT.

The methods applied for extinguishing forest fires depend upon the nature of the fire and the localities. Water in easy access is a great help, but ofttimes the scene of the fire is many miles from a stream or lake. Ground fires discovered at their beginning, and when still of small extent, can be easily put out by a few men using the back of shovels or green boughs to knock out the smouldering combustibles on the soil. But when once a ground fire has taken hold of a large area, the difficulty of preventing its extension grows rapidly. For this reason speedy and most energetic action should be taken, because the danger of its assuming extensive proportions increases with every moment lost.

As soon as the news of a forest fire is learned by the wardens they are instructed to take men and proceed with all due haste to the scene of the fire. The work of the warden and his crew should be aided by the owner or manager of a forest sending as many men as he can to assist in the extinguishment, taking along with them shovels, spades, axes, etc. Arriving at the scene such disposal of the men should be made as seems best adapted to the prevention of further spreading of the fire. Ground fires of small expanse may be put out, as above mentioned, by beating the fringe of the flames with green boughs or with the back of the shovel, or by throwing sand or earth over the flames. When there is no wind or only a slight breeze blowing, ground fires of larger extent may be extinguished by these measures when applied from different sides simultaneously.

MAINE FARMER PRESS, AUGUSTA

Characteristic bark on old yellow birch

When there is a heavy wind blowing, and the smoke and heat in front of the fire become so strong that the men are unable to endure this inconvenience, the extinctive measures are confined at first to the sides and flanks, and when in this way the extent of the fire is decreased, gradual efforts must be made to head off and stop it. Should the breeze be very strong and the fire have gained foothold over any considerable area, it is advisable to commence operations some distance ahead of the line of flames and clear a strip several yards in width from all inflammable material, simultaneously extinguishing the fire along the edges.

When a ground fire is strong and the danger is imminent that it will overleap the check made by the cleared strip, it is advisable to set fire along the inner edge of the cleared line so as to burn against the wind and meet the fire, which will, when it has reached the counter or back fire, subside for lack of fuel. Whenever fire lanes or other protective lines are provided for in a forest, these should be selected as bases of operations, so as to obviate the danger of sparks being blown into the woods lying behind. The starting of a back fire must be conducted with great care, and the line should be sufficiently manned with competent men to see that the counter fire does not burn in the opposite direction, aggravating the damage it was intended to put an end to. When once, however, this counter fire has been well started, it will soon effect its object, making headway against the main line of fire, where the ignition at last subsides for the lack of fuel.

Ground fires that break out in the woods of young growth finally develop into top or crown fires, if they are not checked in time. For as soon as such a fire eats its way into the thickets where the trees have still kept lower branches, it runs up into the crowns, and then the danger of the situation is much increased. Extinctive measures are then far more difficult and troublesome, especially during high winds, when the smoke, flames and heat are driven on ahead against the force of men. In such cases extinctive measures are no longer practically adopted, and the conflagration is only stopped by a natural occurrence, as a drenching rain, or a clearance, a wide road or by reaching the limits of the woods.

Ground or soil fires which have broken out in the bogs, lying in or adjoining a forest, should be extinguished before they reach wooded tracts. The progress of such a fire, which often burns deep under the soil, can only be stopped by digging ditches deep enough to reach the ground water level or the mineral soil, and thus isolating that portion of land which is on fire.

Fires which have originated in the trunk or hole of old hollow trees are extinguished by shutting off the access of air into the interior of the tree.

In bringing these paragraphs as to the cause and means of prevention and extinguishment of forest fires to a close I would advise and urge prudent conduct of all operations within the woods, for the purposes of which it is necessary to employ fire. Hunters, woodsmen and laborers should be thoroughly impressed with the necessity for prudence in this matter.

LOOKOUT STATIONS.

Speedy information in regard to the occurrence of a forest fire is of the greatest importance so that measures for its extinction may be taken at once. Along this line nothing of more importance was accomplished in 1905 than the establishing of several "lookout stations." Three observatories were constructed in that year, located at Squaw Mountain, Attean Mountain and Mt. Bigelow. Each station is connected by telephone with the house of the Chief Fire Warden of the district, who is immediately communicated with in case a smoke or other indication of fire is noted by the operator in charge of the station.

The cost of building the observatories and constructing the telephone lines has been borne by the land owners, while the State has paid the men in charge of the several stations, such an agreement having been made between the land owners and the Forestry Department before work of construction was commenced. The plan has more than met the expectations of its promoters and it is estimated that for the first year alone the direct results amounted to the saving of thousands of dollars worth of timber land.

The station at Squaw Mountain is located at the southern end of Moosehead lake and the crest is rather more than 4000

feet above the sea level. The observatory is a log cabin structure with a flat roof from which the operator makes his observations every hour of the day. This station commands a clean sweep of the entire Moosehead lake region east and west, and to the southwest can control the whole forest in the East Branch section where are located many camps of lumbermen and sportsmen. Between thirty and forty fires were discovered by this station, and the diary kept by the watchman, Wm. Hilton, follows, showing the record as kept by him and illustrates the method employed at all the stations:

DIARY KEPT BY WILL HILTON, WATCHMAN ON SQUAW MOUNTAIN.

Commenced work Saturday, June 10, 1905.

Saturday, June 10, clear, south wind.

Sunday, June 11, raining, south wind.

Monday, June 12, raining, south wind.

Tuesday, June 13, raining, south wind.

Wednesday, June 14, clear, north wind.

Thursday, June 15, clear, north wind.

Friday, June 16, clear, north wind. Began burning on right-of-way at Moxie Pond.

Saturday, June 17, clear, north wind. Fire on C. P. Railway four miles west of Borestone Mountain, reported to E. B. Crowley at 9 A. M.

Sunday, June 18, raining, south wind.

Monday, June 19, foggy, south wind.

Tuesday, June 20, foggy, south wind.

Wednesday, June 21, foggy, south wind.

Thursday, June 22, clear, north wind.

Friday, June 23, clear, north wind.

Saturday, June 24, clear, north wind. Fire twelve miles distant on the C. P. R., 319 degrees, reported at 2 P. M., to W. M. Shaw.

Sunday, June 25, clear in forenoon, squalling in afternoon, northwest wind.

Monday, June 26, rainy, northwest wind.

Tuesday, June 27, squally, northwest wind.

Wednesday, June 28, fair, northwest wind.

Thursday, June 29, fair, northwest wind.

Friday, June 30, fair, northwest wind.

Saturday, July 1, clear, south wind.

Sunday, July 2, rainy, south wind.

Monday, July 3, clear, south wind.

Tuesday, July 4, clear, south wind.

Wednesday, July 5, clear, south wind.

Thursday, July 6, clear, south wind. Fire in Shirley, 160 degrees. Reported to W. M. Shaw, 11.15 A. M. Farmer burning brush.

Friday, July 7, clear, south wind.

Saturday, July 8, clear, south wind.

Sunday, July 9, clear, south wind.

Monday, July 10, clear, north wind. Fire four miles west of Borestone burning again, reported to E. B. Crowley at 10.30 A. M.

Tuesday, July 11, clear, north and south winds.

Wednesday, July 12, cloudy, south winds.

Thursday, July 13, clear, south winds.

Friday, July 14, clear, south winds.

Saturday, July 15, rainy in forenoon, north wind.

Sunday, July 16, clear, north wind.

Monday, July 17, rainy, south wind.

Tuesday, July 18, clear in forenoon and squally in afternoon, north and south winds.

Wednesday, July 19, clear, north winds.

Thursday, July 20, clear, north winds.

Friday, July 21, clear, north winds.

Saturday, July 22, clear, north winds.

Sunday, July 23, clear, south winds.

Monday, July 24, cloudy, south winds. Fire at Monson, at 143 degrees, reported to W. M. Shaw at 8.30 A. M. Fire at Shaw farm, reported to W. M. Shaw at 1.30 P. M. It proved to be burning brush.

Tuesday, July 25, cloudy, south wind.

Wednesday, July 26, clear in forenoon, squally in afternoon, north wind.

Thursday, July 27, clear, north wind.

Friday, July 28, clear, north and south winds. Fire at 120 degrees, 30 miles distant, reported to W. M. Shaw at 12 o'clock.

Saturday, July 29, clear in forenoon; the first bad thunder shower in afternoon; southwest wind.

Sunday, July 30, cloudy in forenoon, rainy in afternoon, southeast wind.

Monday, July 31, rainy, north wind.

Tuesday, August 1, clear, north winds.

Wednesday, August 2, clear, north winds.

Thursday, August 3, clear, north winds. Fire across the line in Canada, reported to W. M. Shaw at 6 P. M.

Friday, August 4, clear, north wind. Fire on the east side of Lobster Lake, reported to W. M. Shaw at 3 P. M.

Saturday, August 5, south wind, smoky.

Sunday, August 6, clear, south wind.

Monday, August 7, clear, north wind.

Tuesday, August 8, cloudy and squally, southwest wind.

Wednesday, August 9, smoky, south wind.

Thursday, August 10, smoky, southwest wind.

Friday, August 11, squally in forenoon, southwest wind.

Saturday, August 12, smoky, southwest wind.

Sunday, August 13, clear, northwest wind.

Monday, August 14, clear. Fire east of Katahdin Mountain. Northwest wind.

Tuesday, August 15, cloudy, southeast wind.

Wednesday, August 16, clear, northwest wind.

Thursday, August 17, clear, northeast wind.

Friday, August 18, clear. Three different fires across the line in Canada burning. Northwest wind.

Saturday, August 19, clear, southeast wind. Fire in Monson, 149 degrees.

Sunday, August 20, clear, south wind.

Monday, August 21, clear, north and south winds.

Tuesday, August 22, clear, north wind. Fire at 259 degrees on the southeast side of the 10,000-acre lot. Proved to be on Mud Pond, a small pond one mile from Kennebec River. Reported at 12.30 to W. M. Shaw. A fire between the Ross farm and Northeast Carry, reported at 12.30 to W. M. Shaw. A fire at Northeast Carry on Russell Stream, reported at 3 P. M. to W. M. Shaw. A fire at Jackman, reported at 12.30 to W. M. Shaw. Two small fires on C. P. R., reported to W. M. Shaw at 3 P. M.

Wednesday, August 23, clear, northwest wind. A fire south of Sebec Lake, 128 degrees, reported at 12.15 to W. M. Shaw. A fire in northeast corner of Monson at 136 degrees, reported at 12.15 to W. M. Shaw.

Thursday, August 24, clear, southwest and northwest winds. Fires at Northeast Carry and 10,000-acre burning badly.

Friday, August 25, clear, northwest wind. A fire on Churchill Stream, one mile from Long Pond, reported at 1.30 to C. D. Shaw. Fire at Lobster Lake, reported at 1.45 to C. D. Shaw. Fire thirteen miles distant at 259 degrees, reported at 3 o'clock to C. D. Shaw.

Saturday, August 26, clear, northwest and southerly winds. Fires at Northeast Carry and Lobster Lake still burning.

Sunday, August 27, clear, northwest wind.

Monday, August 28, clear, northwest wind. Fire in town of Willimantic, west of the north end of Sebec Lake, and reported at 1 P. M. to W. M. Shaw.

Tuesday, August 29, foggy, northwest wind.

Wednesday, August 30, clear, northwest winds. Fire at 193 degrees in the northeast corner of East Moxie proved to be Stacey's men burning campground, reported 11 A. M. to W. M. Shaw.

Thursday, August 31, foggy, north wind.
Friday, September 1, smoky, northwest wind.
Saturday, September 2, smoky, southeast wind.
Sunday, September 3, rainy, southeast wind.
Monday, September 4, rainy, southeast wind.
Tuesday, September 5, rainy, southeast wind.
Wednesday, September 6, squally, north wind.
Thursday, September 7, clear, northeast wind.
Friday, September 8, clear, northwest wind.
Saturday, September 9, clear, northwest wind.
Sunday, September 10, clear, southwest and west winds.
Monday, September 11, clear, south wind.
Tuesday, September 12, rainy, south wind.

Respectfully submitted,

WILL HILTON, *Watchman.*

The operator at Attean Mountain station had a sweep over 200,000 acres of green timber country, most of which lies to

the north and west. Twelve fires were detected and reported by the operator at this point. Attean is on the south shore of Moose river, about twenty miles west of Jackman. A small portion of the Dead River region can be covered by the Attean station.

Mount Bigelow controls a view of upwards of 200,000 acres of timber and farming land and the operator reported eleven fires in the season of 1905.

All the observatories are equipped with the very latest instruments for charting the sections which they are supposed to cover. The observers are supplied with topographical charts of their stations and have also the regulation range finder necessary to the exact location of a forest fire.

The average cost of constructing and equipping these stations is about $750.00. The operator takes observations every hour in the day and noticing the rise of a little stream of white smoke in any direction consults his chart and in one minute can telephone to the fire warden of the district in which the fire is noted. Investigation can then be quickly made by the warden and if necessary crews can be hastened to the scene to fight or check the blaze. A little blaze thus detected and smothered prevents the burning of townships.

This year three more stations have been constructed, located at Skinnertown on a high elevation commanding a view of 250,000 acres of the head waters of the Dead and Moose rivers; at Spencer Mountain, which is about ten miles east of Spencer bay, east shore of Moosehead Lake. Here 200,000 acres of timberland on the Penobscot and Kennebec can be watched; at Whitecap Mountain is another station from which 300,000 acres on the Kennebec and Penobscot watersheds can be overlooked.

WARDEN SERVICE.

The warden service inaugurated in 1903 after the inception of the law by the Legislature of that year, has been continued with modifications to conform to the changes made necessary by a revision of the law by the Legislature of 1905. After the experience of a season it was found by the Forestry Department where the law could be improved, and acting upon the advice of the Forest Commissioner and those who had made

a close study of the matter, the following revision was made by the Legislature:

AN ACT relating to the prevention, control and extinguishment of forest fires in plantations and unorganized townships.

Section 1. The Forest Commissioner shall take measures for the prevention, control and extinguishment of forest fires in all plantations and unorganized townships, and to this end he shall establish such forest districts as he may deem necessary for effective protection against loss or damage by such fires.

Sect. 2. The said Commissioner shall appoint in and for each of said districts, so established, a chief forest fire warden, and he shall also appoint within such districts such number of deputy forest fire wardens as in his judgment may be required to carry out the provisions of this act, assigning to each of the latter the territory over and within which he shall have jurisdiction. All chief and deputy forest fire wardens, so appointed, shall hold office during the pleasure of said Commissioner, be sworn to the faithful discharge of their duties by any officer authorized to administer oaths, and a certificate thereof shall be returned to the office of such Commissioner.

Sect. 3. The said chief forest fire wardens, under the direction of said Commissioner, shall have general supervision of their respective districts and of the deputy forest fire wardens therein. Each chief forest fire warden, when directed by the said Commissioner, shall patrol the forests of his district for the purpose of searching out, extinguishing and guarding against forest fires. He shall investigate and gather evidence regarding the causes of forest fires, enforce all laws relating to forests and forest preservation, arrest all violators thereof, prosecute all offenses against the same, and in this connection shall have the same power to serve criminal processes against such offenders and shall be allowed the same fees as a sheriff, or his deputy, for like services, and shall have and enjoy the same right as a sheriff to require aid in executing the duties of his office. Said chief forest fire wardens shall perform such other duties, at such times, and under such rules and regulations, as the said Commissioner may prescribe, and each shall receive as compensation two dollars and fifty cents for each and every day of actual service, with an allowance for expenses

of travel and subsistence not to exceed two dollars daily for such period. The said Commissioner may authorize the employment of suitable persons to assist said chief forest fire wardens in patrolling their respective districts and every person so employed shall be paid fifteen cents for each hour of service so rendered by him and be provided with subsistence during such period. Deputy forest fire wardens shall perform such duties, at such times and under such rules and regulations, as the said Commissioner, or the chief fire warden of the district, with the approval of said Commissioner, may prescribe, and they shall receive as compensation two dollars for each and every day of actual service.

Sect. 4. Whenever a fire occurs on, or is likely to do damage to forest lands within the district of any chief forest fire warden, he shall take immediate action to control and extinguish the same. If such fire occurs upon or is likely to do damage to forest lands within the territory of a deputy forest fire warden and the chief fire warden of the district is not present, then and in such case the deputy forest fire warden having jurisdiction of the territory shall forthwith proceed to control and extinguish the same, and he shall meanwhile, with all consistent dispatch, cause the said chief fire warden of the district to be notified of the occurrence of such fire. Until the arrival of the chief warden at the place of fire the deputy warden shall be in charge of the control and extinguishment of the same. For the purpose of controlling and extinguishing fires as aforesaid chief forest fire wardens, and deputy forest fire wardens when in charge of the control and extinguishment of forest fires or when so directed by the chief warden, may summon to their assistance citizens of any county in which said fire may be, and each person so summoned and assisting shall be paid fifteen cents, for each hour of service rendered by him. Immediately after the extinguishment of a fire the deputy forest fire warden who for any time may have been in charge of the same shall make return to the chief warden of the district of the expense thereof during the period of his being in charge, including the names of the persons so summoned and assisting, with their postoffice addresses and the hours of labor actually performed by each under his direction. The return shall be made upon oath and the said chief warden is hereby authorized

and empowered to administer such oath. Upon receipt of such return the said chief fire warden shall carefully examine and audit the same and he may direct the deputy to amend and correct any return found to be incomplete, incorrect or insufficient in form. If upon examination and auditing of said return, and investigation of the subject matter thereof, said chief fire warden believes said return to be just and correct, he shall endorse his written approval thereon and forward the same so approved to said Forest Commissioner. The chief fire warden of every district burned by a forest fire shall, upon the extinguishment of such fire, promptly forward an exact and detailed statement of the expense, if any, which said chief fire warden may have incurred in connection with the extinguishment of such fire, to the said Forest Commissioner, who may confirm, reject or recommit either or both said approved return of said deputy or said detailed statement of said chief fire warden if justice so requires.

Sect. 5. All expense incurred under the provisions of this act shall be paid from the funds appropriated to and for the use of the Forest Commission.

Sect. 6. All acts and parts of acts which are inconsistent with the provisions of this act are hereby repealed.

In accordance with the revised law the wild land sections of the State were subdivided into districts, using the river systems as a basis, and fifteen chief fire wardens were appointed and sworn in to take charge of the districts, and to whom all reports of fires are first made for their approval. The reports are then forwarded to the Forestry Department at Augusta, the Forest Commissioner acting as the last auditor of the bills thus presented. In most cases the bills are paid as approved and allowed by the chief wardens, but in some instances where the bills appear at least unreasonable a personal investigation is made by the Forest Commissioner and nothing allowed until he is satisfied it is merited. Necessarily such a process leads to the cutting down of some bills and also serves as a check on any inclined to put in bills other than just. It would be a peculiar law indeed that was perfect, but the amended act is an improvement over the original and a step in the right direction. With such a large area covered by the wild lands it

becomes a problem as to how to best handle the forest fire question and a matter full of study and constant thought.

Under the chief wardens are placed some 175 deputy wardens, with power to employ crews and use all available means to prevent fire. No set rules can be made that will cover all circumstances, but the following general instructions are sent to each warden:

INSTRUCTIONS TO FIRE WARDENS.

"An important part of practical forestry is the prevention of fire. This cannot be accomplished successfully without a well organized force, in which the duties of each individual are well defined and clearly understood. To this end the following instructions should receive careful attention.

"It is the duty of the chief fire warden to see that the district fire wardens are fully supplied with printed notices containing the rules and regulations relating to the prevention of forest fires. Early in the season fire notices are sent to all wardens but more can be obtained at any time by writing to the Forest Commissioner. The district fire wardens should see that their respective districts are properly posted with these notices, putting them up on trees along each forest trail and locations frequented by fishing and hunting parties.

"During the dry seasons when fires are most likely to occur, especially in spring before the trees are in leaf, the chief fire wardens and their deputies should keep a sharp lookout for any sign of fire, and have everything in readiness so that when the smoke is seen there will be no unnecessary delay in reaching the spot. Fishermen, hunters and campers should always be cautioned whenever the opportunity offers to be careful in the use of fire; to refrain from throwing lighted matches on the ground; and, especially, to extinguish their camp fires completely before leaving them.

No instructions seem necessary here as to how the work at a forest fire should be conducted, for it is assumed that each fire warden has had ample experience in this respect. At the same time it may be well to remind each one that backfiring should not be resorted to until its necessity is plainly evident; and, even then, the entire situation should first be carefully examined and well understood.

It should be remembered, also, that in controlling a woodland fire, one hour's work in the early morning or late evening is worth six in the middle of the day. For this reason, if a fire is not extinguished at evening, the men should remain on the ground all night, and the fire wardens should make arrangements to send in food and blankets to the party. If the men are allowed to leave a fire at evening and go back to their homes much valuable time is lost.

"Especial pains should be taken to ascertain the cause of the fire, and the person or persons who started it. Too many reports are received in which the printed questions as to the origin of the fire is answered with the words, 'Cause unknown.' If attended to promptly, there should be little trouble in ascertaining the point at which the fire started, and, in most cases, who started it. The facts should then be written out fully in the report, no matter whom it may concern. Each fire warden should discharge his duty fearlessly in this respect, without fear or favor. If the fire warden is unable to report definitely as to who the guilty parties were and their connection with it, he is at liberty to give his opinion as to the cause and who were to blame in the matter.

"In addition to answering fully the printed questions in the report, the fire warden should furnish such further information as may not be conveyed in the preceding answers, and should take pains to include also everything that might relate directly or indirectly to the matter.

"After a fire occurs the chief fire warden should, as soon as possible, mail the report of the same to the Forest Commissioner, using the printed form furnished for this purpose. Before sending the report he should make an examination of the burned area, so that he may be able to state approximately the number of acres burnt over, the extent of the damages, the amount and kinds of timber destroyed."

EXPENSE OF THE LAW.

To meet the expenses of the act creating a fire warden service the Legislature for the past four years has provided a fund of $10,000 a year, known as an "emergency fund," to be used in co-operation with wild land owners for the protection of forests

against fires. This fund is to be used for posting notices, patrolling in dry seasons, fighting fire and other expenses connected therewith. The Forest Commissioner has endeavored to instill into the minds of every warden that along with carefulness in watching for fires the strictest economy should be used. The expenditures for the several years have been as follows: For 1903, $9,926.20; for 1904, $6,729.46; for 1905, $10,201.25; for 1906, $10,000.

The first year of the service, 1903, proved one of the driest in the history of the state, scarcely any rain falling during the spring, and many forest fires occurred. The new department was scarcely organized before calls were made for its service. As will be seen by the foregoing figures the appropriation was practically exhausted and several large bills for fighting fires had to be carried over into the next year, and that after several bills were scaled down 50 or more per cent. and the cost above what was paid by the State being borne by the owners of the land. Had the State been obliged to pay for all the fighting of forest fires that year, $40,000 would not have settled the bills.

The next year, 1904, was of much different type and had it not been for the bills of 1903 brought over, the expense to the State would have been scarcely one-half the appropriation. In some sections of the State there was considerable to do in 1905 in the way of fighting fire and for that year the cost ran up to a little over the $10,000 appropriation, and the same can be said of 1906.

From the experience gained with the practical work of the past four years it is easy to draw deductions and see that in what are known as reasonably wet seasons the appropriation is ample, but should another especially dry year prevail, such as is liable to occur in any year, the $10,000 would be wholly inadequate to meet all bills and the work would have to be stopped when most needed or some means other than the appropriation provided for continuing and paying bills contracted.

It may not be fully realized or understood, but if the money is not used it goes back to the State Treasurer, or remains in his hands to the credit of the State and not to the department. Only the actual amount needed for paying the fire bills is drawn by the Commissioner. If he finds a surplus after paying all

bills the balance is returned to the State Treasurer and not one cent used for any other work in the Forestry or Land Departments.

LAW AS APPLIED TO TOWNS.

The following law as applied to towns and in relation to the forestry laws of our State is contained in the statues and can be found in its entirety in Chap. 7 of the R. S. of 1903:

"Sect. 52. The selectmen of towns shall be, ex-officio, forest fire wardens therein and shall divide said towns into three districts, bounded as far as may be by roads, streams of water, or lot lines, and assign to each of their number the charge and oversight of one district as district fire wardens therein. A description of each district and the name of the fire warden thereof shall be recorded with the town clerk. The services of such selectmen acting as said fire wardens, shall be paid for at the same rate as is paid for their other official services. It shall be the duty of the fire warden of the district in which a fire is discovered to take such measures as may be necessary for its control or extinction. For this purpose he shall have authority to call upon any persons in the territory in which he acts for assistance, and such persons shall receive such compensation not exceeding fifteen cents per hour as said selectmen may determine, the same to be paid by the town. But no town shall be holden to pay for extinguishing forest fires in any year an amount greater than two per cent. upon its valuation for purposes of taxation. If any person so ordered to assist, and not excused from said service by said forest fire warden on account of sickness, disability or some important business or engagement, shall neglect to comply with any such order he shall forfeit the sum of ten dollars, to be recovered in an action of debt in the name and to the use of the town, by the treasurer thereof.

"Sec. 55. Whoever by himself, or by his servant, agent or guide, or as the servant, agent or guide of any other person, shall build a camp, cooking or other fire, or use an abandoned camp, in or adjacent to any woods in this State, shall before leaving such fire, totally extinguish the same, and upon failure to do so such person shall be punished by a fine of fifty dollars, provided that such fires built upon the sea beach in such situa-

tion that they cannot spread into forest wood or cultivated lands or meadows, shall not be construed as prohibited by this section. One-half of any fine imposed and collected under this section shall be paid to the complainant.

"Sec. 56. Selectmen shall erect in a conspicuous place at the side of every highway as they may deem proper, and at suitable distances alongside the rivers and lakes of the State frequented by camping parties, tourists, hunters and fishermen, in their respective owns, notices in large letters to be furnished by the Forest Commissioner, substantially in the following form: 'Camp fires must be totally extinguished before breaking camp, under penalty of not to exceed one month's imprisonment or one hundred dollar's fine, or both as provided by law....., Forest Commissioner.' The Forest Commissioner shall furnish owners of wood lands situated within this State when called upon to do so, notices of similar tenor to be posted at the expense of said owners upon their respective lands.

"Sec. 58. Municipal officers in towns, and county commissioners, the latter with respect to unorganized places, shall proceed immediately to a strict inquiry into the cause and origin of fires, within wood lands; and in all cases where such fires are found to have originated from the unlawful act of any person, to cause the offender to be prosecuted without delay.

"Sec. 59. The selectmen of towns in which a forest fire of more than one acre in extent has occurred, and the county commissioners where a forest fire of more than two acres has occurred in any of the unincorporated places in any county, within a year, shall report to the Forest Commissioner the extent of area burned over, to the best of their information, together with the probable amount of property destroyed, specifying the value of timber as near as may be, and the amount of cord wood, logs, bark or other forest product, fencing, bridges and buildings that have been burned. They shall also report the cause of these fires if they can be ascertained, and the measures employed and found most effective in checking their progress. Blanks for the reports required in this act shall be furnished by said Forest Commissioner at the expense of the State."

In the carrying out of the foregoing law the Forest Commissioner of the State has no jurisdiction, other than furnish-

ing copies of the printed warning notices and blanks for reports. In many instances the law is lived up to, and in others, according to complaints that come to the Forestry Department from time to time, the law is a dead letter. Probably very few selectmen take the time or trouble to divide their town into fire districts and then assign one district to each member of said board to look after as his particular section.

If a fire breaks out in the residential part of the town the usual prompt methods are adopted for its extinction, but let a fire break out in a farmer's woodlot or other wooded tracts in the town and little or no attention is paid to it by the municipal officers. The selectmen in most such cases overlook the law as found in Sec. 52 making it their duty to provide "such measures as may be necessary for its control or extinction." Section 58 which makes it their duty to proceed immediately to a strict inquiry into the cause and origin is overlooked, as is also Sec. 59 which says that selectmen shall report to the Forest Commissioner the extent burned over, loss, etc.

With all due regard and appreciation to the selectmen who do comply with the forest fire law, there is certainly a lack of observance on the part of many. To remedy this defect a penalty should be put into the law to compel its enforcement.

FOREST FIRES OF 1905.

The early season of 1905 gave promise of a favorable one for the forests, as the spring and early summer months passed with but few forest fires. Those that did occur up to and through July were of small extent and correspondingly small loss.

August, however, brought quite a severe drought, prevailing more particularly in Aroostook, upper Penobscot and Piscataquis counties. During this month the townships in the above named counties suffered from numerous fires, many of the smaller ones not being reported to this department. In some respects it was a repetition of the severe struggle against the flames, experienced in 1903, several townships being badly burned over.

In the incorporated towns the forests of York county came in for the larger share of damage, the burned area covering over 4,000 acres with a damage of nearly $17,000.

The causes of the several fires were varied, fully 50 per cent. being unknown. The attributed causes as tabulated are: Unknown, 67; clearing land, etc., 26; sportsmen, fishermen and campers, 19; railroad, 13; river-drivers, 4; blueberry pickers, 5; smokers, 2; burning hornets' nest, 1; sparks from a chimney, 2; incendiary, 1.

The area burned over, including that of both unincorporated and incorporated towns, covered 20,316 acres; the estimated damage being a total of $63,623. The tabulations follow:

Fires on Unincorporated Towns.

AROOSTOOK COUNTY.

Township.	Date.	Acreage.	Cause.	Amount of damage.
C. R. 2	April 28	2	Unknown	$ 6
Connor Plantation	April 29	5	Clearing land	15
Stockholm Plantation	May 25	6	Unknown	18
Eagle Lake Plantation	May 4	1	Clearing land	5
Hill Plantation	May 26	120	Clearing land	600
T. 16 R. 5	May 28	3	Local fishermen	100
T. 17 R. 10	May 3	5	Clearing land	15
St. Francis Plantation	May 5	55	Clearing land	85
T. 18 R. 10	May 8	8	Fishing parties	25
Hammond Plantation	June 5	20	Unknown	50
T. 13 R. 6	June 2	35	Clearing land	140
T. 3 R. 3	June 25	75	River drivers	75
T. 17 R. 5	June 7	10	Clearing land	3
T. 15 R. 9	June 1	4	Sportsmen	20
T. 9 R. 6	July 1	1	Clearing land	3
Connor Plantation	July 18	7	Clearing land	50
Wallagrass Plantation	July 19	2	Unknown	40
T. 8 R. 4	July 12	50	Unknown	150
Hill Plantation	August 3	100	Unknown	300
T. 11 R. 13	August 4	15	Unknown	150
T. 10 R. 12	August 4	300	Unknown	1,200
T. 17 R. 4	August 3	10	Clearing land	30
T. 7 R. 3	August 6	2,500	Fishing party	10,000
T. 11 R. 13	August 22	1	Unknown	5
T. 17 R. 8	August 18	2	Unknown	10
T. 13 R. 12	August 22	1	Camp fire	5
Merrill Plantation	August 25	1	Fishermen	3
T. 17 R. 9	August 5	20	Camp fire	15
T. 15 R. 6	August 14	250	Clearing land	1,500
T. 16 R. 6	August 12	350	Unknown	800
T. 16 R. 5	August 20	10	Unknown	25
Caswell Plantation	August 17	125	Blueberry pickers	200
T. 17 R. 5	August 20	1	Unknown	3
Cyr Plantation	August 18	75	Blueberry pickers	250
Merrill Plantation	August 12	70	Unknown	160
Connor Plantation	August 19	150	Blueberry pickers	300
Connor Plantation	August 16	30	Blueberry pickers	100
T. 17 R. 7	August 3	10	Unknown	30
New Canada Plantation	August 3	15	Unknown	45
T. 13 R. 6	August 15	4	Unknown	20
T. 12 R. 6	August 2	25	Unknown	75
T. A R. 5	August 22	5	Unknown	100
Oxbow Plantation	August 25	1	Burning hornet's nest	5
Moro Plantation	August 12	400	Fishermen	500
Howe Brook	August 31	30	Unknown	90
Wallagrass Plantation	August 20	125	Unknown	300
T. 17 R. 6	August 1	50	Unknown	100
T. 17 R. 4	August 10	100	Clearing land	300
T. C. R. 2	August 29	35	Unknown	100
T. C. R. 2	August 21	175	Unknown	700
T. D. R. 2	August 21	500	Unknown	2,000
T. C. R. 2	August 21	200	Unknown	800
T. B. R. 2	August 18	20	Unknown	100
T. 16 R. 5	Sept. 1	1	Unknown	5
T. 19 R. 11	Sept. 3	50	Unknown	150
	Total	6,166		$21,876

PENOBSCOT COUNTY.

Township.	Date.	Acreage.	Cause.	Amount of damage.
T. 2 R. 6	April 26	100	Unknown	$200
Hersey Township	May 1	100	Clearing land	100
Stacyville Plantation	May 7	100	Clearing land	100
Sebooeis Plantation	May 10	5	Railroad	5
T. 6 R. 8	July 21	10	Unknown	50
T. 6 R. 8	August 1	1	Boat crew	4
T. 6 R. 8	August 4	525	River drivers	2,625
Stacyville Plantation	August 4	100	Clearing land	100
T. 8 R. 6	August 5	400	Unknown	1,000
Webster Plantation	August 8	1	Unknown	4
T. 4 R. 7	August 19	60	River drivers	150
T. 6 R. 7	August 20	3	Unknown	10
	Total	1,405		$4,348

PISCATAQUIS COUNTY.

T. 7 R. 10	May 24	3	Unknown	$ 8
Elliottsville Plantation	June 1	10	Locomotive	40
Elliottsville Plantation	June 6	3	Locomotive	35
Lobster Lake Township	August 4	8	Unknown	100
T. 2 R. 10	August 14	80	Unknown	400
T. 2 R. 9	August 15	1	Unknown	75
T. 2 R. 10	August 18	100	Unknown	500
4 R. 10	August 19	300	Unknown	1,500
Burbank	August 21	20	Unknown	100
Burbank	August 22	25	Camp fire	50
T. 8 R. 14	August 22	10	Sportsmen	30
Lobster Lake Township	August 22	1,760	Unknown	4,960
T. 4 R. 9	August 28	1,000	Blueberry pickers	4,000
Days Academy Grant	Oct. 10	3	Sportsmen	15
	Total	3,503		$11,813

HANCOCK COUNTY.

T. No. 7	April 25	2	Unknown	$ 6
T. No. 21	April 30	50	Unknown	20
T. No. 7	May 24	500	Railroad	500
T. No. 10	Oct. 17	50	Unknown	20
	Total	602		$546

WASHINGTON COUNTY.

T. No. 43	April 21	5	Unknown	$ 15
Hinckley Twp	April 21	10	Unknown	20
Plantation No. 10	April 28	50	Unknown	50
T. No. 28	July 11	40	Unknown	30
T. No. 19 E. D	August 13	55	Unknown	8
Codyville Plantation	August 28	3	Clearing land	6
T. No. 11	Sept. 1	1	Fishing party	4
T. No. 29	Oct. 9	300	Unknown	50
T. No. 31	Oct. 18	12	Unknown	24
	Total	476		$207

SOMERSET COUNTY.

Spaulding Township	May 25	20	Clearing land	$100
Moscow	May 25	5	Locomotive	100
Chase Stream Tract	August 20	7	Camp fire	35
Long Pond Township	August 22	2	Fishermen	12
Sandwich Township	August 22	2	Locomotive	4
T. 5 R. 18	August 23	2,500	Unknown	1,250
Tomeghan Township	August 25	1	Campers	3
West Moxie Township	Sept. 15	1	Camp fire	16
Moose River Plantation	Oct. 7	30	Unknown	100
Mayfield Plantation	Oct. 8	2	Unknown	10
Sandwich Township	Oct. 10	2	Locomotive	25
Square Township	Oct. 10	1	Clearing land	4
Sandwich Township	Oct. 10	5	Unknown	15
Tomhegan	Oct. 16	6	Campers	50
East Moxie Township	Oct. 20	1	Clearing land	4
	Total	2,585		$1,728

Fires on Incorporated Towns.

AROOSTOOK COUNTY.

Towns.	Date.	Acreage.	Cause.	Amount of damage.
Linneus	July 15	25	Clearing land	$50
Monticello	August 12.	200	Clearing land	1,000
Monticello	August 19.	500	Railroad	2,500
Monticello	August 20.	100	Clearing land	500
	Total	825		$4,050

CUMBERLAND COUNTY.

Gorham	April 23	3	Cigar stub	$20
Pownal	April 24	234	Railroad	1,000
Brunswick	April 26	25	Unknown	75
Brunswick	April 30	5	Burning waste	25
Gorham	May 1	50	Fishermen	100
Baldwin	May 2	50	Cigarette stub	20
	Total	367		$1,240

HANCOCK COUNTY.

Stonington	April 18	4	Incendiary	$25
Franklin	May 9	75	Clearing land	75
	Total	79		$100

KENNEBEC COUNTY.

Chelsea	May 10	8	Unknown	$100

OXFORD COUNTY.

Fryeburg	April 26	150	Railroad	$650
Porter	May 27	10	Unknown	50
Porter	May 28	50	Unknown	200
	Total	210		$900

PISCATAQUIS COUNTY.

Shirley	May 29	15	Unknown	$75

WASHINGTON COUNTY.

Beddington	August 5.	50	Campers	$60

YORK COUNTY.

Wells	April 23	50	Burning brush	$300
York	April 24	10	Burning grass	50
South Berwick	April 24	88	Railroad	775
Kennebunk	April 25	50	Railroad	500
York	April 26	200	Spark from chimney	1,000
Acton	April 27	60	Unknown	150
Lyman	May 6	200	Unknown	1,000
Kennebunk	May 7	100	Railroad	500
South Berwick	May 7	200	Spark from chimney	1,000
Wells	May 8	2,000	Unknown	10,000
Hollis	May 13	600	Unknown	500
Hollis	May 22	400	Unknown	500
Lyman	May 27	15	Unknown	50
South Berwick	July 2	15	Railroad	75
Buxton	July 22	37	Smoker	180
	Total	4,025		$16,580

SUMMARY OF 1905 FIRES.

This includes the acreage and damage in both incorporated and unincorporated places:

County.	Acreage.	Amount of damage.
Aroostook	6,991	$25,926
Cumberland	367	1,240
Hancock	681	646
Kennebec	8	100
Oxford	210	900
Piscataquis	3,518	11,888
Penobscot	1,405	4,348
Somerset	2,585	1,728
Washington	526	267
York	4,025	16,580
	20,316	$63,623

FOREST FIRES OF 1906.

The forest fire loss to Maine in 1906 was fortunately small, for although a fair amount of rainfall occurred in June and July, during August and a part of September it was very dry, as a result of which many fires were started. The small loss was undoubtedly due to the vigilance of the fire wardens, who being soon on the ground prevented many an incipient fire from spreading and doing much damage.

The outlooks on the several mountain tops where stations are maintained, in co-operative work with the fire wardens, also did much to lessen the loss, by quickly communicating with the wardens whenever any signs of fire made an appearance. The practical workings of such stations demonstrated their value and they will be made a permanent feature of the forest protection system of the State.

Only a relative value can be gained by a study of the tables which follow, as they show a small part of the wardens' work. The majority of fires extinguished in patrol service are never reported to this department, as the acreage burned and the loss incurred is not sufficient to make such report of any moment.

The causes of the fires of 1906, in incorporated and unincorporated towns, as reported and tabulated are: Unknown, 33; clearing land, 8; sparks from chimney, 1; sportsmen, fishermen and campers, 5; river-drivers, 1; railroads, 6; blueberry pickers, 2; lightning, 3; incendiary, 2; blasting rock, 1; sparks from burning building, 1; sparks from portable mill, 2; set by children, 1.

The estimated area burned over was 7,528 acres, with the amount of damage figuring $20,919.

The tabulations follow:

Burnt land, Aroostook County

MAINE FARMER PRESS, AUGUSTA

Upland type. Two-storied forest with conifer under the hardwoods

Unincorporated Towns.

AROOSTOOK COUNTY.

Township.	Date.	Acreage.	Cause.	Amount of damage.
Hill Plantation	May 21	50	Clearing land	$200
Reed Plantation	June 14	100	Sparks from chimney	500
T. 1 R. 5	June 14	4	Unknown	20
T. 17 R. 8	June 15	125	Clearing land	100
Hammond Plantation	June 17	20	Clearing land	25
T. 7 R. 3	June 20	75	Unknown	200
T. 7 R. 4	June 20	50	Unknown	100
Merrill Plantation	June 20	50	Unknown	100
Connor Plantation	June 21	1	Fishermen	5
T. 16, R. 7	June 22	300	River drivers	400
T. 18 R. 10	August 1	350	Unknown	200
Reed Plantation	August 2	1	Railroad	5
T. 17 R. 5	August 16	1	Blueberry pickers	5
T. 3 R. 3	August 17	6	Unknown	30
T. 17 R. 4	August 17	12	Camp fire	60
T. 17 R. 7	August 18	13	Unknown	50
T. 16 R. 6	August 18	12	Unknown	50
T. 4 R. 3	August 19	2	Unknown	10
Silver Ridge	August 20	500	Unknown	500
T. 20 R. 11	August 20	2	Unknown	5
T. 11 R. 3	August 20	3	Clearing land	15
T. 16 R. 9	August 26	2	Unknown	10
Wallagrass Plantation	August 10	5	Clearing land	25
	Total	1,684		$2,615

FRANKLIN COUNTY.

Jim Pond Township	August 9	2	Blueberry pickers	$10
Letter E	August 21	1	Unknown	5
Jerusalem Plantation	August 15	500	Unknown	2,500
T. 5 R. 6	August 27	1	Unknown	5
	Total	504		$2,520

HANCOCK COUNTY.

T. No. 9	May 22	250	Unknown	$50
No. 33 Plantation	June 2	2	Unknown	10
T. No. 5	August 10	750	Lightning	300
T. No. 7	August 17	75	Railroad	75
T. No. 4	August 19	200	Unknown	1,000
T. No. 10	August 20	200	Unknown	600
T. No. 5	Sept. 1	150	Unknown	100
No. 21 Plantation	Sept. 1	70	Unknown	140
	Total	1,697		$2,275

PENOBSCOT COUNTY.

T. 1 R. 7	June 14	1,000	Clearing land	$5,000
T. 6 R. 8	June 21	1	Unknown	5
Drew Plantation	August 16	200	Unknown	200
T. No. 3 I. P.	August 19	75	Unknown	400
T. No. 1 N. D.	August 20	2	Incendiary	10
T. No. 4	August 19	640	Unknown	3,200
	Total	1,918		$8,815

PISCATAQUIS COUNTY.

Township.	Date.	Acreage.	Cause.	Amount of damage.
T. 5 R. 13	August 15.	600	Unknown	$100

SOMERSET COUNTY.

Holeb Township	June 14	80	Railroad	$50
T. No. 5	June 15	3	Blasting rocks	9
Y Gore	August 16.	5	Clearing right of way	25
Sandwich Township	August 17.	1	Railroad	5
Cold Stream Tract	August 17.	1	Camp fire	5
T. 4 R. 5	August 25.	2	Unknown	10
T. 4 R. 5	Sept. 12	1	Lightning	5
	Total	93		$109

WASHINGTON COUNTY.

T. 18 E. D	May 23	40	Unknown	$40
T. No. 36	June 18	350	Fishermen	1,500
T. No. 30	June 18	350	Fishermen	1,500
Kossuth	August 5	4	Unknown	4
T. No. 1	August 8	1	Railroad	5
T. Nos. 41 and 42	August 9	7	Lightning	35
Kossuth	August 9	2	Incendiary	10
	Total	754		$3,054

Incorporated Towns.

AROOSTOOK COUNTY.

Town.	Date.	Acreage.	Cause.	Amount of damage.
Benedicta	August 17.	20	Unknown	$100
HANCOCK COUNTY.				
Gouldsboro	May 22...	75	Unknown	$175
LINCOLN COUNTY.				
Wiscasset	May 23...	10	Railroad	$50
OXFORD COUNTY.				
Norway	May 1	15	Burning building	$75
Brownfield	May 19	80	Unknown	400
	Total	95		$475
SAGADAHOC COUNTY.				
Georgetown	May 21	20	Portable mill	$10
Woolwich	Sept. 1	25	Portable mill	100
	Total	45		$110
WASHINGTON COUNTY.				
Edmunds	June 15	15	Set by children	$75
Steuben	August 16.	3	Clearing land	15
	Total	18		$90
YORK COUNTY.				
Lyman	May 1	100	Unknown	$500
Waterboro	May 16	8	Locomotive	40
	Total	108		$540

SUMMARY OF 1906 FIRES.

This includes the fires on both incorporated and unincorporated places:

Counties.	Acreage.	Amount of damage.
Aroostook	1,704	$2,715
Franklin	504	2,520
Hancock	1,772	2,450
Lincoln	10	50
Oxford	95	475
Penobscot	1,918	8,815
Piscataquis	600	100
Sagadahoc	45	110
Washington	772	3,144
York	108	540
	7,528	$20,919

STUDY OF FORESTRY AT UNIVERSITY OF MAINE.

Under a resolve of 1903, $2,500 was appropriated for public instruction in forestry. It was decided to use the larger part of it to establish a chair of forestry at the University of Maine. Prof. S. N. Spring of Washington, D. C., had charge of the work for two years. He was succeeded by Prof. Gordon E. Tower who now holds the position, both gentlemen being graduates of the Yale School of Forestry and later employed by the United States Government in forestry work.

This report contains an extended article by Prof. Spring on the study of the white pine in Maine, while Prof. Tower has a report of the study of the forestry conditions on Indian Township, made during the past season. As Indian Township is owned by the State, it can readily be seen that the State is receiving valuable information in regard to its township, which is worth a large part of the money appropriated for the use of the school.

Pres. Geo. E. Fellows, at the request of the Forest Commissioner, has prepared a report of the teaching of forestry at the University of Maine, which is printed herewith.

REPORT OF PRESIDENT FELLOWS.

To the Forest Commissioner:

SIR:—I have the honor herewith to present a report of the teaching of Forestry in the University of Maine.

In the college year of 1905-1906 37 students elected courses in Forestry. Of this number 17 were registered for Forestry as a major subject. At the beginning of the college year of 1904-5 there were but 10 names recorded for Forestry as a major subject. At the beginning of the present college year, September 20, 1906, there are 26 who have registered to take a major in Forestry, besides 4 taking special work, and 12 freshmen have signified their intention of taking this course as compared with 4 last year.

The increased attendance in this department is one of the evidences that there is a great demand for instruction in this

subject. The increased number of students will soon call for increased force in instruction, and the professional demands made upon foresters will call for an increased number of courses to be given here if we are to provide adequate training for pro-professional men in Forestry.

The course in Forestry has been changed from a 25 credit basis to one of 30 credits. Two courses have been added which are a continuation of former ones, so that now the courses in Forest Measurements which were given only in the fall term are continued in the spring term. The tentative course which had been provided for the junior and senior years has been rearranged and a definite schedule provided. We believe that the courses in Forestry are equal to the courses of a like character and of equal extent offered by other institutions. During the year instruction in Forestry was given in nine different courses, four of which continue more than one semester. The courses and the number of students taking each are as follows:

General Forestry	18
School Course in Forestry	3
Silviculture	5
Field work in Silviculture	5
Forest Measurements	6
Field and office work in Forest Measurements	6
Lumbering	6
Forest Management	6
Thesis in Forest Management	6
	61

The Professor of Forestry receives a large number of letters from all parts of the State asking for information of a practical and scientific nature, as well as for particulars regarding instruction. The advice which can be given on the subject of handling farms, wood lots, and planting seeds and trees, may be of great value to the people of the State, and this work should be increased as far as time can be given to it. It would be highly desirable for the Professor of Forestry to devote a certain number of hours each day, with the service of a stenographer, to replying to such practical inquiries.

Practical scientific work for instructional purposes has been done on the wood lot connected with the University. Two thousand white pine seedlings have been planted, and the students have thus had practical work here and at Brunswick in the forest nursery.

An addition has been made to the equipment of the department by the purchase of tools and instruments for use in the practical work. The list consists of tree calipers, hyperometers for obtaining the height of standing trees, Pressler's increment borers, steel tapes, compass, staff head, mirror, right-angle finder, tally sheet holders, and planting tools.

During the first semester of 1905-1906 the Professor of Forestry visited the Normal Schools at Castine, Presque Isle, Gorham and Farmington, and gave a general lecture of instruction at each school. In the second semester the above institutions were again visited, and also the Normal School at Fort Kent. On this second visit Mr. R. J. Crosby of the United States Department of Agriculture, accompanied the Professor of Forestry and gave instructive talks on school ground improvement with suggestions for the use of native trees and plants for such purposes. Outlines for forestry work in the Normal Schools have been prepared and the work has already been begun at Castine and Gorham and will begin soon in the other Normal Schools.

The Professor of Forestry, in addition to nine visits named, has given public talks on Forestry before the Women's Club at Damariscotta, the Maine Federation of Women's Clubs at their annual meeting in Waterville, to the local granges and Pomona granges in Penobscot county, and to the Twentieth Century Club in Bangor.

An exhibit was prepared for the Maine Farming Special, wood lot management being represented as one of the features.

Large transparent photographs from the Department at Washington attracted much attention.

Instructive and interesting exhibits of the use of timber in the manufacture of paper and pulp also attracted much attention.

The general interest manifested in the work only partially represented by the exhibit was a source of much satisfaction and a criterion of the need of such work in the State.

Respectfully submitted,

GEO. E. FELLOWS, *President.*

THE GYPSY AND BROWN-TAIL MOTH.

In the course of an experiment in trying to get a type of silk worm sufficiently hardy to stand the rigors of the Massachusetts climate, a dozen or more years ago a French professor imported some gypsy moths from Europe. His experiment failed, some of the gypsy moths escaping and in time came to be known as the gypsy moth pest of Massachusetts. Several years later, the brown-tail moth obtained an entrance, concealed in a shipment of roses from Holland.

Over a million dollars has been spent by Massachusetts in fighting these pests and at one time it had them pretty well under control, but it was recognized that some method in addition to destroying the nests and caterpillars must be devised to exterminate the moths, and a parasitic enemy of the moths has been imported from Europe.

For distribution from the infested districts the gypsy moth has to depend upon other agencies than its own, which makes its spreading slow, and is the only explanation why Maine has thus far been exempt from the pest. Could the female moth fly, as does the male, the species would have long since been distributed over all New England. The principal means of distribution by human agency is the transportation of caterpillars of the moths upon vehicles. This occurs mainly in the spring and early summer before the caterpillars have grown too large to spin down on their threads from the trees. The fact that it feeds on about every green thing in its path, attacking both coniferous as well as deciduous trees, makes it a menace to the State that should be carefully guarded against. Once strongly intrenched in Maine it would probably mean the loss of our entire forests, as it is an admitted fact that it is almost useless to attempt to subdue the moth when once it has gotten control.

The destruction and extermination of the gipsy moth is being carefully studied, and much has been done along that line but

it is still a momentous question. In Europe this moth is seen in many sections but its ravages are comparatively mild because of the existence of a four-winged fly which lays its eggs in the gypsy moth caterpillar. Importations of this destroyer of the moth are being made to this country, the U. S. agricultural department acting in cooperation with New England. The work of extermination by the means of the parasites is necessarily slow and in the experimental stage. It is not to be expected that foreign parasites, even when successfully introduced will produce results at once, for it will take much time for them to multiply and increase to such an extent as to materially reduce the number of caterpillars.

The brown-tail moth, while very annoying to the person and destructive to shade and fruit trees, is not so much to be feared by the timber interests as the gypsy moth, as it does not attack coniferous trees as does the latter. It is to be dreaded, however, and every measure should be taken to prevent its spreading over the State. The brown-tail has gotten a hold in Maine and has been discovered in many counties. Much good work along the line of extermination has been done, however, under the direction of the agricultural department of the State, the direct care of that particular work being under the charge of Prof. E. F. Hitchins, State Entomologist.

The habits of the brown-tail and gypsy moths are considerably different inasmuch as the young caterpillars of the brown-tail moth hibernate in winter tents on the twigs of trees, where they can be easily seen and removed at any time during the winter, while the gypsy moth nests are found along the fences, in the grass, closely hidden in the bark of trees and other obscure places which makes it difficult to see them.

From personal observations made in a trip to Massachusetts for the purpose of investigating the damages wrought by the two moths, I am convinced that Maine should do everything possible to prevent a repetition of the trouble experienced by our parent state. Money and labor expended now in the early stages of invasion may save thousands of dollars of expense and millions of dollars of damage later on.

For the photograph from which the cut was made showing destruction by the gypsy moth to coniferous trees, we are indebted to Prof. A. H. Kirkland, Supt. of the Massachusetts Gypsy Moth Commission.

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Dead pines, result of stripping by Gypsy Moth in 1904

CONCLUSIONS AND RECOMMENDATIONS.

In the following paragraphs, touching upon the main topics in this report I wish to make a few recommendations that have occurred to me in their study and preparation.

FOREST FIRES ON UNINCORPORATED TOWNS.

Considerable space has been devoted in this report to dealing with the subject of forest fires, along the lines of prevention and extinguishment, showing the best tried methods of handling them under different conditions. This information I trust will be studied and result in much good from a better understanding of the subject from all points of view.

A careful tabulation has been kept of the reports as returned by the wardens, but no system of tabulations or reports can show the immense amount of work performed by the warden service, which has been inaugurated for protection.

For the several years since the forest fire law was given a passage the legislature has fixed a sum of $10,000 per year, available in case of need. This has done much good, but it has been demonstrated that the appropriation is insufficient for dry years. To cover the area of wild land with properly printed warning notices each year, and to maintain anything like the necessary patrol and fire station watches during the dry months, makes a large inroad on the appropriation. When fires actually get started, requiring many men, the expense increases rapidly and it does not take many fires to exhaust the appropriation.

The forest fire warden system, as in any service of magnitude, has its difficulties. The greatest care is taken in trying to secure the best men for appointment as wardens, but with the utmost caution, some mistakes are made in the appointments. As soon as it is discovered that a warden is not competent and lacks judgment in the carrying out of his duties as prescribed by the forest fire laws, such warden's name is dropped from the rolls, but this weeding out process is accompanied by many drawbacks. The majority of the wardens are, however, very

competent men, exercising judgment in their work and economy in their expenses.

Another difficulty with which I have to deal is that some of the land owners are hard to please and evidently they do not understand the law, as their demands are often beyond my jurisdiction. In the course of the adjustment of claims against the department the law is quite plain as to my duty, and in exercising that duty some of the land owners have been inclined to find fault. It is impossible with the appropriation at hand to pay all bills for fires on all the wild lands of the State. I endeavor, however, to pay so far as I can in justice to all concerned, the labor bills, but in numerous instances have been obliged to reject the supply bills, asking the owners of the land on whose holdings the fire occurred, to pay these bills. Most land owners stand ready to cooperate in this way, but a few have done so very unwillingly.

To make this law effective there must be cooperation between the State and wild land owners. While the land and stumpages are owned by individuals, the right to fish and hunt on these lands has never been sold by the State. The fish and game are protected by severe laws to benefit the hunting and fishing, and citizens from other states are invited to enter the wild lands to enjoy these benefits. As a result hundreds of thousands of dollars are distributed throughout Maine annually, to say nothing of the privileges enjoyed by our own citizens. Under these conditions this State is in duty bound to appropriate a sum sufficient so that when a year as dry as the season of 1903 occurs, something can be done to prevent the destruction of our forests and water powers.

It must not be forgotten that the elements of danger to our forests have greatly increased in the last twenty years. It is safe to assert that the pleasure seekers in the Maine woods have increased fifty fold during that period, to say nothing of the hundreds of miles of railroad that have and are being constructed through the wilderness, adding greatly to the element of danger from fire.

Nor can any reasonable land owner expect the State to meet all the bills incurred in fighting fires in a dry season, but should be willing to care for a proportional part of the expense when the funds in the hands of the Forest Commissioner are not sufficient to meet all demands.

As an extra precaution, it is my opinion that during extremely dry periods the governor of the State should have authority by proclamation, upon the advice of the Forest Commissioner, to prevent sportsmen and fishermen from entering the woods.

FOREST FIRES ON INCORPORATED TOWNS.

While the Forest Commissioner has little or no authority in the handling of the forest fires in incorporated towns, I have endeavored in all ways possible to aid and advise the selectmen in carrying out their duties in this line. I find it hard, however, to create the right sentiment and that part of the forestry law which applies to towns is in a measure ineffective.

The duties of the selectmen are clearly defined and each spring this department has sent the municipal officers copies of the law, but there being no penalty attached it is in a measure a dead letter. The wood lands in incorporated towns pay a municipal tax and the owners of the same have a right to protection.

Let a forest fire get started in a town and in very few instances the municipal authorities make any move to check or extinguish it, unless perhaps it gets too near buildings. The law says it shall be the duty of the fire wardens, which in the case of towns are the selectmen, when a forest fire breaks out to take measures to control or extinguish it. It gives them authority to call upon men, fixes the compensation for the work and allows the town to expend for such work in any one year, a sum up to two per cent of its valuation for purposes of taxation.

With a proper penalty for not following the letter of the herein mentioned law, I believe it would be given more attention, and the owner of a wood or timber lot get his legal right of protection.

PROF. G. E. TOWER'S REPORT.

The report of Prof. Tower shows that the State has a valuable asset in Indian Township, and with proper care can be made to yield a good revenue in years to come. This tract up to within some twelve years had been cut hard. Prof. Tower says that there are now some parts which might be logged to advantage, but it is very doubtful if there are many trees on the town which have reached maturity. However, it might be well to

work over the tract carefully, under intelligent supervision, but I believe it to be for the interest of the State to allow nothing to be cut but mature trees, with the exception of poplar and fir.

Hon. S. L. Peabody of Princeton, the adjoining town, has had the care of the tract for many years. I am glad to state that there has been no trespassing and that no fires have occurred under his management.

S. N. SPRING'S REPORT ON WHITE PINE.

In the summer of 1905 Prof. S. N. Spring then at the head of the Chair of Forestry at the University of Maine, made an extended study of the white pine in this State and in connection with that study a most interesting article on the subject has been prepared by him for this report. The paper deals with the various stages of development of the white pine from a seedling to the time when it is ready for cutting. While this species of wood is found in all parts of Maine it thrives the best in the southwestern part of the State, forming a valuable asset. Those in search of something to cultivate on non-agricultural land will do well to look to the white pine and much instruction along the line of development and growth of the tree can be obtained by a close study of the article on the following pages.

PINCHOT'S PRIMER OF FORESTRY.

Through the courtesy of Hon. Gifford Pinchot, chief of the United States Forest Service, I have reproduced the major portion of his primer of forestry which was originally printed as a bulletin in two parts by the forest service.

The first part deals with the units which compose the forest, with its character as an organic wild and its enemies. It may be said to sketch the foundation of the practice of forestry and of forest policy. The second part deals with the practice of forestry, with work in the woods, with the relations of the forest to the weather and streams, etc.

I believe this primer of forestry to be in all respects the best treatise on the subject ever written and published, and fully worthy of the study of all in the least interested in the matter. I am also indebted to the forest service for the loan of a photograph from which the cut of a burning forest is made.

EDGAR E. RING,
Forest Commissioner.

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General view of forest on Indian Township, looking along the Houlton road

REPORT OF AN INVESTIGATION MADE ON A TRACT OF STATE FOREST LAND IN EASTERN MAINE.

By GORDON E. TOWER, B. S., M. F., (Yale), Professor of Forestry, University of Maine.

PRELIMINARY.

In a study by the Department of Forestry of the University of Maine, made in cooperation with the State Forest Commissioner on a tract of State forest land in Washington county, there were several reasons found which lead to the conclusion that forestry was desirable on the tract, that the practice of forestry would bring certain beneficial results and that the management would cost comparatively little.

These are briefly summarized now for the reader's benefit, a fuller discussion of them appearing throughout the report.

DESIRABILITY OF FORESTRY.

The more important reasons which make forestry desirable are represented in the following:

1. The present character and condition of the forest is in need of modification.
2. There is need of a scheme for fire protection.
3. The general thrifty condition of the forest indicates that the results of applied forestry will be satisfactory.
4. The transportation facilities are good.
5. There is a ready demand for the forest products at good prices.

WHAT THE MANAGEMENT WILL ACCOMPLISH.

The suggestions set forth in this report have been made on the assumption that supervision will be instituted and if carried out in a systematic manner in a plan of forest management will accomplish the following results:

1. A more complete utilization of the produce of the forest and its improvement by a well conducted system of thinnings. In this work the species of low commercial value and the undesirable ones like the maple and the gray birch will be removed and such other portion of the stand as is necessary to relieve the crowded condition. The mature and defective trees will also be cut. The material thus removed is to be utilized to the best advantage either as lumber, lathwood, pulp wood, excelsior wood, or cordwood. Thus the less valuable growth will not only be used, but the more valuable trees and species will be given the proper amount of growing space. The loss occasioned by improper cutting will be reduced to the least amount practical under the conditions governing the work.

The benefits accruing from the removal of the material in the thinnings will be:

A. The utilizing of the less valuable growth.

B. A financial return from the material removed equal to or greater than the cost of the work.

C. A greater total increased production of wood as a result of relieving the crowded conditions.

D. An increase in the value of the forest because of the enhanced wood production; and therefore increased and better financial returns.

2. The institution of a scheme for the protection of the tract, thereby reducing to a minimum the annually recurring danger of fire.

3. The maintenance of a forest cover on all portions of the tract suited to the growth of trees, and the preservation of the desirable young growth for the future forest.

4. The establishment in the public mind of increased confidence in the State in its efforts to protect and care for the forests.

5. The demonstration to owners of woodlots and forest lands, lumbermen and citizens of the State in general by an object lesson, that forestry pays and that it is practical in every way from a purely business standpoint.

RECOMMENDATIONS.

Since the land is better suited for a forest crop than for agricultural purposes it is advised as a general plan for the future:

(1) That the area be set aside as a permanent State forest reserve.

(2) That the exterior boundaries be surveyed and plainly blazed and the underbrush cut out so that the lines can be easily seen.

(3) That the tract be sub-divided into sections approximately one mile square.

(4) That the lot lines of adverse holdings be plainly marked.

(5) That a system of fire patrol during the dangerous season be instituted.

(6) That a series of fire lines be established.

(7) That a road system for the removal of forest produce be developed using the Houlton and Grand Lake Stream roads as a basis and utilizing, as far as possible, the bark roads and wood roads at present on the tract.

(8) That the valuable young growth be protected as a basis for the future crop by preventing the needless destruction of the important commercial species.

(9) That all trees to be cut in a given locality be marked before beginning operations and that the cutting be frequently inspected to see that all trees marked, and only those marked, be removed.

(10) That a forest warden be appointed, who shall cooperate with the Forest Commissioner in carrying out the provisions embodied in this report.

(11) That the tract be surveyed and the timber classified in detail.

(12) That the money derived from the sale of the produce be so set aside that such portion of it as is necessary may be used to defray the expense of the management and thereby reduce the supervision of the tract to a more definite business proposition.

EXPENDITURES NECESSARY.

The proposed management, which involves the above recommendations, will require expenditures estimated as follows:

Surveying exterior boundaries, total expense	$200 00
Marking 12 miles lot lines of adverse holdings, total expense	100 00
Subdivision of area (72 miles line), total expense	400 00
Fire lines, per mile	10 00
Logging roads, per mile	50 00
Marking trees, per acre	50

SUMMARY OF COSTS FOR ONE YEAR.

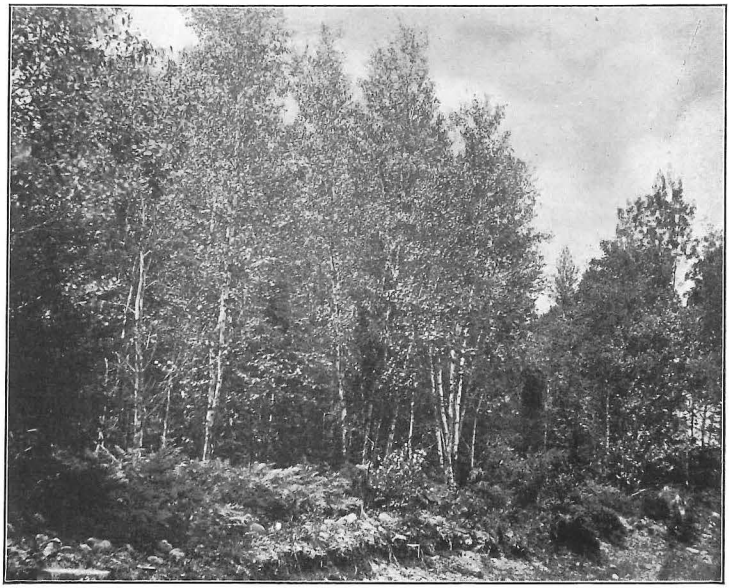
Surveying exterior boundaries	$50 00
Marking lot lines adverse holdings	100 00
Subdivision	100 00
	$250 00

THE RESOURCES OF THE FOREST.

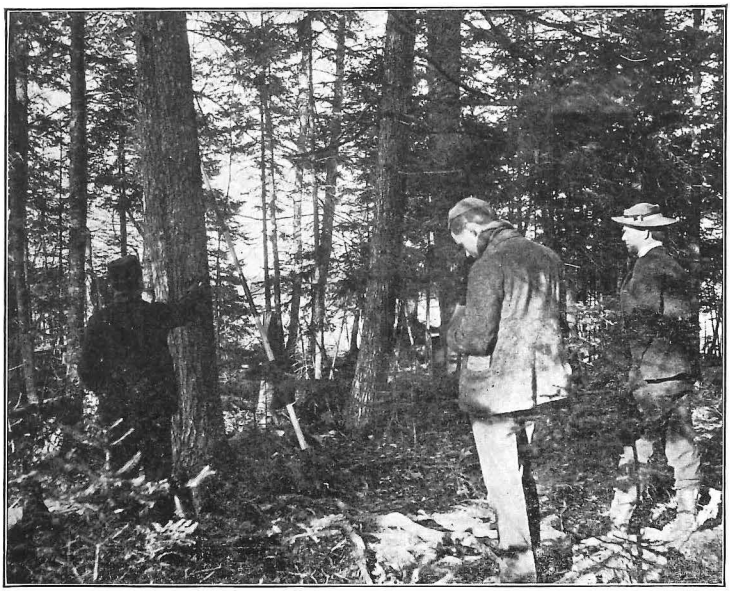
These expenditures are more than justified by the value of the present forest to say nothing of the increase in value that will come as a result of the management. Taking trees down to five and six inches there is now on the tract an amount of material estimated as follows:

White pine, 6,207,000 board feet	$30,035	
Spruce, 17,299,000 board feet	69,196	
Fir, 12,662,000 board feet	50,648	
Hemlock, 7,810,000 board feet	31,240	
Cedar, 2,201,000 board feet	8,804	
Yellow birch, 5,452,000 board feet	5,452	
		$195,375
Poplar, 27,700 cords	$27,700	
Fuel, 72,660 cords	36,330	
		64,030
		$259,405

The timber alone represents an investment of $259,000. If only one-fourth of the present stand were cut in the first rotation the value of the produce would be about $64,000 and if



Gray birch stand on Indian Township



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Students of the forestry class estimating timber,
University of Maine, Orono, Me.

removed in the course of twenty years would represent an annual income of $3,200. In the cutting on the township the utmost care should be exercised, and competent supervision of the work will meet the requirement to which such a splendid forest investment is entitled. A corporation with an invested capital is equal amount would not for a moment think of leaving its plant without supervision.

INTRODUCTION.

The following report is prepared from the information collected during an examination of a tract of forest land on Indian Township in Washington county, the examination being made during the summer of 1906.

PURPOSE OF WORK.

In undertaking the study the primary objects were to determine the character of the tree growth at present on the land and obtain an estimate of the quantity of merchantable material in the forest. The investigation thus undertaken led to the conclusion that the location of the tract, the good facilities for conducting the logging and the conditions for forest growth are such as to make the tract chiefly valuable for its timber. The forest can be made to yield an increased revenue to the State if it is treated in such a way as to improve the present conditions and the future crop not left to be so much a matter of chance production. The results of the study are presented in the following report.

The problem is of such a character that it becomes one mainly of silvicultural improvement. The great variety of trees and the intermingling of the different species adds materially to the difficulties of the problem of management. The study also involves a consideration of market conditions and the question of demand for the several kinds of wood growing on the tract.

CHARACTER OF THE WORK.

A party, consisting of the members of the senior class in forestry * at the State University and the writer, were occupied

* The members of the forestry class (1906) are H. L. Churchill, Lincoln Crowell, W. O. Frost and D. N. Rogers.

two months on the field work. It consisted in making an estimate of timber by means of valuation surveys, a study of growth, the making of volume measurements, a study of a scheme for fire protection, and the construction of a forest map. The data collected is embraced in the following:

1. The measurement of all hardwoods and conifers down to six inches in diameter breast high on the valuation surveys.
2. The measurement of all trees down to one inch in diameter on nine one-half acre sample plots.
3. The measurement of 273 poplar for volume and rate of growth.
4. The construction of a map.

In the measurement of standing trees as a basis for the estimate of the timber, two methods were employed. In one case lines were run on compass courses, the distance between each being one-half mile. The trees on a strip one chain † wide were measured, those of different species and diameter being tallied separately. When ten chains had been run on the course the record would then give the stand of trees on one acre. Topographic features such as streams were also noted on the sheet. A new tally sheet was taken for each acre. At the beginning of the study the forest was divided into types, described later, and as the work of tree measurement progressed each acre was given a designation as to type. The changes in type could then easily be transferred to the map.

The second method is a modification of the preceding. Compass lines were run as in the first except that they were approximately one mile apart, and the trees were measured only on a strip one chain wide and two and one-half chains in length, which would give a record of measured trees for one-fourth of an acre. Such measurements were taken every twenty chains. In chaining the interval between the areas on which measurments were made, changes in type and topographic features were noted on the sheets containing the tree tally.

The last method was adopted because of the limited time for the work and was found to be a ready means of obtaining a rough estimate of the timber, while procuring at the same time

† Surveyor's chain 66 feet long was used.

data for a map. The first method was used on the portion of the tract lying west of the Houlton road and the second method on the remainder of the area to the east of the road.

The method of obtaining the stand by means of sample plots was also used. In this case a representative stand was selected in a type, a given area laid off in it, and the boundaries plainly marked. The diameters of all the trees down to one inch were then measured and recorded, each diameter for each species being tallied separately. A further division of the trees was also made, each species being separated into four classes, dominant, intermediate, suppressed and overtopped. The figures from these sheets gave a very good approximation of the total number of trees per acre and also will serve as a basis in determining what and how many trees should be removed.

A special study was made of the poplar for the purpose of determining the rate of growth and the average volume of trees of different diameters. The volume table is based upon the measurement of 233 trees. The measurements taken for the construction of the table included:

Height of stump.

Diameter of stump inside and outside of the bark.

Diameter outside bark 4½ feet from the ground.

Diameter at the top end of sections 4 to 8 feet long, inside and outside of the bark.

Total height.

Clear length, i. e., distance from ground to the first large limb.

The used length and merchantable length.

The measurements for diameter growth were made on the stump. The annual rings were counted along the average radius, commencing at the outside and counting inward to the center. As the count was made, every ten annual rings were marked off on the radius. A rule was then laid along the line of the average radius and the measurements by ten year periods were taken and recorded. From these figures the average rate of growth in diameter was obtained.

The measurements on poplar were made largely on trees cut during the months of May and June.

In making the accompanying map the township plot from the State land office, which is a combination of exterior boundaries

run by William Dana in 1863 and the survey for the lots along the Houlton road, made by Washburn in 1883, was used as a beginning. The streams and other topographical features as well as the forest types were plotted from the notes of the valuation surveys.

The topographic features of the township are not well defined, the stream beds in many places being hardly discernable. The map-making was, therefore, attended with some difficulties and no claim is made for absolute accuracy. The map shows the main streams, many of the heaths and meadows and forest types.

The stand tables, giving the average number of trees by diameter classes above six inches for each species, were obtained by computation from the valuation surveys. The average number of trees of the diameters below six inches were obtained in the same manner from the half acre sample plots. These tables accompany the description of the forest types. The area of each type was obtained from the map by means of the planimeter.

The yield tables give the average amount of timber per acre of each species and show the amount at present on the tract. These tables are a combination of the stand tables and volume tables. The method of obtaining the results is as follows: From the stand table the average number of trees of a given species and a given diameter is obtained, and this multiplied by the volume of a tree of that diameter, obtained from the volume table, gives the average amount of timber for that diameter and species. This is carried through for every diameter and each species. The result is the average amount of timber per acre for the different types, and then multiplying this by the number of acres of that type we have the total amount.

THE TRACT—GENERAL DESCRIPTION—LOCATION AND AREA.

The tract, with which this report deals, comprises the greater part of Indian Township and is located in Washington county, in the eastern part of the State of Maine. The area of the township is about 24,072 acres.

TOPOGRAPHY.

The tract is in the drainage basin of the West Branch of the St. Croix River and lies in the broad and rather level valley of that stream. The general slope of the entire township is to the south. Tomah Stream, Berry Brook, George's Brook, Huntley Brook and Flipper Creek are wholly or in part within the township and with their few small tributaries form the drainage system of the tract.

Huntley Brook crosses about midway of the northern boundary and emptying into Lewy's Lake on the southern boundary is the only one which crosses the township. Tomah Stream is much the largest of the streams, but it only crosses the northeast portion of the town. All of the streams are sluggish, their fall being so little that in many portions of them there is no perceptible current during the season of low water. Nearly all are characterized by a stretch of "dead water" extending back some times a mile or more from their outlets.

In crossing the small tributaries during the summer when there is little water in them it is very difficult to determine their direction because they have so little fall. It was hard therefore to locate their branches for the purpose of constructing a map. During flood time the volume of water is considerable and the current is more pronounced in all the streams.

The topography is fairly uniform throughout the area. The general character of the country may be described as gently undulating. The ridges, extending in a more or less northernly and southernly direction, are as a general thing low and broad, and so covered with forest that they are hardly discernible. As a rule their slopes are very gentle but occasionally the westerly exposures are quite steep and abrupt, due to the outcropping of the rock. On top of the ridges themselves there are small minor ridges, and slight depressions in which, not infrequently, swamp-like conditions exist. In the northern part the elevation increases and in the northeast part of the tract the ridges develop into well defined hills and in this portion of the township are to be found steep and rather rugged western slopes.

Swamps are plentiful and in the aggregate form a considerable area. These swamps vary in their character, some having a growth of alders, others being sphagnum bogs with cranberry

bushes and stunted black spruce, and others with only sphagnum moss and cranberry bushes, and all indiscriminately termed "heaths" in that region. They vary much in size, one of the largest being in the northern part of the township and commonly known as Patch Dam Heath.

ROCK AND SOIL.

The underlying rock, wherever observed in outcrops, is of sedimentary origin being of a slate-like character, fine grained, dense and of rather hard texture. The outcropping of the rock is not of frequent occurrence, the most extensive and noticeable being in the east central part, near Berry Brook. In this portion of the tract, there are one or two places on the western exposures of the ridges which are quite rough and the slope steep owing to the rock outcrop.

The mantle of soil covering the rock is largely of glacial origin, and of fairly uniform depth. Occasionally on the tops of the ridges it is rather thin. Even in the valleys the accumulation of soil is only of ordinary depth. It is of comparatively uniform character over the whole tract. In some parts of the area the soil is rather sandy but as a general thing it is a loamy sand. By the weathering of the slate rock a soil of fine texture is produced. With the exception of the sphagnum bogs the swamp lands have a uniformly wet and loamy soil. Glacial boulders of various kinds are scattered through the soil in abundant quantities. Boulders of large size, strewn over the surface, are common and sometimes abundant.

With the exception of the sphagnum bogs and some of the other swamp land where the physical conditions are unsuitable for tree growth, the soil is well adapted for a forest crop. In fact it is the only crop which can be satisfactorily grown on the larger part of the area. There are small portions of the tract, however, which would be fairly suitable for agricultural purposes, but the amount of such land is small.

CLEARINGS AND ADVERSE HOLDINGS.

The survey of the lots along the Houlton road was primarily for the purpose of selling them to would-be settlers. In all there are 53 lots, 16 of which have been sold. One dollar per

acre was the nominal price settled upon and the lots were sold at this low figure in the hope that the purchaser would settle permanently on the land and improve it for farming purposes. Lots 1, 2, 15, 21, 23, 30, 31, 32, 33, 34, 36, 37, 39, 41, 51 and 53 were sold making a total of 2,544 acres. Lots 1, 2, 51 and 53 are the only ones on which any real improvement has been made for the purpose of growing farm crops and on three of these lots the improved area is only a very small part of the whole. On lot No. 1 the cleared and improved area is about 40 acres which is much more than the total of such land on the other three lots. In addition to the previously mentioned lots which have been sold, the large area to the south of the lots and between Lewy's Lake and the West Branch of the St. Croix River is also in private hands. In the first place it came into the possession of a Captain Lewy by a resolve of the legislature of 1871. This area, containing 443 acres, is now known as the Mercer lot. Quite a portion of this area has been cleared and improved and is now in hay land and forms the largest continuous stretch of cleared land on the township. With the exception of the land on which the Indian Village is located the total area of adverse holdings is 2,987 acres or 12.4 per cent of the tract. The total of cleared land is about 225 acres or 0.9 per cent.

Although the lots were surveyed 23 years ago and the 16 for which a deed was given by the State were sold within a short period of time after the survey was made, these still remain for the most part unimproved. Even though the lots have changed ownership from time to time they have, with the exceptions noted, been held as more valuable for timber land than for farm land. This and the fact that there has been only 0.9 per cent of the land cleared is good evidence of the general unsuitableness of the land for agriculture.

ROADS.

The wagon road from Princeton to Houlton, known as the Houlton road, runs in a diagonal line, northward from Princeton, across the township, there being about seven miles of this road in the town. The Grand Lake Stream road runs westerly from a point on the Houlton road about two miles north of Princeton. Connecting with this road is the one to the Indian

Village. In the northeast part of the tract there is the Tomah road running parallel to Tomah Stream. Altogether there are about 14 miles of wagon road. These are all State roads with the exception of the Tomah road.

SETTLEMENTS.

The population living on the township is small and for the most part Indians. There is a dwelling house on lot No. 1 and a few on the Houlton road just across the river from Princeton. The most extensive settlement is the Indian Village located on Indian Point between Long Lake and Big Lake. There are about 60 Indians here and about 75 altogether on the township, these being a remnant of the former tribe of Passamaquoddy's.

Princeton, a town of about 1,000 inhabitants, is located at the outlet of Lewy's Lake and just across the river from Indian Township and is a good shipping point for forest produce.

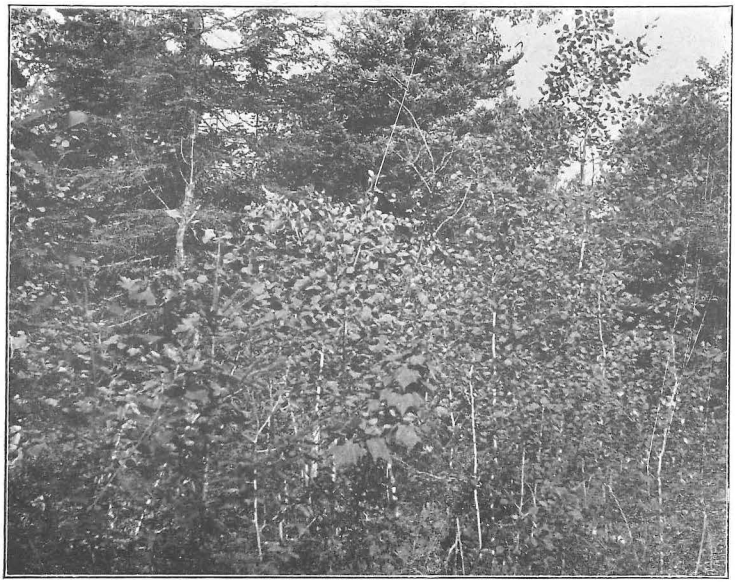
AREA CLASSIFIED.

	Acres.	Per cent of township.
Forested area	20,941	87.0
Waste land; largely bogs	2,079	11.2
Meadow land	227	0.9
Cleared land	225	0.9
Adverse holdings	2,987	12.4

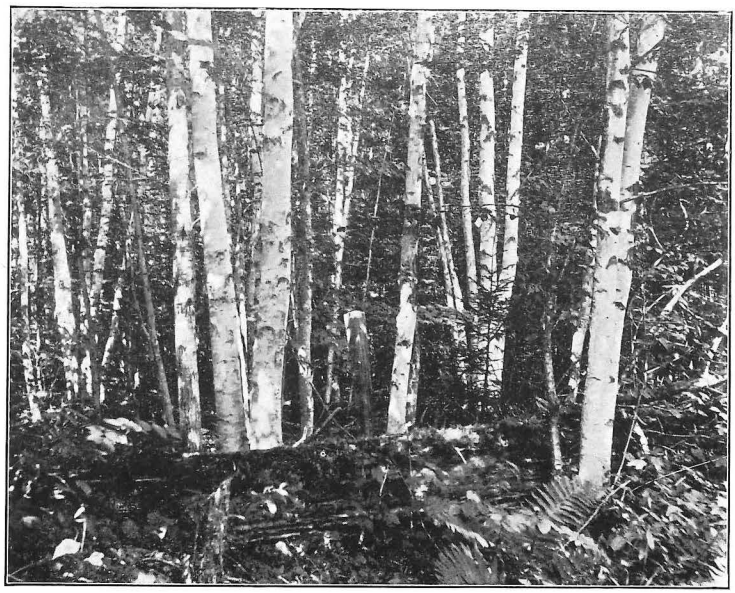
THE FOREST.

THE ORIGINAL GROWTH.

The large stumps of white pine that are scattered here and there over the whole tract, some of which are more than four feet in diameter, are an evidence of the size attained by some of the former trees and give a clue to the character of the original growth. In the course of the work a large "pumpkin" pine was found which was about four feet in diameter and probably fully 100 feet high. It was unsound, a portion of the top had been broken off by the wind and it was slowly dying. Nevertheless it was a living specimen of the growth of pine which was found at one time on the tract. But the pine was not the only species. Along with this splendid growth there



Reproduction of poplar. Both species found



MAINE FARMER PRESS, AUGUSTA

Best white birch stand on Indian Township

must have been the other species common in the coniferous forest of this region, species that compared favorably in size with the pine. Spruce, hemlock, fir and cedar, in varying degrees of mixture with the pine, with probably several different species of hardwoods scattered through the forest, must have made up the splendid stand which grew at one time on the tract.

PAST CUTTING.

The cutting of the timber on Indian township began previous to 1830 but was not conducted on any very extensive scale until 1853, when a lease was given for 15 years to cut the timber on the township. At the expiration of the lease in 1868 a second lease for 15 years more was given and the township was again cut over. From 1883, the year in which the second lease expired, up to 1890, comparatively little timber was cut. During the next decade the cut was materially increased, as high as 908,700 feet of timber being removed in a year. Thus during a period of 30 years beginning with 1853 logging operations were conducted on an extensive scale and the best timber was culled from the tract. In the next period of 16 years the logging operations continued the culling process. Since 1900 the cutting has been restricted to the hardwoods.

With the low stumpage prices prevailing at the time of the early cutting and the abundance of timber, the lumberman did not feel the need of exercising any great care in his work and the result was that the early logging operations were characterized by reckless and haphazard methods. Stumps were cut high and logs only slightly defective were left in the woods. Some of these logs, often 20 and 30 feet long and still showing the cut made by the axe, are to be seen today.

EFFECT ON THE FOREST.

This brief survey of the past cutting makes two things quite apparent: First, that a forest tract of the size of Indian township after being twice cut over on two 15-year leases still has a stand of timber containing trees of commercial value and in sufficient quantity so that cutting can still be continued to some extent. Second, that such cutting brought about a decided change in the character of the forest.

If a tract of forest land of the size of Indian township can furnish commercial material for a period of 46 years when lumbered without any regard for the future of the forest, surely under forest management such a tract should respond readily with good results and be a source of permanent revenue to the State.

The best of the stand was cut on the first 15-year lease and the logging on the second lease "skinned off" the valuable timber still more completely, only the conifers, it is claimed, being taken. In the operations of the next 16 years the conifers were still further culled, the pine and spruce, such as it was, still being the preferred species as is shown by the records of the land agent. A little hard wood was also cut. The reckless and haphazard methods and the culling process repeated with each succeeding operation radically effected the condition of growth and materially altered the character of the forest. The cutting of the conifers made an opening for the hard-woods. Species like the birches and poplars which produce an abundance of light seed, easily carried long distance by the wind and also producing seed every year would quickly fill up any openings made in the forest. The spruce producing seed about every three years and the pine about every five years naturally is at more of a disadvantage when competing with those species in reproduction from seed. The birches and poplars have, therefore, seeded in to the greater or less exclusion of the conifers.

THE PRESENT FOREST.

CHARACTER.

A forest in which the conifers predominated with trees exceeding four feet in diameter and easily 100 feet high has been changed as a result of the indiscriminate cutting and now it is one in which there is a high per cent of broad leaved species. The trees are small, 20 inches in diameter being only occasionally exceeded, while the height attained is seldom more than 80 feet. On a considerable portion of the area the conifers have come in under the hardwoods making a two-storied forest with the upper story of hardwoods. Reference to the list of tree species given further along in the report shows the great variety to be found on the tract. Of the broad-leaved species the more common are the poplars, birches and maples. White

pine, spruce, fir, hemlock and cedar are the important conifers. As a general thing these various species are to be found throughout the extent of the tract more or less indiscriminately mixed, and forming a dense growth with stands containing as high as 2,000 trees per acre of all kinds and every diameter from 1 inch to 25 inches and sometimes larger. In some places the conifers predominate; in still other places the broad-leaved species are the prevailing ones; but everywhere there are conifers and everywhere there are broad-leaved species. A sprout growth or coppice forest is found in parts of the tract where hardwoods have been cut and such growth follows a burn in hardwoods, but as a general thing the forest is composed of trees that have grown from seed.

CONDITION.

The forest covers the area with a very uniform growth except where the physical conditions are unsuitable for trees, this uniformity in the character of the forest being due in a measure to the uniform conditions which prevail on the tract in respect to the topography and the soil. For such a large tract the condition of the forest is good and presents a general healthy appearance notwithstanding the existing crowded conditions. The too great density of the stand seriously interferes, however, with the best development of the individual trees and materially retards the growth. Proper cutting will remedy this condition and greatly increase the total annual production of wood, and is to be the aim of the management.

AGE.

The forest is what the lumbermen would term "second growth." Various stages of growth are represented, ranging from reproduction of several species to mature stands of one or two species, approaching a selection forest in respect to age.

The mature stands do not, however, represent the oldest age classes in the forest because short lived trees like poplar reach maturity in less time than pine or spruce. Neither does a stand of trees necessarily represent a single age class. Each specie of tree may be a different age class and in many instances may represent more than one. In the case of some of the species there is a difference of about five years in the age of the individual trees. This is the case with the poplar which, for the

most part occurs in groups, all the trees of which are practically the same age or an even-aged stand. Some of these stands of poplar are 35 to 40 years old and one stand noted was 75 years. The white and gray birch are species which also occur in even-aged stands. The gray birch stands have a maximum age of about 30 years and the white birch about 40 years. These and the poplar are the only species that occur in even-aged stands on the tract. The red and silver maples are two species common in the forest and the maximum age of these is about 40 years.

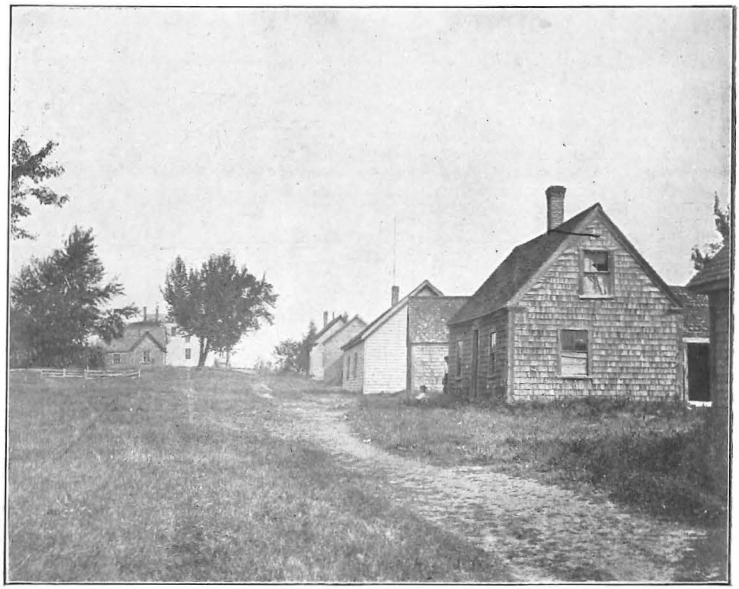
The conifers have a relatively greater maximum age. The pine is about 60 to 80 years and the white spruce about 60. The age of the balsam fir is about 70 years. The red spruce is one of the oldest species with a maximum age of 140 years while the cedar is still older being about 150 years.

AREA.

The total area of the forest on the township is 20,941 acres or about 87.0 per cent of the tract. Deducting the forest area represented in adverse holdings leaves 18,113 acres equivalent to 75.2 per cent of the tract.

TYPES.

Variations in the soil and topography of a region have an influence on the distribution of the species of trees and the composition of the forest. On Indian Township the uniform character of the soil and the slight changes in the topography cause but little variation in the forest over areas of considerable extent. The factor here of greatest influence in altering the composition of the forest is the difference in the moisture conditions of the soil. It has, however, measurably altered the distribution of the tree species only in point of individual numbers, as most of the different species are common on a large part of the tract. In some parts of the tract the changes in the composition of the forest are clearly defined. For the most part, however, the change is so gradual from one condition to another that it is often difficult to discover differences in the forest in merely passing through it. A tally of the trees on sample acres denotes a difference.



Indian Village on Indian Township, Washington County, Me.

MAINE FARMER PRESS, AUGUSTA

Logging camp, Indian Township

It would be possible to recognize several types and to treat each one separately, but for the purpose of this investigation and the report three main types have been made,—the upland, lowland and conifer.

UPLAND.

The upland comprises about 8,083 acres which is 33.6 per cent of the whole tract and 38.6 per cent of the forested area, the adverse holdings being excepted. It occupies the ridges and high land outside of the conifer type. The soil for the most part is of moderate depth and good quality, varying from a loamy sand to a sandy loam and containing quantities of pebbles and boulders of various sizes. In some places it covers the underlying rock with only a thin layer and is there a dry, sandy or gravelly loam and very rocky. On such areas the trees are shorter and there are a less number per acre than elsewhere in the type. The covering of leaf mould, from one to four inches deep, is fairly uniform and is composed of a mass of leaves and needles, together with twigs and small branches. The decomposition of this covering provides the organic matter in the soil, the presence of which increases its water holding capacity and is essential in enriching the soil. It also protects the soil from the drying action of the sun and wind and thereby preserves the moisture for the use of the trees. In the dense stands this covering of vegetable matter becomes a deep matted mass which decays very slowly because of the dense shade. Moss and herbaceous plants provide a further covering that varies with the density of the tree growth. The bunchberry, a specie of brake, twin flower, wintergreen, shin leaf and princes pine are among the most common plants. In the dense stands moss constitutes almost the only plant form while in the more open places grass occurs in the cover. The undergrowth as a general thing is not abundant and very often in some stands there is none at all.

The species of shrubs met with are the alder, arrow-wood, sweet fern, species of vaccinium, hazel, mountain maple, shadbush, wild rose, dogwood, azalea, and ground hemlock.

The forest cover is a mixture of conifers and hardwoods in which the conifers are in some instances the predominating species, in others the hardwoods, while in some cases there is about an equal distribution of the two classes of trees. The

slightly greater frequency of the hardwoods, however, is a characteristic of the type. Moreover they form the larger part of the upper story of the forest, the conifers composing a part of it in some places, and when they do the spire-like tops of the balsam fir are a conspicuous feature in the canopy. The conifers occur more commonly, however, in the form of an understory and are nearly always present.

Although the upland forest is in a healthy condition and making a fair rate of growth, judicious cutting will greatly increase the production of the forest and give good returns for the work itself.

Reproduction on the upland type is good in quantity, but of questionable quality, because of the high per cent of balsam fir. A white pine seedling is only rarely found, trees of this species of a size to produce seed, being so scattering as to practically eliminate its reproduction if other conditions should be favorable. The stand is uniformly so dense that the reproduction of white pine is prevented while the shade enduring species are plentiful. The balsam fir is the most abundant of the conifers, as high as 600 seedlings being found on an acre. Spruce is the next most abundant followed by the cedar and hemlock. The reproduction of the broad-leaved species is scant, the maples being the most common. In open places, however, a good reproduction of birches and poplar occur.

Table I shows the representation of species on the upland and gives the average stand per acre of the conifers and the more important hardwoods. The yield of this type is given in table II.

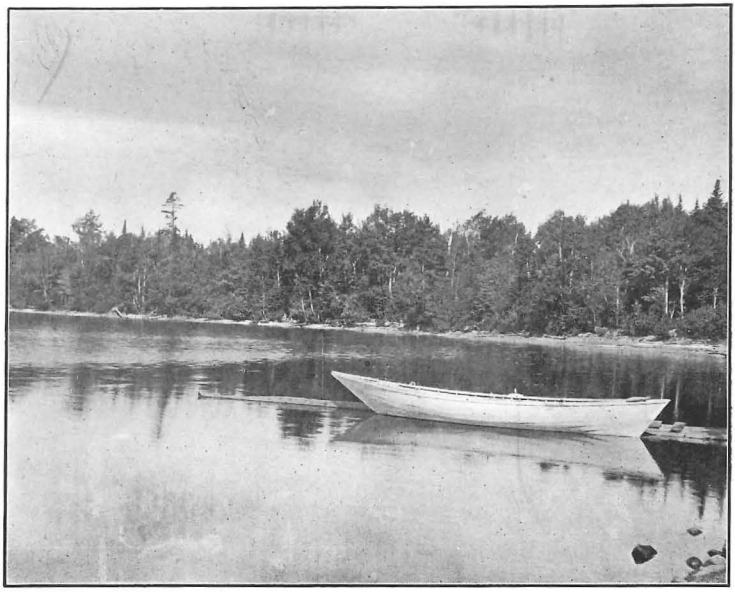
TABLE 1—Present Stand on the Upland.

Diameter breast high—inches.	Number of Trees per Acre.											
	White pine.	White spruce.	Red spruce.	Hemlock.	Balsam fir.	Cedar.	White birch.	Yellow birch.	Ash.	Poplar.	Other hardwoods.	Total.
1	2.00	20.00	41.60	45.00	172.00	79.50	6.00	38.50	... ...	1.00	59.50	465.10
2	7.00	21.50	44.00	30.00	133.50	58.00	14.00	28.50	1.00	3.50	82.00	423.00
3	10.00	14.50	16.00	7.50	78.50	39.00	39.50	29.50	.....	10.00	45.50	290.00
4	11.00	10.50	13.00	2.50	41.50	20.00	30.00	11.00	0.50	17.50	35.50	193.00
5	11.60	2.50	7.00	1.00	16.50	11.50	17.50	19.00	0.50	8.86	20.50	116.46
6	1.49	2.98	5.63	2.33	8.95	4.80	13.51	3.60	0.49	7.95	10.23	61.96
7	0.69	1.14	2.42	1.46	4.29	1.51	5.50	1.16	0.23	4.94	3.05	26.39
8	0.79	0.83	1.43	2.29	3.02	1.20	3.95	0.76	0.22	2.85	1.70	19.04
9	0.46	0.59	1.48	1.47	2.23	0.89	1.72	0.68	0.17	2.56	1.19	13.44
10	0.51	0.31	1.02	1.56	1.62	0.36	1.16	0.53	0.16	2.06	1.07	10.36
11	0.22	0.13	0.40	0.80	0.70	0.20	0.32	0.26	0.05	0.81	0.40	4.09
12	0.16	0.11	0.51	1.17	0.77	0.14	0.26	0.38	0.10	0.76	0.71	5.07
13	0.08	0.05	0.27	0.47	0.22	0.47	0.18	0.14	0.04	0.32	0.40	2.64
14	0.04	0.04	0.10	0.22	0.09	0.02	0.14	0.24	0.06	0.23	0.22	1.40
15	0.06	0.02	0.06	0.23	0.02	.....	0.02	0.16	.....	0.14	0.10	0.81
16	0.04	0.02	0.01	0.13	.....	0.01	0.03	0.12	0.01	0.06	0.14	0.57
17	0.01	0.01	0.02	0.05	0.04	.....	0.01	0.03	0.01	0.02	0.06	0.26
18	0.02	.....	0.01	0.06	0.01	.....	0.01	0.11	... .	0.02	0.03	0.27
19	0.01	... .	.....	0.02	.....	.....	0.01	0.06	.....	.....	0.01	0.11
20	0.01	0.01	.....	0.02	.....	.....	.....	0.07	.....	.....	0.01	0.12
21	0.01	.....	0.01	0.01	.....	0.07	.....	0.03	.....	0.01	0.03	0.17
22	.....	.....	.....	0.02	.....	.....	.....	0.05	0.02	0.01	0.03	0.13
23	.....	.....	.....	.....	.....	.....	.....	0.05	.....	.....	0.02	0.07
24	.....	.....	.....	.....	.....	.....	.....	0.05	.....	.....	.....	0.05
25	.....	.....	.....	.....	.....	.....	.....	0.01	.....	.....	0.01	0.02
26	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.01	0.01
28	.....	.....	.....	.....	.....	.....	.....	0.01	.....	.....	.....	0.01
32	.....	.....	.....	.....	.....	.....	.....	0.01	.....	.....	.....	0.01
40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.03	0.05
Total	46.00	75.24	134.97	98.31	463.96	217.67	133.82	135.01	3.56	63.60	262.45	1634.59
Trees 10 inches and over in diameter breast high.												
Total	1.17	.70	2.41	4.76	3.47	1.27	2.14	2.31	.45	4.44	3.25	26.2
Per cent.	2.5	.9	1.8	4.8	.7	.5	1.6	1.7	12	6.9	1.2	1.6
Trees 14 inches and over in diameter breast high.												
Total	.20	.10	.21	.76	.16	.10	.22	1.00	.10	.49	.67	4.01
Per cent.	.4	.1	.1	.7	.03	.4	.1	.94	2.8	.77	.25	.24

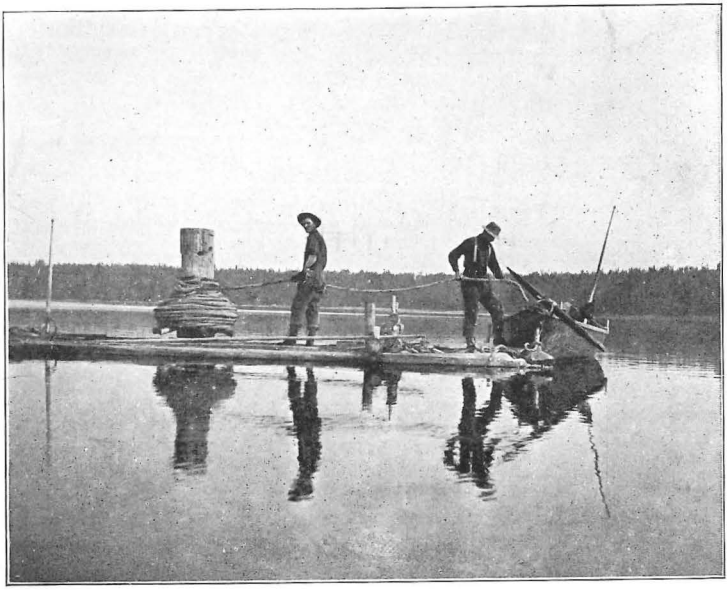
LOWLAND.

This type occupies an area outside of the adverse holdings of about 4,710 acres, 19.6 per cent of the whole tract and 22.5 per cent of the forest area. It comprises the forest in depressions and on the flat land along the creeks and on the borders of swamps. The soil is deep and uniformly more moist than that of the upland type in which respect it varies from moist to wet and with the water table but very little below the surface. In some places it is of a mucky character, but is more commonly a sandy loam or occasionally approaching a clay loam. Along the streams it is an alluvial deposit. Pebbles and boulders are freely scattered through the soil. The decaying vegetable matter covering the soil is composed of leaves, needles and twigs more or less matted into a mass from three to six inches deep and in a better state of decomposition than is the case in the preceding type. A distinguishing difference in the ground cover on this land is the occurrence of sphagnum moss, which in many places forms a spongy, springy covering a foot or more deep and very retentive of moisture. This covering is very often accompanied by a rank growth of ferns. The meadow-rue, purple-fringed orchis, bunchberry, willow herb, and golden-rod are found in the ground cover, the most of which are especially common along the streams. The alder is the common shrub in the growth of underbrush which is abundant in this type, and in some places becomes a dense undergrowth. Other species represented are Appalachian tea, Labrador tea, sheep laurel, willows, steeple bush, and mountain ash.

The tree growth is similar to that on the upland, being composed of both conifers and hardwoods, but with the conifers as the ruling species. The white pine is the least numerous, generally being very scattering, although small areas will contain a fair number of trees. The spruce and fir are the most abundant and stands of cedar of small diameter are common. The hemlock is more sacttering and less abundant than the balsam fir or spruce. Among the hardwoods are the ashes and the yellow birch, the latter being so commonly distributed that it is especially characteristic of the type. Stands of poplar occur on the lowland but its distribution is restricted.



General view of forest on shore Long Lake, Indian Township



MAINE FARMER PRESS, AUGUSTA

Headworks taking in the "rigging" preparatory to moving the anchor

Splendid specimens of the yellow birch were observed, some of the trees having a diameter of more than 30 inches and apparently sound. The ash is of poor quality. The growth of the poplar is slow and the trees are apt to be unsound. With these exceptions the general condition of the stand is good, but like the preceding type would be greatly improved by judicious cutting.

The reproduction of the conifers is very good with the exception of the white pine which is very scattering or entirely wanting for the reasons before mentioned. The balsam fir, cedar and spruce are the most abundant there being a greater amount of cedar than on the upland. The reproduction of hemlock comes along with that of the other conifers and for the most part is fairly good. Maple represents about the only reproduction there is of hardwoods.

Table 2 shows the representation of species for the type and gives the average per acre on lowland. The yield of this type is given in table 12.

TABLE 2—Present Stand on Lowland Type.

Diameter breasthigh—inches.	Number of Trees per Acre.											
	White pine.	Red spruce.	White spruce.	Hemlock.	Balsam fir.	Cedar.	White birch.	Yellow birch.	Ash.	Poplar.	Other hardwoods.	Total.
1	.....	7.00	3.00	1.00	97.00	77.00	1.00	2.00	3.00	.....	.....	191.00
2	.....	10.00	7.00	6.00	54.00	86.00	1.00	8.00	1.00	.....	.....	173.00
3	.....	3.00	2.00	5.00	18.00	56.00	.....	3.00	.....	1.00	1.00	89.00
4	.....	.....	1.00	8.00	32.00	31.00	2.00	1.00	.....	.....	1.00	76.00
5	1.00	6.00	1.00	8.00	18.00	17.00	3.00	3.00	.....	1.00	1.00	59.00
6	1.34	8.39	2.88	2.24	12.36	10.74	3.28	3.23	1.09	4.64	11.35	61.54
7	.90	4.11	1.33	1.50	5.99	4.39	1.82	1.39	.35	1.93	3.64	27.35
8	.64	3.10	.81	1.83	3.96	2.94	.84	1.58	.73	1.30	2.17	19.90
9	.40	2.05	.50	1.22	3.91	2.10	.52	.99	.45	.98	1.48	14.60
10	.64	2.05	.39	1.35	2.58	1.34	.47	.99	.39	.64	1.36	12.20
11	.38	.47	.07	.41	.83	.19	.10	.34	.10	.21	.47	3.57
12	.37	.75	.10	1.00	1.03	.37	.04	.76	.45	.27	.65	5.79
13	.07	.33	.06	.27	.24	.12	.02	.32	.14	.16	.44	2.17
14	.07	.10	.03	.16	.17	.13	.10	.39	.03	.07	.34	1.59
15	.03	.11	.01	.07	.81	.02	.....	.11	.04	.04	.19	1.43
16	.05	.....	.05	.03	.14	.03	.....	.17	.20	.03	.22	.92
17	.01	.07	.....	.02	.....	.01	.....	.03	.....	.....	.04	.18
18	.....	.01	.....	.....	.....	.....	.....	.02	.03	.....	.07	.13
19	.....	.01	.....	.....	.....	.....	.....	.06	.....	.02	.08	.17
20	.01	.01	.....	.02	.....	.....	.....	.05	.03	.....	.03	.15
21	.....	.....	.....	.....	.....	.....	.....	.08	.....	.....	.05	.13
22	.01	.....	.....	.....	.....	.....	.....	.03	.....	.....	.07	.11
23	.....	.....	.....	.....	.....	.01	.....	.01	.....	.....	.02	.04
24	.01	.....	.....	.....	.....	.....	.....	.03	.....	.....	.....	.04
25	.....	.....	.....	.....	.....	.....	.....	.01	.....	.....	.02	.03
26	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
27	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.02	.02
28	.....	.....	.....	.....	.....	.....	.....	.01	.....	.....	.....	.01
29	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
31	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.02	.02
32	.....	.....	.....	.....	.....	.....	.....	.01	.....	.....	.....	.01
40	.....	.....	.....	.....	.....	.....	.....	.01	.....	.....	.....	.01
Total	5.94	47.56	20.23	38.12	251.62	289.39	14.19	27.62	8.03	12.29	25.73	740.12
	Trees 10 inches and over in diameter breasthigh.											
Total	1.65	3.91	.71	3.33	5.80	2.22	.73	3.43	1.41	1.44	4.09	28.72
Per cent	28.0	8.0	3.5	9.0	2.3	.7	5.1	12.4	17.4	11.6	15.0	3.8
	Trees 14 inches and over in diameter breasthigh.											
Total	.19	.31	.09	.30	1.12	.20	.10	1.02	.33	.16	1.17	4.99
Per cent	3.0	.7	.4	.8	.45	.07	.7	3.7	4.1	1.3	4.5	.67

CONIFER.

An area of about 5,266 acres is included in this type which is 21.9 per cent of the tract and 25.1 per cent of the forested area. In this type there is quite a difference in the stand on the east side of the Houlton road and that on the west side, the area on the east side having much the better timber. The type comprises the forest for the most part on an irregular area extending nearly across the township in an easterly and westerly direction and occurs on land of a more diversified character than either of the other types, being represented on ridges, on gently rolling high land and on level stretches where the conditions are similar to those of the lowland. There is, then, a corresponding diversity in the character of the soil. Where the type occurs in the northeast part of the township west of the Tomah road and also on the ridges in the eastern part, the soil is sandy and dry. A gravelly soil, sandy loam to loamy sand, clay loam and mucky-like conditions are other variations in the character of the soil, a sandy loam being the most common. For the most part the soil is of good depth and retains moisture well, being thin and poorly retentive only on top of the higher ridges in the east part of the township. Boulders of various sizes are common in the soil. A mass of dead and decaying vegetable matter from two to four inches deep furnishes a covering to the soil which differs in composition from that of the other types in the relatively greater abundance of conifer needles contained in it. The needles of the conifers do not decay as rapidly as the leaves of hardwood species and their presence in the leaf mould therefore retards the rapidity of its decomposition as a whole. Moss is quite common in the ground cover especially in the denser stands. The higher plant forms are not abundant and in some cases are scant or even wanting. Bunchberries and a little grass here and there enter into the composition of the ground cover along with ferns and brakes, the latter two being of most frequent occurrence. The type is also characterized by a lack of underbrush or a cover which is meager. It is only occasionally that it becomes of any great density. The alder, though not abundant, is common throughout the type. The arrow wood occurs to some extent and the Juneberry and the common hazel now and then.

The general character of the forest differs from that of the other types, there being for one thing a proportionately smaller amount of hardwood growth. The prevalence of more or less white pine and its general distribution over the area gives the forest a distinctive feature and especially characterizes this type. There are areas with stands of white pine running 3,000 and 4,000 feet per acre. The balsam fir is the least desirable of the conifers and also the most abundant of any one species, somewhat exceeding the spruce which occurs in considerable quantities. The cedar is quite common but mostly of the small diameters, while of the hemlock there is relatively but a small amount. The birches, maple and scattering poplar appear in the hardwood growth. All together this type constitutes the most important part of the forest on the township.

The pine is making a fair rate of growth and the conditions in general are good. The management in this type must be somewhat different from that of the others, but here, as elsewhere on the tract, restricted cutting under proper supervision would be a helpful thing and would improve the conditions of growth especially in respect to the white pine.

The condition of the reproduction is good so far as the amount is concerned, but in other respects it presents objectionable features. There is but very little seedling growth of the hardwoods. The cedar is very good and compares favorably with the other species. The balsam fir being a shade-endurer and a good seeder reproduces abundantly even in dense stands and seeds up the area more readily than the spruce to the extent of excluding, in some measure, even this tolerant species. Sometimes on a single acre, containing a good stand of white pine, spruce, and balsam fir 8-14 inches in diameter, as many as 1,200 seedlings of the balsam fir alone can be counted, a number in itself sufficient to stock the area in good shape. It becomes so well established under conditions which exclude the white pine that it is difficult for the latter to get a start even when an opening is made in the stand, and the almost total absence of this valuable species in the reproduction is only a natural result of existing conditions. This is to be deprecated, but is no more than is to be expected where cutting has been conducted with absolutely no regard for the future crop. While this condition cannot be entirely eliminated under a system of management

MAINE FARMER PRESS, AUGUSTA

Stand of conifers on Indian Township. Hemlock in foreground

except in the course of one or more generations it can be modified to the extent of favoring the reproduction of valuable species and conducting the cutting with that object in view.

Table 3 shows the representation of species on this type east of the Houlton road, and Table 4 that west of the road and gives the average per acre in each case. The yield of this type is given in Tables 13 and 14.

TABLE 3—Present Stand on Conifer Type East of Houlton Road.

Diameter breasthigh—inches.	Number of Trees per Acre.											
	White pine.	White spruce.	Red spruce.	Cedar.	Hemlock.	Balsam fir.	White birch.	Yellow birch.	Poplar.	Ash.	Other hardwoods.	Total.
1	.....	10.00	4.66	94.00	10.66	53.34	.....	2.68	.....	2.00	6.00	183.34
2	.....	8.66	8.66	83.32	8.66	3.34	.....	.68	.....	2.00	10.68	126.00
3	4.00	19.34	5.34	42.66	7.34	34.00	1.34	1.34	.....	.....	6.00	121.36
4	6.66	17.34	3.34	30.66	3.34	36.68	2.66	.....	.....	1.66	6.68	109.02
5	9.34	18.00	7.34	45.34	3.34	20.66	3.34	2.00	.....	.....	8.68	118.04
6	4.00	6.88	23.20	7.12	2.52	15.56	3.40	2.40	1.12	.28	5.72	72.20
7	2.42	4.52	13.48	2.08	1.56	6.60	2.88	1.32	1.64	.28	2.68	39.46
8	3.48	2.96	8.16	2.08	1.32	4.68	2.96	1.04	.60	.16	2.60	30.04
9	2.68	1.40	4.64	.88	1.04	4.68	1.12	.52	1.40	.16	1.40	19.92
10	2.88	.88	3.48	1.48	1.04	3.48	2.08	.16	.44	.....	1.20	17.12
11	2.08	.44	1.12	.44	.44	.52	.60	.20	.....	.08	.68	6.60
12	2.08	.24	1.48	.60	.28	1.12	1.48	.....	.44	.28	.44	8.44
13	1.48	.....	.20	.08	.60	.52	.24	.....	.....	.....	.16	3.28
14	1.20	.08	.52	.08	.36	.08	.08	.....	.08	.16	.12	2.76
15	.80	.....	.36	.....	.24	.16	.28	.....	.....	.....	.....	1.84
16	.12	.....	.....	.....	.....	.08	.....	.....	.08	.....	.08	.36
17	.....	.....	.....	.....	.08	.....	.....	.....	.20	.....	.....	.28
18	.....	.....	.....	.....	.08	.....	.....	.....	.....	.08	.12	.28
19	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
20	.08	.....	.....	.....	.....	.....	.....	.08	.....	.....	.....	.16
25	.....	.....	.....	.....	.....	.....	.....	.16	.....	.....	.....	.16
Total	43.30	90.74	85.98	310.82	42.90	185.50	22.46	12.58	6.00	7.14	53.24	860.66
Trees 10 inches and over in diameter breasthigh.												
Total	10.72	1.64	7.16	2.68	3.12	5.96	4.76	0.60	1.24	0.60	2.8	41.28
Per cent	26.0	1.8	8.3	.8	7.2	3.2	21.0	4.0	20.6	8.4	5.2	4.7
Trees 14 inches and over in diameter breasthigh.												
Total	2.20	.08	.88	.08	.76	.32	.36	.24	.36	.24	0.32	5.84
Per cent	5.4	.08	1.0	.02	1.7	.17	1.6	1.9	6.0	3.3	0.6	.67

TABLE 4—Present Stand on Conifer Type West of Houlton Road.

Diameter breasthigh—inches.	Number of trees per acre.											
	White pine.	Red spruce.	White spruce.	Hemlock.	Balsam fir.	Cedar.	Yellow birch.	White birch.	Poplar.	Ash.	Other hardwoods.	Total.
1	.....	4.66	10.00	10.66	53.34	94.06	2.68	.....	.....	2.00	6.00	183.34
2	.....	8.66	8.66	8.66	43.34	83.32	.68	.....	.....	2.00	10.68	164.00
3	4.00	5.34	19.34	7.34	34.00	42.66	1.34	1.24	.....	.....	6.00	101.36
4	6.66	3.34	17.34	3.34	36.68	30.66	.....	2.66	.....	2.66	6.68	119.42
5	9.34	7.34	18.00	3.34	20.66	45.34	2.00	3.34	.....	.....	8.68	128.04
6	2.11	16.54	1.73	9.80	21.84	6.55	.65	3.33	2.30	.18	3.92	68.95
7	1.76	8.54	.94	5.64	10.90	3.12	.36	1.30	2.09	.03	1.69	36.37
8	1.64	7.36	1.00	5.35	5.67	1.82	.39	.98	1.45	.12	1.52	27.30
9	1.17	4.54	.67	3.00	3.12	1.03	.59	.70	.97	.06	.88	16.53
10	1.45	3.70	.64	3.28	2.88	.55	.39	.48	1.12	.03	.90	15.42
11	.76	1.22	.27	1.45	.82	.27	.12	.24	.15	.03	.40	5.73
12	.88	1.00	.36	2.00	.85	.24	.21	.30	.72	.10	.81	7.47
13	.30	.49	.18	.49	.10	.06	.03	.15	.10	.....	.24	2.14
14	.10	.24	.09	.10	.06	.03	.10	.30	.10	.....	.36	1.48
15	.03	.10	.03	.10	.03	.....	.03	.10	.03	.....	.15	.60
16	.06	.....	.12	.18	.....	.....	.10	.03	.06	.....	.10	.65
17	.10	.....	.06	.....	.....	.....	.....	.12	.....	.03	.06	.37
18	.03	.....	.....	.....	.....	.....	.....	.....	.....	.....	.03	.06
19	.....	.....	.....	.....	.....	.....	.....	.....	.....	.03	.03	.06
20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	30.39	73.07	79.43	64.73	234.29	309.65	15.57	15.37	9.09	7.27	49.13	888.29
Trees 10 inches and over in diameter breasthigh.												
Total	3.71	6.75	1.75	7.60	4.74	1.15	0.98	1.72	2.28	0.22	3.08	33.98
Per cent	12.0	9.0	2.1	11.0	2.0	0.37	6.2	11.0	25.0	3.0	6.0	3.8
Trees 14 inches and over in diameter breasthigh.												
Total	0.13	0.34	0.30	0.38	0.09	0.03	0.23	0.55	0.19	0.06	0.73	3.22
Per cent	1.0	0.40	0.38	0.50	0.03	0.009	1.0	3.5	2.0	.84	1.50	0.36

WASTE LAND.

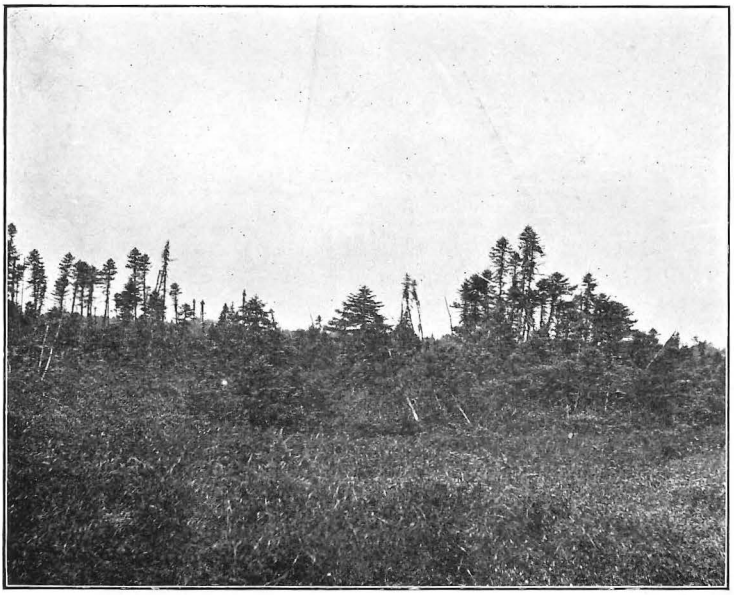
There is a large area of the township on which, with few exceptions, the physical conditions are unsuitable for a growth of trees. The swamps which are so common on the tract make up the area of waste land, the total amount being 2,679 acres, 11.2 per cent of the tract. These swamps, commonly termed heaths, vary considerably in size, some of the larger ones containing several hundred acres, but more often they are only a few acres in extent. Patch Dam Heath and Round Heath are two of the largest, the former having an area of about 635 acres and the latter containing about 300 acres. These two heaths, like a few others on the tract, probably were shallow ponds at some former period and in the course of time became filled up by the gradual accumulation of organic matter. The former shore line that can readily be distinguished in some places and the body of water remaining in the middle of one heath are evidences to bear this out.

Along the lake shores are small areas which have been flooded as the result of building a dam across the river at Princeton which in one or two instances has killed a small amount of timber. Then, too, the waste land is not all of a uniform nature, varying somewhat in character, and it is possible to recognize at least four different conditions, which, for the purpose of the report are designated as sphagnum bogs, spruce swamp, alder swamp and larch swamp, but these are not shown on the map.

The sphagnum bogs are characterized by a deep accumulation of sphagnum moss, often several feet in thickness which forms a covering soft and springy to walk upon and like a sponge to hold water. The higher plant forms are represented by a species of pitcher plant (Sarracenia purpurea) and the cranberry which grow commonly in this mossy covering. There is no tree growth and even shrubs like the alder are wanting.

The spruce swamps are similar to the sphagnum bogs in containing the deep accumulation of sphagnum moss, the pitcher plants and cranberry bushes. The thing that gives them their distinctive feature is the small stunted growth of black spruce (Picea mariana, Larg). Although the trees are very well scattered over the swamp, there is a tendency for them to occur in small distributed groups sometimes containing a dozen or

Reproduction of red spruce, Indian Township



MAINE FARMER PRESS, AUGUSTA

Stunted black spruce in bog. Trees 4-10 feet tall and 30 to 80 years old

more trees. The height of the spruce varies between 3 feet and 12 feet, although on some areas and on the borders of the swamps they may attain a height of 20 to 25 feet and a diameter of 6 to 8 inches. In the case of the small trees, the short, dense and tufted crowns make their dwarf appearance all the more pronounced. The age of these trees is surprising. In an investigation made by the writer, two trees, selected at random, were cut close to the surface of the moss and the annual rings counted with the aid of a hand lens. The following figures procured are interesting. Annual rings to the number of fifty-four were counted on one 9 feet and 11 inches tall and 1.6 inches in diameter where cut. The other, which was 5 feet and 10 inches in height and 1.1 inches in diameter showed thirty-nine annual rings. A more extensive investigation would undoubtedly show an even greater age on trees but little if at all exceeding the above in height and diameter. When compared for example, with the red spruce growing under normal conditions, the length of time represented in the growth of the youngest of these two trees is sufficient to produce a tree 8 to 10 inches in diameter and 40 to 50 feet tall. The black spruce is an exceedingly persistent species and it is this characteristic which explains its ability to exist under conditions that entirely exclude all other native trees.

Under alder swamps is included the strips of alder growth on the borders of the other swamps and the areas containing a growth largely of alders. These areas are common on the tract but generally of small size. Sphagnum moss is common to this swamp type, but the depth is less than in the sphagnum bogs.

The larch swamps are of very limited area, only two being observed in the course of the work. On both of these there is a fair stand of larch, mostly of small size, with a few trees six and seven inches in diameter. Grass forms the ground cover in both of these. On one there is scarcely any underbrush and in the other it is a scattering growth of alders.

Though the larch on the swamps is a young growth and contains no trees large enough for the axe, the stand has a value even now, and in the course of a comparatively short time can be expected to yield a marketable timber. Excepting these two larch swamps the remainder of the swamp land is worthless so far as the production of the forest is concerned.

MEADOW LAND.

The meadow land, as it is termed, occurs along the streams, the largest area being in the southeastern part of the township. The next in size is on George's Brook and extends up the stream about a mile from its mouth. In the spring there is more or less standing water on this land which remains until quite late. The soil is deep and of a mucky character. The marsh grasses indigenous to such soil and conditions are of a fair quality. As the grass is cut to some extent for hay, this land is a source of slight revenue.

GENERAL SUMMARY.

Type.	Area.	Per cent of tract.
Upland	8,083	33.6
Lowland	4,710	19.6
Conifer	5,266	21.9
Waste land	2,679	11.2
Meadow land	227	0.9
Cleared	225	0.9

GROWTH AND VOLUME OF POPLAR.

The study of the poplar involved a determination of the rate of growth and the volume; and the following tables which were constructed, have been computed from the measurements taken of 233 trees on Indian township. The trees taken grew on an area having a sandy loam to clay loam soil, moderately deep, for the most part well drained and the conditions in general suitable for the growth of poplar. Other hardwoods and conifers grew in mixture with it. In compiling the tables the value of trees of different diameters were first averaged. For example the volumes of all ten-inch trees were totaled and the average volume found and so for all diameters. These averages were then plotted as points on cross section paper and rounded off by means of a curve. The volumes for different diameters are then read directly from the curve. The tables of height, rate of growth, etc., are computed in the same way.

Table 5 shows the height, and clear length of trees of different diameters at breasthigh.

TABLE 5—Height and Clear Length of Poplar.

Diameter breasthigh.	Total height.	Basis.	Clear length.	Basis.
Inches.	Feet.	Trees.	Feet.	Trees.
1	15	16	6	12
2	25	15	9	15
3	34	15	12	14
4	40	14	15	12
5	44	12	17	15
6	46	15	20	15
7	51	15	22	18
8	55	18	24	19
9	59	19	27	21
10	62	21	29	14
11	65	14	31	18
12	68	17	33	17
13	70	16	34	16
14	72	7	36	7
15	74	9	37	9
16	76	4	39	4
17	78	2	40	2
18	80	1	41	1

Table 6 gives the average rate of growth of the poplar in height and diameter on the basis of age.

TABLE 6—Rate of growth in diameter and height of Poplar.

Age—Years.	Diameter—Breasthigh—Inches.	Height—Feet.
10	.8	12
20	2.1	27
30	4.2	43
40	8.6	64
50	15.0	75

Table 7 gives the volume in cubic feet, cords and board feet on the basis of diameter breasthigh for all height classes. From the table in cubic feet the table in cords was obtained by the following principle. The number of cubic feet was divided by 128 and the result by 0.7, or what is practically the same thing, dividing directly by 90. In the case of split wood that is not very crooked it has been found by experiment that 89.6 solid cubic feet will make one cord of stacked wood. In case the wood is small another converting factor must be used.

TABLE 7—Volume of Poplar.

Diameter breasthigh.	Volume.	Volume.	Volume.	Basis.
Inches.	Cu. feet.	Cords.	Bd. feet.	Trees.
5	2.82	.031	.....	15
6	4.10	.046	.....	15
7	5.75	.063	17	18
8	7.80	.087	37	19
9	10.60	.118	56	21
10	13.95	.155	77	14
11	17.50	.194	101	18
12	21.75	.241	129	17
13	26.30	.292	159	16
14	31.10	.345	193	7
15	36.40	.404	232	9
16	41.95	.466	277	4
17	47.90	.532	328	2
18	54.50	.605	400	1
19	60.35	.675	.....	0
20	66.50	.740	.....	0
21	73.00	.810	.....	0
22	79.40	.880	.....	0

Board measure volume for tables 7 and 10 were computed from the Champlain log rule.

Table 8 gives the volume in cubic feet for trees of different heights as well as different diameters. Table 9 gives the volume in cords by height classes, the volume in cubic feet in table 8 being reduced to cords in the same manner as in table 7. Table 10 gives the volume in board feet for different heights and diameters.

TABLE 8—Volume of Poplar.

Diameter breasthigh.	Height of Tree in Feet.								
	40	45	50	55	60	65	70	75	80
Inches.	Cu. ft.	Cu. ft.	Cu. ft.	Cu. ft.	Cu. ft.	Cu. ft.	Cu. ft.	Cu. ft.	Cu. ft.
5	2.60	2.60	3.10	.....	.....	.....	.....	.....	.....
6	3.35	3.60	4.00	4.70	4.90	.....	.....	.....	.....
7	4.10	4.70	4.90	5.90	5.80	7.50	.....	.....	.....
8	.....	6.45	6.70	7.80	8.00	9.50	.....	.....	.....
9	.....	.....	8.60	9.35	10.60	11.15	13.00	13.60	.....
10	.....	.....	10.90	11.50	13.20	13.80	15.80	16.60	.....
11	.....	.....	.....	13.50	16.10	16.00	19.10	19.20	.....
12	.....	.....	.....	16.40	19.40	19.35	22.60	22.80	.....
13	.....	.....	.....	.....	.....	23.40	25.50	27.00	29.20
14	.....	.....	.....	.....	.....	27.30	29.60	31.20	33.70
15	.....	.....	.....	.....	.....	31.50	33.30	36.15	37.30
16	.....	.....	.....	.....	.....	36.60	39.00	42.10	42.80
17	.....	.....	.....	.....	.....	.....	43.60	48.00	48.52
18	.....	.....	.....	.....	.....	.....	.....	.....	54.50

TABLE 9—Volume of Poplar.

Diameter breasthigh.	Height of Trees in Feet.								
	40	45	50	55	60	65	70	75	80
Inches.	Cords.	Cords.	Cords.	Cords.	Cords.	Cords.	Cords.	Cords.	Cords.
5	.029	.029	.034	.....	.....	.....	.....	.....	.....
6	.037	.040	.044	.052	.054	.....	.....	.....	.....
7	.046	.052	.054	.066	.064	.083	.....	.....	.....
8	.....	.072	.074	.087	.078	.106	.....	.....	.....
9	.....	.....	.096	.104	.118	.124	.144	.151	.....
10	.....	.....	.121	.128	.147	.153	.176	.184	.....
11	.....	.....	.....	.150	.179	.178	.223	.213	.....
12	.....	.....	.....	.182	.216	.215	.251	.253	.....
13	.....	.....	.....	.....	.....	.260	.283	.300	.324
14	.....	.....	.....	.....	.....	.303	.329	.347	.374
15	.....	.....	.....	.....	.....	.350	.370	.401	.414
16	.....	.....	.....	.....	.....	.407	.433	.468	.475
17	.....	.....	.....	.....	.....	.....	.484	.533	.539
18	.....	.....	.....	.....	.....	.....	.....	.....	.606

TABLE 10—Volume of Poplar.

Diameter breasthigh.	Height of Trees in Feet.									
	40	45	50	55	60	65	70	75	80	85
Inches.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.
7	10	15	20	26	33	41	.....	.....	.....	.....
8	20	26	33	40	47	55	.....	.....	.....	.....
9	.....	34	42	48	56	65	76	.....	.....	.....
10	.....	.....	50	57	66	75	85	95	.....	.....
11	.....	.....	.....	72	81	91	102	115	.....	.....
12	.....	.....	.....	84	95	108	123	140	.....	.....
13	.....	.....	.....	.....	.....	130	147	170	191	.....
14	.....	.....	.....	.....	.....	155	173	198	225	252
15	.....	.....	.....	.....	.....	187	212	238	268	301
16	.....	.....	.....	.....	.....	222	248	275	306	345
17	.....	.....	.....	.....	.....	.....	290	318	350	383
18	.....	.....	.....	.....	.....	.....	.....	.....	368	400

Volume table 7 for poplar was used in determining the number of cords and board feet in standing trees of this species on the tract. In computing the volume of other species, volume tables made in other localities were used and these, therefore, will not appear in this report.

LUMBERING.

PAST LUMBERING.

As has been before noted, cutting began on Indian township previous to 1830, and during the period extending to 1853 more or less timber was removed. A lease to cut the timber on the township, granted in 1853 for fifteen years, marks the beginning of extensive logging operations. Owing to the low stumpage prices which prevailed at that time only the very best timber was removed. As a consequence a good stand of trees remained and with the added increment of fifteen years the stand on the tract was still valuable. Therefore, when the first lease expired in 1868, a second lease was obtained for another fifteen years and the best timber on the township was again taken off. A copy of this lease is given below.

Know all men by these presents, that I, *Parker P. Burleigh,* Land Agent of Maine, under the direction of the Governor and Council, and by virtue of "Resolve providing for the sale of timber and grass on Indian township of the Passamaquoddy tribe of Indians" passed by the Legislature of Maine and approved February 29, 1868, having first advertised the sale of the premises in the manner provided by the order of the Governor and Council as aforesaid and the grantees herein being the highest and only bidders therefor, at the sum hereinafter named—in consideration of five thousand two hundred twenty-five dollars, to me paid as such Land Agent for the use of the State, the receipt of which is hereby acknowledged, do hereby sell, and convey to *Putnam Rolf, William Stewart,* and *Charles Waite* of Princeton in the county of Washington, the exclusive right to cut and manufacture and take away from the lands, not otherwise disposed of, of the Indian township in said county of Washington all the timber of whatever kind or quality, standing or lying down; also the grass that grows on the natural meadows, except what is herein reserved, together with the use of the water power not otherwise disposed of, on said township, for the term of fifteen years from the twentieth day of August last, eighteen hundred sixty-eight; reserving to the Indians of the Passamaquoddy tribe their possessions or farms and the right to cut any timber such as they may need for building purposes, broom and basket stuff, fencing and firewood and also for

their benefit, all the young growth on said township, six inches in diameter one foot from the ground, all which shall be left by the grantees in its natural state; reserving also to said Indians to cut what grass they may want for their own private use and benefit and to clean up and improve any lands not otherwise disposed of for agricultural purposes, all which right said Indians shall hold during all said term of fifteen years.

Excepting from said premises a strip one mile in width off of the Eastern side of said township extending from the north to the south line, said being granted to William Todd and conveyed to him by deed dated March 14, 1862.

To have and to hold the premises to these the said Putnam Rolf, William Stewart, and Charles Waite and assigns until the twentieth day of August eighteen hundred eighty-three and no longer.

In witness whereof I, the said Parker P. Burleigh, in my said capacity have hereunto set my hand and seal the first day of September eighteen hundred sixty-eight.

Signed, sealed and delivered
in presence of

C. R. WHIDDEN. PARKER P. BURLEIGH.

Washington ss. September 7, 1868.

Personally appeared Parker P. Burleigh and acknowledged the foregoing instrument to be his free act and deed.

Before me,
C. R. WHIDDEN, Justice of the Peace.

In 1883, the year of the expiration of the above lease, the survey of the lots was made. Beginning with this year, a very good record has been kept of the amount of timber cut and in most cases, too, the stumpage price at which it was sold. This record shows that from 1883 to 1886 a total of only about 165,000 feet B. M. of timber was removed from the tract. In 1887, pine, spruce and hemlock to the amount of 173,600 feet was cut and then for two years there was a relaxation in the cutting, during which time only about 70,000 feet was removed. During the period from 1890-1900 there was a very material increase in the amount of timber cut, the average per year, in round numbers, being 403,600 feet of pine, spruce, and hemlock and 18,600 feet of hardwoods, or a total of 4,440,000 feet of the conifers and 205,000 feet of hardwoods. The largest cut, in

any one year during this period was in 1894 when 908,700 feet was removed. Since 1900 the cutting has been restricted to the hardwoods. Dating only from 1853 the cutting on the township covers a period up to 1900 of forty-seven years and in the first thirty years of this time the township was cut very hard.

PRESENT LUMBERING.

The cutting now done on the township is on a very limited scale, the most extensive being on the lots under private ownership. On State land the cutting is restricted to the broad-leaved species. The poplar is cut for excelsior and pulp-wood, and the other hardwoods for fuel. No conifers are supposed to be cut except such as are necessary in the construction of roads for the removal of the material.

TRANSPORTATION.

There are three ways in which the timber on the tract can be transported and in some cases all may be employed in getting the logs to the mill. Transportation by means of horses is the most common and is the method which is employed to a greater or less extent in all logging operations. The yarding and hauling is done with horses. In some cases the logs can be taken directly to the mill, but on the larger portion of the tract the timber can be hauled to a driveable stream and floated out during the spring freshet. In some parts of the tract quite a long haul will be required to reach even the most convenient stream. The transportation of the heavy hardwoods must necessarily all be done by horses. On the area within easy reach from the lakes the logs can be hauled to the shore and then towed down to Princeton.

The road to the Indian Village, the grand Lake Stream road and the Houlton road are public highways which can be utilized in the transportation of forest products. The Tomah road is also suitable for this purpose. In addition there are numerous wood roads constructed in the course of former logging operations which, in many cases, are still adequate as logging roads.

All of the streams on the tract are in part suitable for driving. Relative to the township the driveable distance of each is about as follows: Berry Brook, one mile; George's brook, one mile;

Flipper Creek, one mile; Huntley Brook, three miles. The last named stream is the best for driving purposes. It has been driven from a point a quarter of a mile above where the Houlton road crosses it and with a little labor the distance could be increased. In a former lumbering operation a dam known as Patch dam was constructed on Huntley Brook to store water for driving. The remains of this dam, which was located where the brook leaves Patch Dam heath, can still be seen. Tomah Stream crossing the northeast corner of the township is there a diveable stream. In driving Flipper Creek, logs are floated to Musquash Stream and down it to Big Lake. From here the logs are towed down the lakes.

MARKET.

There is a ready demand for practically all kinds of material which can be obtained on the tract. Long lumber, box-boards, pulp-, excelsior- and lath-wood are the classes of products for which the greatest supply of raw material is required. Next in this respect are cord-wood and hemlock bark. Spool bars, cedar fence posts and railroad ties, and telephone poles added to the above makes the list about complete. There is, however, very little material on the tract suitable for poles or ties and there is only a small amount of cedar that can be utilized for fence posts. The sale of hemlock bark is governed by the facilities for getting it to market, the customary way in its removal being to take bark only on trees cut for logs. The local consumption of cord-wood is small but the general strong outside market makes feasible the shipment of this product by rail. The available raw material suitable for long lumber, box-boards and excelsior can all be used by the local mills. The pulp-wood goes to outside points, the spruce being transported by water and the poplar shipped largely by rail.

There are three sawmills located at Princeton each producing a different class of material. At one of the mills laths are the main output although this year some spool-bars were sawed. Another of the mills is engaged in the manufacture of long lumber, sawing, also, a quantity of laths from the slabs produced. The reported output of this mill has been only about 10,000 feet B. M. per day, but with the new power which has just been installed the daily cut should be greatly increased. The

third mill produces box-boards and in addition manufactures excelsior. In the production of the last named commodity 500 and 600 cords of poplar are used in the course of a year.

In addition to the mills at Princeton there is a pulp-mill located at Woodland which is about ten miles down the river from Princeton.

With one or two exceptions the market prices are good for the locality. Below are given stumpage quotations prevailing for the different kinds of timber as far as they were obtained.

White pine, $5.00 per M.; spruce, $4.00 per M.; hemlock, $4.00 per M.; balsam fir, $4.00 per M.; Cedar, $4.00 per M.; poplar (pulp or excelsior), $1.00 per cord; cord-wood, $0.75 per cord.

The poplar is mostly sold by the cord, but in some cases the cord measure is obtained indirectly, by first scaling the logs for their board measure content and then reducing to cords on the basis that 1,000 feet equals two cords. The rule used in this locality for obtaining the contents of logs is commonly termed the "caliper" rule. In its use the logs are calipered in the middle and the contents read directly from the rule.

DAMAGE TO THE FOREST.

FIRE.

In the early fifties a fire occurred on the area to the north of Huntley Brook and burned across to Tomah Stream. About 1880 a fire burned over an area of about 350 acres lying between George's Brook and Berry Brook and well to the south. This area now contains a growth mostly of gray birch which is less than six inches in diameter. On the Houlton road just north of Huntley Brook is a small burned area of about 40 acres on which fire occurred but a short time ago. With the exception of this area there have been no fires in recent years.

INSECT ENEMIES.

Insects have done so little harm that the damage from this source is unimportant. A few white pine are affected by the bark beetle and the work of borers is seen occasionally on the cedar and still more rarely on the spruce.

FUNGI.

As a general thing there is very little damage caused by fungi. Some of the white pine is "conky," a defect to which it is quite subject. The most extensive damage caused by rot producing fungi occurs with the poplar, and it is not uncommon for a large number of trees on an area to be affected more or less seriously. The decayed portion does not occur in any particular part of the bole, the top being as likely to be affected as the stump section. When the poplar is used in the manufacture of excelsior, the rot is a serious defect, but it is not of so much consequence when the tree is to be used for pulp.

TREES ON INDIAN TOWNSHIP.*

(Common and Botanical Names.)

Conifers.

White pine, *Pinus Strobus.* L.
Norway pine, *Pinus resinosa.* Ait.
Larch, *Larix Americana.* Michx.
Black spruce, *Picea Mariana.* B. S. & P.
Red spruce, *Picea rubens.* Sarg.
White spruce, *Picea Canadensis.* B. S. & P.
Hemlock, *Tsuga Canadensis.* Carr.
Balsam fir, *Abies balsamea.* Mill.
Cedar, *Thuya occidentalis.* L.

Hardwoods.

Aspen, *Populus tremuloides.* Michx.
Poplar, *Populus grandidentata.* Michx.
Balsam, *Populus balsamifera.* L.
Ironwood, *Ostrya Virginiana.* K. Kcoh.
Yellow birch, *Betula lutea.* Michx.
Gray birch, *Betula populifolia.* Marsh.
Canoe birch, *Betula papyrifera.* Marsh.
Beech, *Fagus Americana.* Sweet.
Red oak, *Quercus rubra.* L.
White elm, *Ulmus Americana.* L.

* Sargent has been followed for names and order of trees and Britton for shrubs and other plants.

Crataegus, two species.
Bird cherry, *Prunus Pennsylvanica.* L.
Wild black cherry, *Prunus serotina.* Ehrh.
Moosewood, *Acer Pennsylvanica.* Lam.
Sugar maple, *Acer saccharum.* Marsh.
Soft maple, *Acer saccharinum.* L.
Red maple, *Acer rubrum.* L.
Bass wood, *Tilia Americana.* L.
Black ash, *Fraxinus nigra.* Marsh.
White ash, *Fraxinus Americana.* L.

Important Shrubs.

Ground hemlock, *Taxus canadensis.* Marsh.
Sweet fern, *Comptonia peregrina.* (L.) Coulter.
Beaked hazelnut, *Corylus rostrata.* Ait.
Hoary alder, *Alnus incana.* (L.) Willd.
Wild gooseberry, *Ribes Cynosbati.* L.
Fetid currant, *Ribes prostratum.* L'Her.
Witch hazel, *Hamamelis Virginiana.* L.
Steeple bush, *Spiraea tomentosa.* L.
Mountain ash, *Sorbus Americana.* Marsh.
Shad bush, *Amelanchier canadensis.* (L.) Michx.
Mountain maple, *Acer spicatum.* Lam.
Red-osier cornel, *Cornus stolonifea.* Michx.
Stiff cornel, *Cornus stricta.* Lam.
Alternate-leaved cornel, *Cornus alternifolia.* L. f.
Labrador tea, *Ledum Groenlandicum.* O Eder.
Pink azalea, *Azalea nudiflora.* L.
Sheep laurel, *Kalmia angustifolia.* L.
High-bush blueberry, *Vaccinium corymbosum.* L.
Black blueberry, *Vaccinium atrococcum.* (A. Gray.) Heller.
Low-bush blueberry, *Vaccinium Pennsylvanicum.* Lam.
American elder, *Sambucus Canadensis.* L.
Red-berried elder, *Sambucus pubens.* Michx.
Maple-leaved arrow-wood, *Viburnum acerifolium.* L.
Appalachian tea, *Viburnum cassinoides.* L.

A Few of the Other Plants.

Brake, *Pteridium aquilium.* (L.) Kahn.
Fern, *Woodwardia Virginica.* (L.) J. E. Smith.
Wild yellow lily, *Lilium Canadense.* L.
Painted wake-robin, *Trilium undulatum.* Willd.
White-fringed orchis, *Blephariglottis blehariglottis.* (Wild.) Rydb.
Purple-fringed orchis, *Blephariglottis psycodes.* (L.) Rydb.
Gold thread, *Coptes trifolia.* (L.) Salisb.
Tall buttercup, *Ranunculus acres.* (L.)
Tall meadow-rue, *Thalictrum polyganum.* Muhl.
Pitcher plant, *Sarracenia purpurea.* (L.)
Scarlet strawberry, *Fragaria Virginiana.* Duchesne.
American wood strawberry, *Fragaria Americana.* Porter-Britton.
Rough cinquefoil, *Potentilla Monspeliensis.* L.
Northern willow-herb, *Epilobium adenocaulon.* Haussk.
Common evening-primrose, *Onagra biennis.* (L.) Scop.
Bunch-berry, *Cornus Canadensis.* L.
Shin-leaf, *Pyrola elliptica.* Nutt.
Prince's pine, *Chimaphila umbellata.* (L.) Nutt.
Indian pipe, *Monotropa uniflora.* L.
Trailing arbutus, *Epigaea repens.* L.
Bulb-bearing loosestrife, *Lysimachia terrestris.* (L.) B. S. P.
Heal-all, *Prunella vulgaris.* L.
American twin-flower, *Linnaea Americana.* Forbes.
Cardinal flower, *Lobelia cardinalis.* L.
Golden-rod.
Ox-eye daisy, *Chrysanthemum Leucanthemum.* L.
Tansy, *Tanacetum vulgare.* L.
Thistle, *Carduus discolor.* (Muhl.) Nutt.

MANAGEMENT.

INTRODUCTION.

Although the study made of the tract was not extensive and more in the nature of a preliminary investigation, yet in the course of the work certain features necessary in the management of the forest became apparent and of such importance as to warrant some consideration.

On the township the conditions are exceedingly favorable for the application of practical forestry. The present stand of timber is good and although not mature there is a quantity of material that should be removed in order to improve the condition of the forest; after lumbering, a good young growth develops which under management could be made of a more desirable character; the protection of the tract against fire can be easily managed; the logging operations can be conducted without excessive cost; the transportation is easy and the expense moderate; the market is good; and the mills at Princeton can utilize a large portion of the material produced on the tract.

ADMINISTRATION.

FOREST WARDEN.

The employment of a forest warden is recommended who will cooperate with the Forest Commissioner in carrying out the recommendations of this report and the execution of a plan of management. His services should be procured at a yearly cost of $300.00 and expenses. He should have a general supervision of the work and his duties will include:

1. The outlining of the work each year.
2. The preparation of a report showing improvements made and the cost of the same.
3. Directing the Forester in the execution of the plan.

FORESTER FOR THE TRACT.

For the work of administration the employment of a competent man is suggested, who shall be designated as Forester for the tract. His duties shall be:

1. To act as chief of the fire patrol and personally direct the work of fighting bad fires.

2. To mark trees to be cut.
3. To inspect the cutting and see that no areas are cut over on which the trees have not been marked.
4. To inspect and carefully study the logging operations for the purpose of eliminating the waste that results from cutting high stumps, chopping the trees instead of sawing them, leaving merchantable material in the tops, leaving logs in the woods and damaging small trees and young growth in the felling of other trees.
5. To lay out the roads for a system of permanent wood roads.
6. To do the scaling for all operations.

NEED OF SUPERVISION.

The forest is not producing timber to its full capacity and in order for this to be done it must be brought into normal condition as quickly as possible. To do this requires competent supervision.

MANAGEMENT OF THE FOREST.

THE PRESENT YIELD BY TYPES.

Tables 1, 2, 3 and 4, giving the stand of trees for each type, show the sivicultural differences in the forest and in a measure give an idea of the commercial importance of the type.

Tables 11, 12, 13 and 14 give the yield of merchantable timber by types for each diameter and show more explicitly their relative importance from the lumberman's standpoint. These tables are a combination of the stand tables and volume tables. In estimating the yield the conifers and hardwoods have been computed separately. The yield in board feet is given for each species of conifer and also, in addition, the cord feet of spruce. The estimated yield of hardwoods has been computed in cord feet and in board feet for some. In the case of some species the contents of trees of small diameter are not given. Furthermore the stand on the conifer type west of the Houlton road being so much different from that on the west side made it seem advisable to compute the yield separately on each of the respective areas and two tables were accordingly constructed.

TABLE 11—Present Yield on the Upland Type.

AREA 8083 ACRES.

Conifers.

Diameter breasthigh.	White Pine.		Hemlock.			
	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.
Inches.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.	Cds. bark.	Cds. bark.
5	.....	.....	.....	.....	.....	.....
6	14.90	121,000	18.64	151,300	.....	.....
7	8.92	72,000	14.60	118,000	.....	.....
8	14.22	115,000	36.64	297,000	....	.....
9	11.96	96,600	36.75	298,000	.....	.....
10	19.81	158,500	49.28	398,060	.032	258
11	11.66	94,300	47.20	381,000	.016	129
12	10.88	88,000	94.77	764,000	.035	283
13	6.80	54,900	50.29	406,000	.019	153
14	4.28	34,700	29.70	240,000	.013	105
15	7.68	62,000	37.95	306,000	.016	129
16	5.92	47,800	26.00	210,000	.012	97
17	1.72	14,500	12.00	96,800	.005	40
18	4.10	33,100	17.10	138,000	.007	56
19	2.40	19,400	6.70	54,200	.003	24
20	2.80	22,600	7.80	63,000	.003	24
21	3.25	26,300	4.53	36,600	.002	17
22	.....	.....	10.50	81,200	.004	32
Total	131.30	1,060,700	500.25	4,039,100	.167	1,347

TABLE II—Continued.

Conifers—Continued.

Diameter breasthigh.	CEDAR.		BALSAM FIR.		RED SPRUCE.	
	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.
Inches.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.
5	.....	.....	.....	.....	.....	.....
6	19.20	155,000	89.50	723,000	56.30	455,000
7	7.55	60,900	64.35	520,000	43.56	353,000
8	8.40	67,800	72.48	593,000	38.61	313,300
9	8.90	71,800	75.82	612,000	59.20	478,000
10	5.40	43,600	71.28	576,000	55.08	445,000
11	5.00	40,400	40.60	328,000	29.60	239,000
12	4.90	39,600	56.21	454,000	48.45	391,000
13	23.50	190,000	19.80	160,000	31.32	253,000
14	1.20	9,700	9.72	78,600	13.80	117,000
15	.....	.....	2.52	20,300	9.60	77,500
16	.75	6,000	.....	.....	1.85	14,900
17	.....	.....	6.84	55,300	4.32	34,800
18	.....	.....	1.95	17,400	2.48	20,200
19	.....	.....	.....	.....	.....	.....
20	16.80	135,800	.....	.....	3.70	29,800
21	.....	.....	.....	.....	.....	.....
22	.....	.....	.....	.....	.....	.....
Total	101.60	820,600	510.07	4,137,600	397.87	3,221,500

TABLE 11—Continued.

Conifers—Concluded.

Diameter breasthigh.	Red Spruce.		White Spruce.			
	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.
Inches.	Cords.	Cords.	Bd. feet.	Bd. feet.	Cords.	Cords.
5	.125	1,010	.....	.....	.045	363
6	.197	1,590	29.80	242,000	.105	848
7	.131	1,058	20.52	166,000	.062	501
8	.116	936	22.41	181,000	.067	541
9	.148	1,195	23.60	191,000	.059	477
10	.125	1,010	16.74	135,000	.038	307
11	.065	525	9.62	77,700	.027	218
12	.097	785	10.45	84,200	.021	170
13	.058	468	5.80	46,800	.011	89
14	.027	218	5.52	44,500	.011	89
15	.017	137	3.20	25,800	.006	48
16	.003	24	3.70	29,800	.007	57
17	.007	56	2.16	17,200	.004	32
18	.004	32	.....	.....	.....	.....
19	.....	.....	.....	.....	.....	.....
20	.005	40	3.18	25,700	.004	32
21	.....	.....	.....	.....	.....	.....
22	.....	.....	.....	.....	.....	.....
Total	1.125	9,084	153.70	1,266,700	.467	3,772

TABLE 11—Continued.

Hardwoods.

Diameter breasthigh.	Yellow Birch.		White Birch.		Poplar.	
	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.
Inches.	Bd. feet.	Bd. feet.	Cords.	Cords.	Bd. feet.	Bd. feet.
4	.....	.....	.....	.....	.....	.....
5	.....	.....	.543	4,380	.....	.....
6	14.40	116,400	.521	4,210	.....	.....
7	8.12	65,600	.347	2,820	.....	.....
8	9.12	73,600	.344	2,760	.....	.....
9	12.24	82,500	.203	1,630	.....	.....
10	17.49	147,000	.180	1,455	287.37	2,320,000
11	16.12	131,000	.062	501	141.75	1,142,000
12	34.96	283,000	.063	508	165.30	1,330,000
13	16.94	138,400	.053	428	84.16	680,000
14	35.28	285,000	.048	387	71.53	577,000
15	27.52	223,000	.008	64	50.96	411,000
16	23.64	191,000	.014	113	25.17	203,000
17	6.75	54,500	.005	40	9.58	77,400
18	28.60	239,000	.006	48	10.90	88,000
19	18.18	146,500	.007	56	.....	.....
20	24.29	196,000	.....	.....	.....	.....
21	10.55	85,000	.....	.....	7.30	59,000
22	20.65	166,500	.....	.....	7.94	64,200
23	21.90	177,500	.....	.....	.....	.....
24	23.05	186,000	.....	.....	.....	.....
25	4.83	39,000	.....	.....	.....	.....
Total	374.68	3,036,900	2.404	19,400	861.96	6,951,600

TABLE II—Concluded.

Hardwoods—Concluded.

Diameter breasthigh.	Poplar.		Ash.		Other Hardwoods.	
	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.
Inches.	Cords.	Cords.	Cords.	Cords.	Cords.	Cords.
4	.....	.....	.019	154	.604	4,870
5	.275	2,220	.014	113	.574	4,640
6	.366	2,950	.018	146	.368	2,980
7	.311	2,520	.013	105	.174	1,420
8	.248	2,020	.018	146	.138	1,170
9	.302	2,440	.018	146	.125	1,050
10	.319	2,570	.020	162	.132	1,067
11	.157	1,350	.011	89	.062	501
12	.183	1,480	.018	146	.130	1,051
13	.093	753	.019	154	.085	687
14	.079	638	.014	113	.053	428
15	.057	461	.....	.....	.027	218
16	.028	226	.003	24	.042	339
17	.011	89	.003	24	.020	162
18	.012	97	.....	.....	.011	89
19	.....	.....	.....	.....	.004	32
20	.....	.....	.....	.....	.004	32
21	.008	65	.....	.....	.013	105
22	.009	73	.....	.....	.014	113
23	.....	.....	.....	.....	.010	81
24	.....	.....	.....	.....	.....	.....
25	.....	.....	.....	.....	.....	.....
Total	2.758	19,952	.168	1,582	2.595	21,075

TABLE 12—Present Yield on the Lowland Type.

AREA 4710 ACRES.

Conifers.

Diameter breasthigh.	White Pine.		Hemlock.			
	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.
Inches.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.	Cds. bark.	Cds. bark.
5						
6	13.40	63,200	17.92	84,600		
7	11.70	55,100	15.00	70,800		
8	11.52	54,300	29.28	137,600		
9	10.40	49,000	30.50	143,000		
10	24.96	117,800	51.30	243,000	.027	127
11	20.14	94,800	24.19	113,800	.008	38
12	25.16	114,100	81.00	383,000	.030	142
13	5.95	28,000	20.09	136,000	.011	52
14	7.49	35,300	21.60	101,000	.010	47
15	3.84	18,400	11.55	54,400	.005	23
16	7.40	34,800	6.00	28,300	.003	14
17	1.72	8,100	4.00	22,600	.002	9
18						
19						
20	2.80	13,100	7.00	36,700	.003	
21						
22	3.78	17,800				
22						
24	4.80	22,700				
Total	115.06	736,500	329.83	1,554,800	.099	452

TABLE 12—Continued.

Conifers—Continued.

Diameter breasthigh.	CEDAR.		BALSAM FIR.		RED SPRUCE.	
	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.
Inches.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.
5	.....	.....	.....	.....	.....	.....
6	42.96	262,000	123.60	581,000	83.90	395,000
7	21.95	103,500	89.85	423,000	73.98	348,500
8	20.58	96,900	95.04	448,000	83.70	394,000
9	21.00	98,800	132.94	626,000	32.00	385,500
10	20.10	94,400	113.52	534,000	110.70	525,000
11	4.75	22,400	48.14	227,000	34.78	164,000
12	12.95	61,100	75.19	354,000	71.25	337,000
13	6.00	28,300	21.60	102,000	30.28	181,000
14	7.80	36,700	18.36	86,100	13.80	65,500
15	1.50	7,000	102.06	481,000	17.60	82,900
16	2.85	13,400	20.72	97,500	.....	.....
17	1.15	5,400	.....	.....	15.12	71,300
18	.....	.....	.....	.....	2.48	11,300
19	.....	.....	.....	.....	2.80	13,200
20	.....	.....	.....	.....	3.18	15,000
21	.....	.....	.....	.....	.....	.....
22	.....	.....	.....	.....	.....	.....
23	3.35	1,500	.....	.....	.....	.....
24	.....	.....	.....	.....	.....	.....
Total	66.94	761,400	839.02	3,959,600	633.57	2,990,700

TABLE 12—Continued.

Conifers—Concluded.

Diameter breasthigh.	Red Spruce.		White Spruce.			
	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.
Inches.	Cords.	Cords.	Bd. feet.	Bd. feet.	Cords.	Cords.
5	.108	508	.....	.....	.018	84
6	.294	1,384	28.80	136,000	.101	475
7	.222	1,044	23.94	112,800	.072	338
8	.252	1,182	21.87	102,700	.066	311
9	.205	965	20.00	94,400	.050	236
10	.250	1,176	21.06	99,300	.048	226
11	.077	364	5.18	24,400	.011	52
12	.143	672	9.50	44,700	.019	90
13	.071	334	6.96	32,800	.013	61
14	.027	127	4.14	19,500	.008	38
15	.032	151	1.60	7,500	.003	14
16	.....	.....	9.25	43,600	.017	80
17	.025	118	.....	.....	.....	.....
18	.004	19	.....	.....	.....	.....
19	.004	19	.....	.....	.....	.....
20	.004	19	.....	.....	.....	.....
21	.....	.....	.....	.....	.....	.....
22	.....	.....	.....	.....	.....	.....
23	.....	.....	.....	.....	.....	.....
24	.....	.....	.....	.....	.....	.....
Total	1.718	8,062	152.30	717,700	.426	2,021

TABLE 12—Continued.

Hardwoods.

Diameter breasthigh.	Yellow Birch.		White Birch.		Poplar.	
	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.
Inches.	Bd. feet.	Bd. feet.	Cords.	Cords.	Bd. feet.	Bd. feet.
5	.....	.....	.093	438	.....	.....
6	12.92	61,000	.151	713	.....	.....
7	9.73	45,800	.115	543	.....	.....
8	18.96	89,500	.073	344	.....	.....
9	17.82	84,000	.061	287	.....	.....
10	32.67	153,800	.073	344	89.28	420,000
11	21.08	99,300	.019	90	36.75	173,000
12	69.92	329,000	.010	47	53.73	253,000
13	38.72	183,000	.006	28	42.08	198,000
14	57.33	270,000	.035	165	21.77	105,000
15	18.92	78,500	.....	.....	3.64	16,700
16	33.49	158,000	.....	.....	12.59	58,200
17	6.75	31,800	.....	.....	.....	.....
18	5.20	24,500	.....	.....	.....	.....
19	18.18	85,200	.....	.....	12.07	56,700
20	17.35	81,700	.....	.....	.....	.....
21	30.80	145,500	.....	.....	.....	.....
22	12.39	58,400	.....	.....	.....	.....
23	4.38	20,700	.....	.....	.....	.....
24	15.83	74,800	.....	.....	.....	.....
25	4.83	22,900	.....	.....	.....	.....
Total	447.27	2,108,200	.543	2,999	271.91	1,378,600

TABLE 12—Concluded.

Hardwoods—Concluded.

Diameter breasthigh.	Poplar.		Ash.		Other Hardwoods.	
	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.
Inches.	Cords.	Cords.	Cords.	Cords.	Cords.	Cords.
5	.031	146	.....	.....	.028	132
6	.213	1,040	.039	184	.409	1,927
7	.122	574	.020	94	.207	978
8	.131	630	.059	278	.116	547
9	.116	546	.043	203	.155	730
10	.099	467	.048	226	.167	787
11	.041	193	.016	75	.073	344
12	.065	306	.082	386	.119	564
13	.047	222	.030	141	.94	443
14	.023	108	.007	33	.082	387
15	.004	19	.011	52	.051	241
16	.014	66	.060	283	.066	311
17	.....	.....	.....	.....	.017	80
18	.....	.....	.011	52	.025	118
19	.014	66	.....	.....	.029	137
20	.....	.....	.012	57	.012	57
21	.....	.....	.....	.....	.022	104
22	.....	.....	.....	.....	.033	155
23	.....	.....	.....	.....	.010	47
24	.....	.....	.....	.....	.....	.....
25	.....	.....	.....	.....	.011	52
Total	.920	4,383	.437	2,064	1.743	3,221

TABLE 13—Present Yield on the Conifer Type West of the Houlton Road.

AREA 832 ACRES.

Conifers.

Diameter breasthigh.	White Pine.		Hemlock.			
	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.
Inches.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.	Cds. bark.	Cds. bark.
5	.....	.....	.....	.....	.....	.....
6	21.10	17,550	78.40	65,200	.....	.....
7	22.88	19,050	56.40	47,000	.....	.....
8	29.52	24,500	85.60	71,200	....	....
9	30.42	25,300	75.00	62,400	.....	.....
10	56.55	47,000	124.64	20,500	.066	55
11	40.28	33,500	65.55	54,600	.029	24
12	59.84	48,800	162.00	135,000	.060	50
13	25.50	21,200	52.43	43,600	.020	17
14	10.70	8,900	13.50	11,200	.006	5
15	3.84	3,100	16.50	13,700	.007	6
16	8.80	7,300	36.00	29,900	.016	13
17	17.20	14,300	.....	.....	.....	.....
18	6.15	5,100	.....	.....	.....	.....
Total	342.78	276,600	766.02	554,300	.204	17

TABLE 13—Continued.

Conifers—Continued.

Diameter breasthigh.	CEDAR.		BALSAM FIR.		RED SPRUCE.	
	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.
Inches.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.
5	.....	.....	.....	.....	.....	.....
6	26.20	21,800	218.40	181,500	165.40	137,500
7	15.60	13,000	163.50	136,000	153.72	127,800
8	12.74	10,600	136.08	132,000	198.72	165,100
9	10.30	8,500	106.08	88,400	181.60	151,000
10	8.25	6,800	126.72	105,300	199.80	166,000
11	6.75	5,600	47.76	39,700	90.28	75,000
12	8.40	7,000	62.05	51,600	95.00	79,000
13	3.00	2,500	9.00	7,500	56.84	47,300
14	1.80	1,500	6.48	5,400	33.12	27,500
15	.....	.....	3.78	3,100	16.00	13,300
16	.....	.....	.....	.....	.....	.....
17	.....	.....	.....	.....	.....	.....
18	.....	.....	.....	.....	.....	.....
Total	93.04	77,300	879.75	670,500	1,190.38	989,500

TABLE 13—Continued.

Conifers—Concluded.

Diameter breasthigh.	Red Spruce.		White Spruce.			
	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.
Inches.	Cords.	Cords.	Bd. feet.	Bd. feet.	Cords.	Cords.
5	.133	110	.....	.....	326	271
6	.579	482	17.30	14,400	.061	51
7	.461	383	16.92	14,000	.051	42
8	.596	495	27.00	22,400	.081	67
9	.454	377	26.80	22,300	.067	56
10	.451	375	34.56	28,700	.078	65
11	.199	166	19.98	16,600	.044	37
12	.190	158	34.20	28,400	.068	65
13	.106	88	20.88	17,400	.039	32
14	.065	54	12.42	10,300	.024	20
15	.029	24	4.80	4,000	.009	7
16	.....	.....	22.20	18,500	.040	33
17	.....	.....	12.96	10,800	.021	18
18	.....	.....	.....	.....	.....	.....
Total	3,243	2,712	250.02	207,800	.909	764

TABLE 13—Continued.

Hardwoods.

Diameter breasthigh.	YELLOW BIRCH.		WHITE BIRCH.		POPLAR.	
	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.
Inches.	Bd. feet.	Bd. feet.	Cords.	Cords.	Bd. feet.	Bd. feet.
4						
5			.104	87		
6	2.20	1,800	.153	127	94.30	78,500
7	2.52	2,100	.081	67	85.69	71,400
8	4.68	3,900	.085	71	113.10	94,000
9	7.02	5,800	.083	69	112.82	94,000
10	12.87	10,700	.074	62	157.24	131,000
11	7.44	6,100	.047	38	26.25	21,800
12	19.32	16,100	.072	60	155.60	129,500
13	3.63	3,000	.044	37	26.30	21,900
14	1.47	1,200	.104	87	31.10	25,800
15	5.16	4,300	.040	33	14.37	11,900
16	1.97	1,600	.014	12	32.70	27,200
17			.064	53		
18						
19						
Total	68.28	56,600	0.975	803	849.47	707,000

TABLE 13—Concluded.

Hardwoods—Concluded.

Diameter breasthigh.	Poplar.		Ash.		Other Hardwoods.	
	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.
Inches.	Cords.	Cords.	Cords.	Cords.	Cords.	Cords.
4	.....	.....	.028	22	.114	95
5	.....	.....	.....	.....	.243	202
6	.106	88	.009	8	.141	117
7	.132	109	.016	13	.096	80
8	.091	76	.013	11	.123	102
9	.084	70	.017	14	.092	76
10	.232	193	.....	.....	.110	92
11	.013	11	.012	10	.062	51
12	.248	207	.051	42	.147	122
13	.040	34	.....	.....	.051	42
14	.047	39	.038	32	.086	71
15	.016	13	.....	.....	.041	34
16	.018	15	.....	.....	.030	25
17	.....	.....	.....	.....	.020	17
18	.....	.....	.019	16	.011	92
19	.....	.....	.....	.....	.012	100
Total	1.029	855	0.203	169	1.359	1,318

TABLE 14—Present Yield on the Conifer Type East of the Houlton Road.

AREA 4434 ACRES.

Conifers.

Diameter breasthigh.	White Pine.		Hemlock.			
	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.
Inches.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.	Cds. bark.	Cds. bark.
5						
6	40.00	173,000	20.16	87,200		
7	31.46	136,600	15.60	67,500		
8	62.64	272,000	21.12	91,000		
9	69.68	301,000	26.00	163,000		
10	112.32	485,000	32.52	145,000	.020	87
11	110.24	477,000	25.96	161,000	.009	38
12	141.44	612,000	22.68	98,000	.008	35
13	125.80	545,000	64.20	278,000	.024	104
14	128.40	555,000	48.60	211,000	.021	91
15	102.40	493,000	39.60	179,000	.017	74
16	17.76	76,700				
17			19.20	83,000	.008	35
18			22.80	98,800	.010	43
19						
20	22.40	97,000				
Total	964.54	4,133,300	358.44	1,662,500	.117	507

TABLE 14—Continued.

Conifers—Continued.

Diameter breasthigh.	CEDAR.		BALSAM FIR.		RED SPRUCE.	
	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.
Inches.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.	Bd. feet.
5.....	.....	.....	.....	.....	.....	.....
6.....	28.48	123,000	155.60	672,000	232.00	1,010,000
7.....	10.40	45,000	99.00	428,000	242.64	1,050,000
8.....	14.56	63,000	112.32	485,000	220.32	955,000
9.....	8.80	38,200	159.12	688,000	185.60	803,000
10.....	22.20	96,000	153.12	663,000	187.92	814,000
11.....	11.00	47,600	30.16	130,000	82.88	358,000
12.....	21.00	90,900	81.76	353,000	140.60	632,000
13.....	4.00	17,300	46.18	200,000	23.20	101,000
14.....	4.80	20,800	8.64	37,400	71.76	301,000
15.....	.....	.....	20.16	87,000	57.60	249,000
16.....	.....	.....	11.84	51,400	.....	.....
17.....	.....	.....	.....	.....	.....	.....
18.....	.....	.....	.....	.....	.....	.....
19.....	.....	.....	.....	.....	.....	.....
20.....	.....	.....	.....	.....	.....	.....
Total	125.24	541,800	877.30	3,894,800	1,444.52	6,273,000

TABLE 14—Continued.

Conifers—Concluded.

Diameter breasthigh.	Red Spruce.		White Spruce.			
	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.
Inches.	Cords.	Cords.	Bd. feet.	Bd. feet.	Cords.	Cords.
5	.133	576	.....	.....	.324	1,420
6	.712	3,080	68.80	197,500	.241	1,040
7	.728	3,150	81.36	353,000	.244	1,058
8	.671	2,910	79.92	346,000	.240	1,039
9	.464	2,020	56.00	243,000	.140	606
10	.425	1,840	47.52	206,000	.107	464
11	.183	749	32.56	139,000	.072	312
12	.281	1,218	22.80	99,000	.066	286
13	.053	229	.....	.....	.....	.....
14	.141	610	11.04	49,300	.022	95
15	.104	450	.....	.....	.....	.....
16	.....	.....	.....	.....	.....	.....
17	.....	.....	.....	.....	.....	.....
18	.....	.....	.....	.....	.....	.....
19	.....	.....	.....	.....	.....	.....
20	.....	.....	.....	.....	.....	.....
Total	3.895	16,832	400.00	1,632,800	1.456	6,320

TABLE 14—Continued.

Hardwoods.

Diameter breasthigh.	YELLOW BIRCH.		WHITE BIRCH.		POPLAR.	
	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.
Inches.	Bd. feet.	Bd. feet.	Cords.	Cords.	Bd. feet.	Bd. feet.
4	.....	.....	.....	.....	.....	.....
5	.....	.....	.104	450	.....	.....
6	9.60	41,000	.156	675	.....	.....
7	9.24	40,000	.181	781	.....	.....
8	12.48	54,000	.258	1,120	.....	.....
9	9.36	40,000	.132	571	.....	.....
10	5.28	22,000	.322	1,390	61.38	266,000
11	12.40	54,000	.116	501	.....	.....
12	.....	.....	.357	1,550	95.70	414,000
13	.....	.....	.070	303	.....	.....
14	.....	.....	.028	121	24.88	107,800
15	.....	.....	.113	489	.....	.....
16	.....	.....	.....	.....	33.56	145,000
17	.....	.....	.....	.....	95.80	415,000
18	.....	.....	.....	.....	.....	.....
19	.....	.....	.....	.....	.....	.....
Total	58.36	251,000	1.838	7,951	311.32	1,347,800

TABLE 14—Concluded.

Hardwoods—Concluded.

Diameter breasthigh.	Poplar.		Ash.		Other Hardwoods.	
	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.	Average yield per acre.	Total yield.
Inches.	Cords.	Cords.	Cords.	Cords.	Cords.	Cords.
4	.....	.....	.045	195	.114	493
5	.....	.....	.....	.....	.243	1,049
6	.052	225	.006	26	.206	892
7	.103	445	.002	8	.153	662
8	.052	225	.010	43	.211	910
9	.022	95	.006	26	.147	638
10	.076	329	.004	17	.148	640
11	.....	.....	.005	22	.105	437
12	.106	458	.018	78	.081	351
13	.....	.....	.....	.....	.034	147
14	.028	121	.....	.....	.029	125
15	.....	.....	.....	.....	.....	.....
16	.037	161	.....	.....	.024	104
17	.106	458	.010	43	.....	.....
18	.....	.....	.....	.....	.043	186
19	.....	.....	.011	48	.....	.....
Total	.582	2,517	.117	506	1.538	6,634

GENERAL SUMMARY OF PRESENT YIELD.

	Board feet.	Value.	
White pine	6,207,000	$30,025	
Spruce	17,299,000	69,196	
Balsam fir	12,662,000	50,648	
Hemlock	7,810,000	31,240	
Cedar	2,201,000	8,804	
Yellow birch	5,452,000	5,452	
			$195,375
	Cords.	Value.	
Poplar	27,750	$27,750	
Cordwood	72,660	36,330	
			64,080
			$259,455

Taking trees down to five and six inches in diameter breast-high there is now on the tract an amount of timber represented by the above figures. The forest as a general thing is much too dense and is in need of thining. If, therefore, only one-fourth of the present yield were removed in the first rotation, the total value of the produce would be about $64,000. To remove that amount of material from a tract of over 23,000 acres in one year would not be desirable, though it might be feasible. If, then, a 20 year rotation is adopted at first and one-twentieth of the tract gone over each year, the annual income to the State would be about $3,200, an amount considerable in excess of the present returns from the tract. This is an amount more than sufficient to cover the expense of the management. Furthermore if the cuttings are properly conducted the forest will be left in a far better condition and its producing capacity increased, resulting in an increased revenue to the State. This will be the great result of the proper treatment of the forest. The management of the tract, looking to a sustained annual yield, is an entirely practical undertaking, a paying thing for the State, and the quicker it is undertaken the sooner will the State realize the highest possible returns from the forest investment.

TREATMENT OF THE FOREST.

GENERAL.

The treatment to which the forest has been subjected in the last half century brought about radical and sudden changes in its density and composition to which it has attempted to become adjusted by natural processes. This readjustment was generally at the expense of the quality of the stand, for the operations of the past favored the growth of the less valuable species. On the tract there are also a large number of different species of trees grouped naturally to form many different mixtures, but not, however, in a manner suitable for the production of the best timber. The forest as a general thing is much too dense so that a good development of the individual tree is retarded. In many instances there is too great a predominance of a species of poor quality like the balsam fir, for example, which reproduces easily and grows readily even in dense shade and because of these inherent qualities frequently crowds out the valuable white pine.

The character of the stand and the present condition of the forest make the problem mainly a silvicultural one and one which demands treatment that will improve the present conditions. Improvement cuttings will best meet the needs sought in the management and should be the main feature in the prosecution of the work.

OBJECTS TO BE ATTAINED ON EACH TYPE OF FOREST LAND.

CONIFER TYPE.

In addition to the other conifers in the type, there is a good stand of white pine, on some areas, running as high as 4,000 feet board measure per acre. The white pine is the most valuable species and on land suited to its growth is easily the most profitable one to grow. The growth of this tree should therefore be favored and the per cent of this timber increased as much as possible. The balsam fir and hemlock are usually the most numerous trees and these should, therefore, be removed first and such of the other species as is necessary to relieve the crowded conditions. Trees should be marked for removal in all cases where an inferior tree of white pine is crowding and inter-

fering with the growth of a good thrifty tree, or where a tree is known to be rotten or showing evidence of decay. As a general thing, however, the white pine is in a thrifty condition and should not be cut for some time. As far as possible the hardwoods should be removed since they occupy space that might be devoted to the growth of the valuable conifers.

UPLAND TYPE.

The hardwoods are most numerous on the upland area and largely compose the upper story of the forest. In this type the object should be to diminish the amount of hardwoods and increase the conifers, especially the important ones, like white pine and spruce. The poplar and white birch are the most valuable of the hardwoods. The yellow birch is a valuable timber tree but occurs so scatteringly in the type that it is not of great importance. The character of the soil in this type is well suited for the best development of the poplar and if stands of this species are to be grown on the tract they should be maintained on the upland area.

The removal of the poplar can be accomplished readily as it is in good demand for pulp and especially for excelsior wood. Furthermore, an increase in the price may be expected and in view of this it would be good sound policy to restrict its removal in accordance with the rules for cutting, which appear later. As a general thing the other hardwoods are of small diameter and can be utilized only for cordwood.

LOWLAND TYPE.

The general moist character of the soil in this type is not well adapted for the growth of certain species now found in it. The white pine grows to some extent on the area and does fairly well. The poplar also occurs but its development is more or less hampered by the unsuitable condition of the soil; hence stands of poplar on this type are not to be encouraged. The cedar and yellow birch are most common on the lowland type and the conditions are well suited for their growth. In the management of this type the growth of these species should be encouraged along with the spruce which is adapted for growth in moist soil. The fir and hemlock, which find on this area condi-

tions also well suited for their growth, should be restricted in amount and should compose only a small per cent. of a stand. The soft maples which occur on this area should be removed as far as possible.

LUMBERING.

THE REMOVAL OF PRODUCE.

Where the hardwoods are abundant on the tract they generally compose the forest canopy and beneath them there is commonly an understory of conifers. These, being well established, are going to form the forest cover to a greater or less extent as soon as the hardwoods are removed. Since the conifers are as a rule more valuable than the hardwoods, the removal of the latter, as far as possible, is desirable, but judgment should be exercised in the cutting. The complete removal of all hardwoods in one cutting is not advisable and two or three rotations will be required before the proper adjustment can be established. In many stands there are a large number of balsam fir which are occupying growing space that might be devoted to the more valuable conifers. With certain exceptions, the removal of all fir down to five inches in diameter breast high, would be beneficial.

USE OF MATERIAL.

In a flat country such as the tract under consideration, soft places are common and in the construction of logging roads across them the use of corduroy is frequently necessary. On roads used only temporarily or where temporary repairs are made on permanent roads, the less valuable species will answer every purpose. In cutting trees for corduroy or skids the red and silver maples, gray birch and balsam fir should be taken, the latter tree being the best for skids.

YARDING.

In lumbering, the logs are dragged from the stump to the yard by horses. In cutting out the roads to the logs much valuable young growth can easily be destroyed when no care is exercised. Young stands of trees of the valuable kind should be avoided, whenever possible in swamping out, and in yarding

the logs care should be taken to do as little damage as possible to the standing trees. The use of a single horse in yarding is strongly advised, thereby avoiding the necessity of swamping out a wide road, not only saving much young growth but lessening the expense of the yarding.

HIGH STUMPS.

The tendency at present in felling is to make the stump cut well up from the ground especially on trees of the larger diameter. In the case of a defect near the base of the tree it is justifiable in avoiding it, to cut a high stump. Another source of waste is in felling and cutting up the tree with the axe especially when timber is cut for saw logs. The butt portion of the log contains the best quality of lumber and cutting stumps low and sawing the trees instead of chopping, will be a gain not only in quantity but in quality as well.

Table 15 shows the amount of timber saved by cutting stumps one foot high intsead of one and one-half or two feet as is now done, and by sawing down trees instead of chopping. The measurements for the length of the axe cut were taken parallel to the vertical axis of the tree. For trees of the larger diameter, the saving is considerable and on the whole tract, even with the present stand, would amount to 7,700,000 feet board measure. If the stumps were cut even lower the saving would be still greater. The waste at the mill on logs chopped is a still further source of loss.

TABLE 15—Height of stump and length of axe cut.

Diameter breasthigh.	Height of stump.	Length of axe cut.	Gain per tree by		Total.	Number of trees to make 100 feet if		Total.
			Cutting stump 1 ft.	Felling with saw.		Stumps cut 1 ft.	Trees are sawed.	
Inches.	Feet.	Feet.	Bd. ft.	Bd. ft.	Bd. f.			
5	0.90	0.4	0	.36	0.36	0	277.8	277.8
6	0.91	0.5	0	.72	0.72	0	138.8	138.8
7	0.95	0.5	0	1.00	1.00	0	100.0	100.0
8	1.00	0.5	0	1.35	1.35	0	74.0	74.0
9	1.10	0.6	0.35	2.10	2.45	291.0	47.6	40.8
10	1.15	0.6	0.66	2.64	3.30	151.5	37.9	30.3
11	1.25	0.7	1.35	3.78	5.23	74.0	26.4	19.1
12	1.35	0.7	2.27	4.55	6.82	44.0	24.2	14.6
13	1.45	0.8	3.51	6.24	9.75	28.8	16.0	10.3
14	1.55	0.8	5.00	7.28	12.28	20.0	13.7	8.1
15	1.70	0.9	7.35	9.45	16.80	13.6	10.6	6.0
16	1.80	0.9	9.68	10.89	20.57	10.3	9.2	4.8
17	1.95	1.0	13.05	13.70	26.75	7.7	7.3	3.7
18	2.05	1.0	16.27	15.50	31.77	6.1	6.5	3.1
19	2.12	1.08	19.37	18.68	38.05	5.2	5.3	2.6
20	2.24	1.13	23.90	21.76	45.66	4.2	4.1	2.2
21	2.35	1.18	28.75	22.66	51.41	3.5	4.4	1.8
22	2.45	1.24	34.00	26.28	60.28	3.0	3.8	1.6
23	2.57	1.29	40.50	33.28	73.78	2.5	3.0	1.3
24	2.68	1.34	44.30	36.79	81.09	2.3	2.7	1.2
25	2.80	1.40	55.03	42.84	97.92	1.8	2.3	1.0

Another source of loss results in not cutting up into the tops as far as possible. In the study of the poplar, measurements were made to determine, in trees of different diameters, the length of merchantable material, if taken to a diameter of three inches in the top, this being the diameter which could govern the cutting if the trees were taken for pulp. At the same time the length actually taken by the logger was also measured. Table 16 gives results of the figures obtained and shows that no small portion of the tree is left in the woods.

TABLE 16—Merchantable length and used length of Poplar.

Diameter breasthigh.	Merchantable length.	Used length.	Length left.	Basis.
Inches.	Feet.	Feet.	Feet.	Trees.
5	35	24	11	15
6	36	28	8	15
7	39	31	8	18
8	42	35	7	19
9	45	36	9	21
10	48	40	8	14
11	51	43	8	18
12	53	45	8	17
13	55	47	8	16
14	57	49	8	7
15	59	50	9	9
16	61	51	10	4
17	62	51	11	2
18	63	52	11	1

RULES FOR CUTTING.

The following rules embody the suggestions to be followed in the cutting conducted on State land.

1. Trees to be cut shall be marked and trees not marked are not to be removed.

2. No white pine below seventeen inches in diameter shall be cut and trees above this diameter shall not be removed, if in the forester's judgment they should be left. Trees of the smaller diameters can be cut if they are suppressed, crooked or decayed or in case a poor tree is crowding one of thrifty growth.

3. All balsam fir above five inches can be cut.

4. Only poplar above eight inches shall be marked for removal. Trees of smaller diameter shall be taken only when their removal will prove beneficial to the stand.

5. Saw logs shall be cut up to six inches in diameter in the tops in the case of conifers. Spruce cut for pulp shall be taken to a diameter of not less than three inches in the tops.

6. Poplar shall be cut to a top diameter of not less than three inches.

7. In the case of conifers cut for saw logs the tops shall be utilized for lathwood or pulp wood.

8. The hardwoods shall be cut for cordwood except in the case of species which are of more value for other purposes.

Peeling hemlock. Note high stump left

MAINE FARMER PRESS, AUGUSTA

Poplar cutting. Trees piled on top of one another

9. The material from the thinnings which cannot be utilized to good advantage for the better classes of forest products shall be used for firewood as much as possible.

10. Injury to valuable trees or young growth in felling shall be avoided, and also the cutting of valuable young trees in swamping out logs for yarding.

11. Yarding shall be done with a single horse.

12. Stumps shall not be cut higher than one foot if the trees are sound at the base.

13. In the use of the better hardwoods or the conifers other than the fir, for corduroy or in the logging operations, which cannot be avoided, the supply shall be obtained from dense thickets of young growth rather than from the scattering trees, selecting in such cases the unpromising trees, leaving the straight and thrifty ones as the basis for future crops.

PROTECTION OF THE FOREST.

FIRE.

Fire is the worst enemy of the forest and the cause of worry to the lumberman. Forestry cannot exist where fire prevails, therefore any scheme of management involving the permanent welfare of the forest and which anticipates the wise use of its produce necessitates the establishment of an efficient system of protection against this arch enemy of the forest. Many conditions prevail which make a decided difference in the liability to fires getting started and notable among these are wet and dry seasons, topography, length of time since the occurrence of a large fire, the extent and character of the logging, the number of small wood cutting operations and the number of hunters and berry-pickers.

On Indian township the present sources of danger from fires are on the lots held by private owners where a great deal of slash is left after the logging, and on those areas of State land logged for poplar. This slash soon drys out and a fire once started in it would almost instantly get beyond control and might easily burn over a thousand or more acres of valuable timber before it could be stopped. The thousands of trees often destroyed by a single fire would require several thousand dollars and many years to replace, while to protect them

requires but a trifle. The fact that there have been no serious fires in recent years does not argue that there will be none in the future. The danger is one ever present and to be guarded against constantly.

Protection against fire cannot be carried out in a half hearted manner neither can the discovery of a fire be left entirely to the chance oversight of individuals whose time and attention must be given to personal affairs. In the scheme of protection all effort should be directed to prevent fire from getting started rather than in fighting it when once it gets under way. Effective protection can be accomplished along three lines:

1. By a system of fire patrol.
2. By a system of fire lines.
3. By burning the slash.

FIRE PATROL.

It has been proved beyond any shadow of doubt that a system of fire patrol is the only efficient method of controlling forest fires. Experience on the Federal Forest Reserves has demonstrated that fires can be practically eliminated by a well organized system of patrol and a sufficient force of men.

In contending with the danger of fire, when the risks are great, a daily patrol of the tract is necessary. By doing a little road construction so that portions of the tract now not easily accessible could be reached, one man could do the work of patrol in any ordinary season. In an unusually dry time extra help would probably be necessary.

Outlook stations erected in different parts of the tract would materially add to the efficiency of the protection. These should be easily accessible and should be built in a substantial manner, and should be of sufficeint height above the surrounding trees to permit an unobstructed view all around. In addition, they might be used as a place in which to store the fire fighting equipment. The cost of constructing these stations would be of no material amount as compared with their usefulness in discovering fires. A good location for one of these stations is on Grand Lake Stream road on the high hill just west of Huntley Brook. Other stations are needed on the area east of the Houlton road. The man on patrol should visit these stations each day and make observations for fire.

FIRE LINES.

The heaths and other swamp areas which sometimes occur in more or less continuous lines and the water courses on the tract serve as natural fire lines but are not wholly adequate for the purpose of fire protection. A series of fire lines should be constucted, thereby adding to the ease and effectiveness of the fire patrol. The cost of making fire lines might be as high as $25.00 per mile, but this would be greatly reduced by the sale of material obtained in cutting the lines.

BURNING SLASH.

The burning of slash left on lumbered areas would be a most important step in the protection from fire. The debris left after the logging is completed is always a great source of danger and remains so for two or three seasons. To burn this as soon as possible after logging is the wisest course, is entirely feasible and is practical. In the late fall after the first good rain, and in the spring before the dry season begins are times when slash can ordinarily be burned. The burning should not be attempted when the material is too wet to be thoroughly consumed, at the same time the ground should be moist enough to prevent the danger of fire getting beyond control. Slash of the conifers is quite inflammable when green owing to the large amount of resinous matter in the leaves and branches, and debris of this character can be burned even when there is more or less snow on the ground.

In some localities the attitude of the people toward forest fires is one of indifference and sometimes amounts to a total disregard of the danger. In the locality under consideration the people recognize the danger of forest fires and fully appreciate the necessity for fighting them. Their attitude is in every way commendable and the necessity for contending with a sentiment of indifference toward and a disregard of the danger of forest fires does not exist. This and the topographic features which serve naturally in the protection of the tract, together with the existing highways make the protection from fire easy and inexpensive. With the establishment of a system of fire patrol, a series of fire lines, and the burning of the slash the danger of forest fires can be practically eliminated.

TRESPASS.

The protection of the State land against trespass emphasizes the need of a survey and demarcation of the exterior lines of the township and the establishment of suitable monuments, and still more the necessity of marking the boundaries of the adverse holdings. No excuse could then be offered for cutting over the line. Even then trespass probably cannot be eliminated until more effective measures are instituted and constant vigilance will be necessary to guard against the mischief.

ROADS.

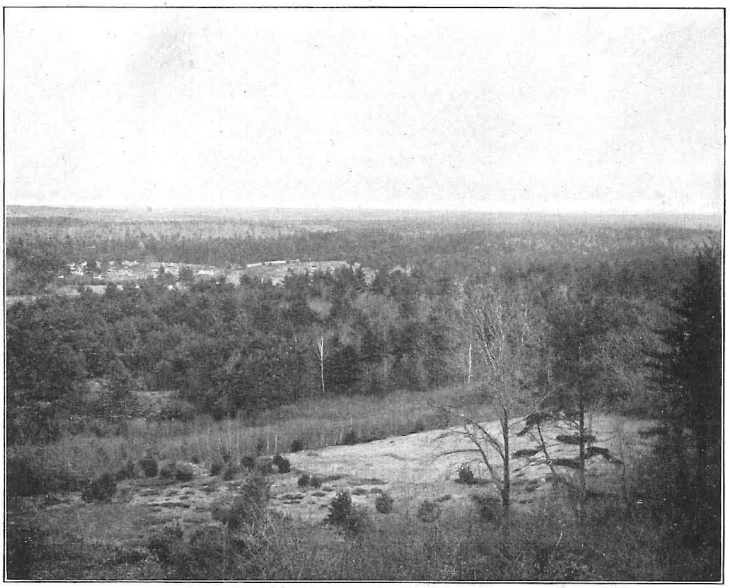
Some of the roads constructed for the purpose of getting out the forest produce should be laid out with a view to using them repeatedly, since portions of the tract will be cut over quite frequently especially in the beginning of the management. The main arteries of the road system will be made up of the public highways at present on the tract, the secondary roads branching off from these. An average width of ten feet will be sufficient for the latter.

A little road construction must be done immediately in order to reach some portions of the tract with the fire patrol. Aside from this the logging roads need not all be built at once, but may be extended in accordance with the needs of the management and in that way their cost will not seem such a burden. With a very little attention, the wood roads can be kept in serviceable condition for the fire patrol and also answer the purpose of fire lines.

The general level character of the tract makes road construction comparatively easy and the cost small. The greatest difficulty in this work will be encountered in carrying the roads across the low, wet places.

CONCLUSIONS.

The management by the State of its forest lands on Indian Township is practical in every way. Not only will it be an object lesson, but it will demonstrate to the people that the State is interested in caring for its great forest area. Moreover, the treatment will very materially increase the production and with a sustained annual yield the forest will be a source of permanent revenue to the State.



General view of second growth white pine region, Alfred, Me.

MAINE FARMER PRESS, AUGUSTA

The present method of lumbering white pine. The adjacent woods will assist in reseeding the lot

SECOND-GROWTH WHITE PINE IN MAINE.

S. N. SPRING, M. F.

INTRODUCTION.

The pine tree has been closely associated with the name of Maine from early colonial times. The magnificent old-growth of white pine was nearly all utilized many years ago and yet today the State has a valuable asset in the numerous woodlots of second-growth found in the southwestern part of the State. The soil of these second-growth lands, which is usually of slight value from the standpoint of agriculture, should yield not only the present crop of merchantable pine but be perpetually productive. Observations have shown, however, that much pine land becomes barren or covered with a valueless growth after it is lumbered. This is largely due to ignorance of the natural characteristics of this tree in its growth and a disregard for the future value of lumbered lands. Hence, the object of this report is to furnish some information that may be of value to those interested in the future of this tree.

DISTRIBUTION AND ASSOCIATED TREES.

White pine occurs throughout all of Maine, but the characteristic pure pine woodlot is found in the southwestern part of the State. Its northern boundary may be considered in general as follows: the Androscoggin river eastward from the New Hampshire line to the point where the river turns south in Maine, thence a line southeast to Boothbay. In the region thus limited on the north, the pine grows rapidly, replaces itself and is extended abundantly under favorable conditions. On the natural hardwood land it is a valuable though minor part of the forest, but on sandy soils and wherever farm land has fallen into disuse it forms a pure growth. Nearly all the woodlots of pure pine grew up on land abandoned thirty to fifty years ago.

Between this portion of Maine, described above, and the true spruce region to the north, white pine is found mingled with hardwoods on the higher lands and with the growth of conifers on the lower lands. In the latter case it sometimes forms the principal growth and is associated with spruce, fir, cedar and hemlock. Its reproduction except on abandoned farm land is much poorer than in southwestern Maine and its growth is slower owing to the shorter growing season.

In the spruce region white pine occurs singly or in occasional small groups mingled with the spruce. On burned lands such as the region covered by the fire of 1825 it has reproduced itself somewhat more abundantly among birch and poplar owing to the favorable conditions of light. The characteristics of white pine growth in this region are entirely different from those of southwestern Maine and will not be considered further in this report.

GROWTH AND DEVELOPMENT.

A pine seedling grows very slowly during the first five years of its life. When the seed germinates it sends a little root downward and a small stem upward. At the end of one year this stem is about one and one-half inches long with a little tuft of needles at the top. The next season it adds an inch to its height and the third season about two inches. The third or fourth year side branches are developed and at five years of age seedlings may vary from twelve to eighteen inches in height. Between the ages of five and ten the white pine begins a faster growth and after this period it gains in height very rapidly until sixty years is reached, when the annual rate of growth gradually becomes less. Each circle of side branches marks the termination of one year's growth in length and under very favorable conditions a pine may add as much as thirty inches in height during one season of this period of rapid upward growth. At the same time the pine adds to its stem by growth in diameter, adding a ring of wood yearly just beneah the bark.

The amount of wood thus added to the tree each year depends upon a number of factors in addition to the natural rapidity of growth which this tree possesses. These are the conditions of soil, moisture and light. White pine will grow on almost

any soil but attains its best development on a fertile, well-drained soil of middling porosity. On the other hand it is an especially valuable tree for Maine because it attains a fair growth even on the poorest soils where farming does not pay. Such lands covered by a young pine growth are an asset increasing in value year by year.

White pine is able to survive in a dry situation, hence it is found on dry, sandy lands that cannot support the hardwoods with their greater demands upon the soil for moisture and richness. Pine is frequently found upon the hummocks of swampy land, thus showing to what a wide range of moisture conditions it can successfully adapt itself.

The requirement of this tree for light is of very great importance in its growth and natural replacement. Any tree requires light because its food, necessary for growth, is made in the leaves under the action of sunlight. No food can be made unless there is light. For this reason the more a tree is shaded by others the less it can grow. With an increasing amount of shade a point is reached where the tree finally becomes sickly and dies. Trees have individual characteristics much as people do and white pine needs a fair amount of light in order to live. Hemlock and maple can stand a great deal of shade; a young white birch or a poplar requires abundant sunlight or else it will die. About midway between these two extremes the white pine can be placed, for it can endure the shading of a low open stand of young hardwoods growing above it, but on the other hand one seldom finds pine seedlings under a dense, tall stand of older pine or of hardwood. This need of sunlight together with the light winged character of the seed is the reason for its abundant extension over pastures and old fields.

The growth and development of this tree, as has already been explained, depend primarily on the physical and chemical character of the soil, the moisture available for the roots and the amount of sunlight received by the crown of the tree. In addition to these the form and development is altered according as the tree grows by itself in the open or with others in the forest. If a tree, such as a pine standing alone in a pasture, has unrestricted space in which to grow, its crown is large and its stem is thick at the base, tapering rapidly to the top. It is of slight value as a merchantable tree because its stem is so

short and branchy. In the forest the white pine grows tall and slender and has a trunk free from branches.

Trees growing together in the forest struggle with each other for light and growing space, but the close canopy of crowns thus formed retains the moisture in the ground by shading it, and an enriching vegetable soil is formed there by decaying leaves and litter. The close contact of the crowns causes the lower branches to be shaded and subsequently to die. The dead branches fall off after some years and the tree covers over the branch-wound by new wood. It is desirable, therefore, that a pine forest should be sufficiently dense to bring about this development of tall, clean-boled trees.

ENEMIES.

White pine is a tree valuable to Maine not only because of its rapid growth but the fact that up to the age at which it is usually cut its enemies are comparatively few.

Of these fire is the worst, because even a slight surface fire will kill all the little pines in its path over a pasture or on cut-over land. Fires burning in second-growth pine woodland nearly always kill the trees outright, but since southwestern Maine is well settled a perfect control of fires is possible there providing proper care is taken. Since the woodlots are usually more or less separated by tilled land the danger of fire is not so great as in continuous woodland.

The pine weevil (*Pissodes strobi, Peck*) is another enemy of the pine. This insect lays its eggs in the bark of the leading shoot during the spring. The larvae, tiny white worms, eat in the region of the bark and wood of the shoot, causing it to die. The effect of this injury on the tree is to deform it, since a crook occurs where a side branch takes the place of the main shoot. Pine trees scattered over a pasture and not forming a thick growth together are often attacked several times and become bushy, crooked trees. The trees are attacked when young, usually between the fifth and twentieth year. This insect damage varies in severity locally but in the ordinary woodlot of pine in Maine, only about two to eight per cent. suffer. The appearance of the pine attacked by this insect is very characteristic: the leading shoot is whitened with the resin

which flows out and the new season's growth at the tip is wilted and dead.

Whenever this insect injures the young trees of a planted stand the shoots thus affected should be clipped off as soon as the injury is noted, and burned. This will destroy a great number of the worms feeding inside the shoot at this time.

THE EXTENSION OF WHITE PINE BY NATURAL SEEDING.

Production and distribution of seed: In order that any tree may bear seed or fruit it must store up food in excess of that needed for yearly growth. This fact is a well known one in regard to fruit trees and is no less applicable to pine trees. Certain years come when a great many cones, sometimes called "burs," are found on white pine trees, and certain other seasons only a few cones can be seen. These times of periodic seeding are known as seed years and occur at an interval of every five of six years. This interval is spent by the trees in growing larger and storing up food for the next crop of seed. A seed year is usually a local affair, being confined to one valley or section of the State while the pine trees of another locality may not be bearing seed during that particular year. A small number of cones, however, may be found on the trees almost any year if a careful search is made. Trees begin to seed when about fifteen years old and at thirty-five years begin to bear good-sized crops each seed year.

A cone consists of a series of papery scales arranged spirally on a central stem, overlapping each other. On the face of each scale two winged seeds are developed, the wing and seed together being about an inch long. It takes two years to develop the seed. At the end of the first season the cones are about an inch long and by August of the second year they are full grown but still remain closed. Toward the end of August the cone begins to dry and turn brown. The scales open as the cone dries and the seeds slip out when the branches are shaken by the wind.

Pine seed is distributed principally by the wind and nearly all the seed is gone from the cones by the second week in September. At this time of year the winds are westerly as a rule and so the seed is scattered to the east, southeast or north-

east of the trees that bear them. The following year the old empty cones drop from the trees as the season progresses.

One can depend on trees seeding the ground thoroughly to a distance of about twice their height, for example, most of the seed from pine trees fifty feet tall will fall within one hundred feet from the foot of the tree on the side opposite the quarter from which the wind blows. Of course some seeds may be caught up by a gust and carried much farther. These facts must be kept in mind when a cutting is planned with the object of securing a new growth of pines.

The life history of the pine: From the seed to the merchantable tree is a story of much loss and a struggle for existence. Millions of seeds are produced but many never find a place where the conditions of moisture are favorable for germination. Some seeds falling in wet places decay, some lie dormant in dry spots and lose their vitality, and a large number are eaten by animals.

Many seeds germinate in places where the light is insufficient for their growth and they die within a shorter or longer time, according to the conditions in that spot. On pastures and cut-over land near to seed trees numerous seedlings may spring up, but much loss occurs during the tender period of the first two years when the root system extends to such a slight depth that death may result from the drying out of the surface soil or from intense sunlight after a shower. Other seedlings, however, find the necessary protection in the light growth of grass, ferns, vines or weeds that form small bunches or spots here and there.

As the pine seedlings grow their branches begin to interlace with those of their neighbors and a forest cover is established when the trees are ten to fifteen years old. The struggle for growing space and light becomes sharp. Some have a little start in point of time or because of favorable conditions of soil and moisture, hence these go ahead and others begin to lag behind in growth according to the amount they are shaded. Soon three classes of trees are established, those that have full light on their crowns, those that are almost wholly shaded and will eventually die, and those in an intermediate position between the two preceding classes. The size of the tree corresponds to its class; the dominant are the largest, the suppressed small-

est, and the balance are intermediate in height and diameter growth.

The number of trees upon an acre steadily decreases from several thousand seedlings in the beginning to a few hundred trees when the woodlot is fifty years old. This struggle furnishes the right sort of timber, namely, tall trees that are clear of branches. This condition is due to the fact that the lower branches become shaded early in the life of the stand, die and gradually drop off. This gives a stimulus to height growth because more mineral food from the soil passes directly to the upper part of the tree, and, also, the dense shade on the ground keeps the soil moister as well as causing it to become richer from the decaying leaves and twigs on the surface, thus favoring a more rapid growth of the tree. The trees that die during the struggle, though an apparent loss, have, however, contributed to the welfare of the whole woodlot.

Numerous woodlots are found in which the trees are branchy and the stand is open and thin. This is often due, very frequently, to an insufficient seeding of the ground in the beginning owing to lack of adjacent seed trees and the absence of the forest conditions, described above, which are essential to a thrifty growth.

THE PRACTICE OF FORESTRY ON THE WHITE PINE WOODLOT.

The object of adopting forestry methods in managing white pine land is simply a business proposition; to obtain a larger amount of good merchantable timber from each acre in a shorter time than at present and to use simple methods of securing another growth of pine instead of letting the land go to waste, regardless of a future supply of timber. It is simply putting into practice nature's own methods and thus improving the conditions of growth and securing reproduction.

Thinning a woodlot: Thinnings are made for the purpose of improving the growth. By removing certain trees the rest have a chance to expand their crowns and make a faster growth, hence thinnings shorten the time needed to grow trees to a desired size. Thinnings should not be made unless there is a market for the material and the operation will pay for itself, or unless the owner wishes to make a slight outlay at present

in order to improve his lot and get better future returns from the forest. The time to make thinnings is when the trees are struggling hard with each other for growing space and light and as a result are all growing very slowly. In such a case it will be noticed that the trees have unusually small crowns closely crowded together. At twenty-five to thirty-five years of age this condition usually arises and then it is the time to thin.

In a woodlot composed entirely of white pine, thinnings consist simply of taking out suppressed trees and those from the intermediate class which are crowding the better trees of the leading class. Not more than a fifth of the trees per acre should be removed and great care should be used not to make a greater opening in the crown cover of the forest than can be filled by the expanding of the remaining crowns during the next ten years. Such a thinning can be repeated when the tops again become very crowded. In thinning one must consider always the opening in the crown cover made by the removal of a tree and not the relative number or position of the trunks of the trees. Diagrams of the proper way to make thinnings have been made by the Bureau of Forestry, U. S. Department of Agriculture.*

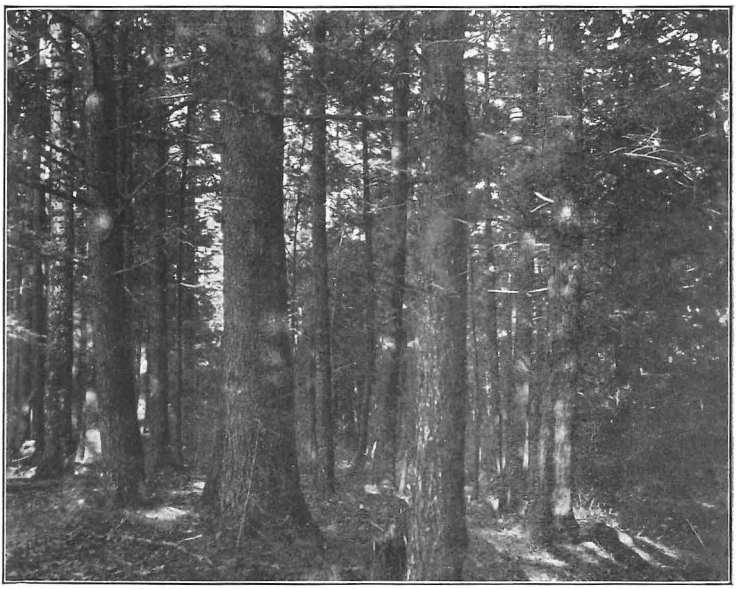
Where pine is growing in mixture with hardwood the thinnings should aim to remove the suppressed hardwood trees and the less valuable species that are injuring the pines by crowding. Crooked, diseased or dying trees may also be utilized at this cutting.

Another condition of growth quite commonly found in Maine is pine under gray birch or other hardwood trees. In this case the birch at first furnished a protection for the pine but some years later becomes a hindrance to the proper development of the pine. The treatment needed is the gradual removal of the hardwood growth in order that the more valuable pine may secure vigorous, thrifty growth.

Pruning the branches: It is not advisable to cut off the lower green branches of a young tree, but, rather, the seedlings should be close enough together to cause the branches to die naturally a few years after they begin to interlace when the

* Bulletin No. 42, "The Woodlot." Graves and Fisher.

A pasture slowly being covered by white pine, Alfred, Me.



MAINE FARMER PRESS, AUGUSTA

Interior view of a good stand of white pine

trees are ten to fifteen years old. The trimming off of the dry dead branches hastens the closing over of the wound by new wood and is advisable if the lot is to be kept for saw timber until it is seventy or eighty years old. If the pine is to be cut at forty years of age for box boards, pail staves or match wood the removal of the dead branches is not of so great importance. Pruning should be done with a sharp axe and the limbs taken off even with the bark but very carefully in order not to wound the tree.

Final cutting of the timber: Nearly all pine woodlots are at present cut clean and the logs sawed by a portable mill placed at a convenient point on the lot. This is the best and cheapest method and includes in some parts of southwestern Maine the working up of the tops for fuel. Rarely is any provision made for the natural reseeding of the land. This is the point of vital importance for Maine, because pine land is of little value for agriculture and should yield crop after crop of pine. Although the present owner of pine land may not himself cut the second crop of timber yet a young growing pine woodlot steadily adds value to the farm and will undoubtedly increase the sale value of the land if the owner desires to dispose of it. Cutting so as to get a natural replacement of the pine by young pine seedlings costs the owner but little if any outlay, while it makes sure another crop instead of allowing the land to become barren or to support only a scanty growth of bushes and gray birch. This waste condition arises directly from the lack of trees and woods to maintain natural seeding.

Scattered seed-tree method: Every acre of a pine woodlot has usually two or three trees on it which are short-boled and low-branching because they began growing in advance of the rest and received full light. Frequently these few trees are large ones that did the original seeding for that land. They do not pay for the cutting and sawing or at best bring a very small return. Such trees, however, have a very great value as seed trees, since they are wind firm and will not die from exposure after the others are cut down. Spindling, slender trees if left for this purpose will surely die or be blown down. Four or five pines are sufficient to seed one acre, provided they are sufficiently old to bear plentifully. They should be left on the western half of the acre, since the prevailing winds are westerly during the time the seed escapes from the cone.

If it is desired to burn up the branches and tops after lumbering the debris must be removed well apart from the foot of the seed tree. If there is little danger from fire these tops may remain and will soon decay after the young growth gets well started. A light growth of birch may first occupy this cut-over land but will serve as a protection to the tender pine seedlings which will appear later beneath them.

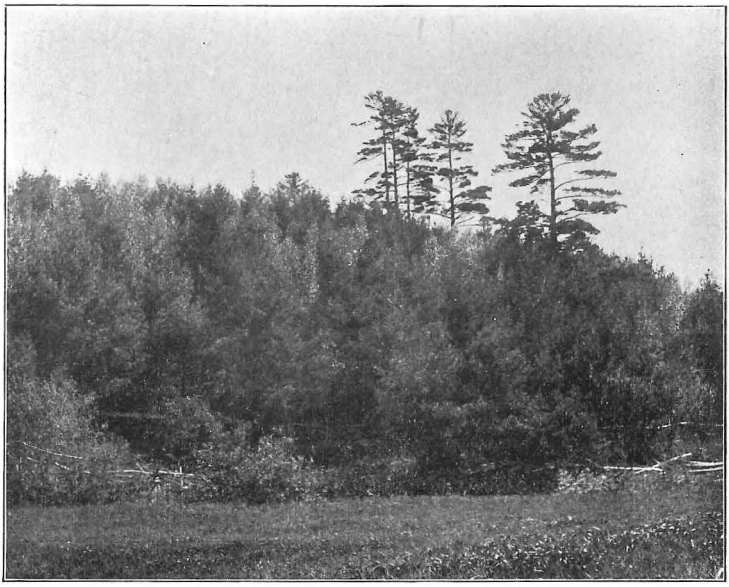
The strip system: This method may be used where the woodlot is a large one. Successive strips of the forest are cut, beginning on the east side and working west. Advantage may be taken of a seed year for the time in which to cut one strip. Seed years can be judged by the presence of the little cones in the tops of the trees. The strip should be not more than two to three times as wide as the trees are high if a complete seeding of the ground is desired. The wind will blow the seed from the adjacent woods over the newly cut land and after a few years, the seedlings having appeared, a new strip may be cut and so on until the land is all lumbered and naturally reseeded. The principle on which this system is based may be understood by noting the thick reproduction of pine in pastures or fields on the easterly side of any pine woodlot.

Natural seeding under old woods: Frequently a dense growth of pine seedlings may be noticed under an open stand of merchantable pine. The fact that plenty of light reached the ground enabled the seedlings to get a start and live. All that remains is to remove the old trees and the young growth will take their place. Such a condition may be secured by cutting out half the timber of a woodlot, waiting for the seedlings to get a start under the more open stand of old trees and later removing the rest of the mature timber. This method, however, cannot be practiced where the woodlot is in a position where heavy winds are likely to fell the timber after the partial clearance has been made.

THE EXTENSION OF WHITE PINE BY PLANTING.

Every part of a farm should be productive. Portions not suited to agriculture should have a growing forest crop. Of the trees suitable for planting white pine is one of the most profitable. Natural seeding should be taken advantage of wher-

White pine replaced by a few clumps of gray birches



MAINE FARMER PRESS, AUGUSTA

A thick stand of pine and gray birch. The five old trees reseeded this ground

ever it is possible through the presence of seed-trees in the vicinity. But when there are none adjacent to the land, planting must be undertaken, if it is desired to have a pine woodlot. Natural seeding costs little if anything, but planting involves a small outlay per acre in the beginning. Planting is sure and successful but it has been found that sowing seed on old fields and pastures is seldom successful. The cheaper the first cost of a plantation the greater the final profit if cheapness does not imply poor, weak plants and careless methods of planting. In some sections wild seedlings may be dug from roadsides or mowing fields at a very small cost, but usually the surest and best way is to grow one's own stock, since it occupies a very small space and requires very little work.

Raising pine seedlings: Cones should be collected from the trees in the last week of August or the first week in September before the seed escapes. A good-sized solitary tree in a pasture furnishes more cones and is usually more easily climbed. The cones may then be spread out to dry on a bare sunny spot. During the drying the scales open and the seed can be readily shaken out. The wings should then be rubbed off and the seeds winnowed. The best way to keep seed is to wrap it in heavy paper, place it in a small cloth sack and hang it in an unheated room for the winter.

The first step to be taken in the spring is to choose a place in which to plant the seed. Several places are suitable: (1) A good-sized open place in the woods. (2) Along the easterly edge of the woods. (3) Any well-worked soil that is not stiff and hence subject to heaving by the frost. The best place is one that is naturally free from weeds, has a well-drained, loamy soil and is near to the place where the pine is finally to be planted.

Beds four feet wide prepared like a garden bed are the most convenient size to use. The seed can be sown in very shallow drills six inches apart and crosswise of the bed. About one inch of pine needle litter makes a good mulch through which the little seedlings push up. This mulch keeps an even degree of moisture in the bed and hinders weed growth. In an open spot in the woods or on the eastern edge of the woods the beds need no artificial shading, as they receive shade about half of the day, but seedbeds situated in the open must have lath or

brush screens in order to protect the delicate seedlings during the first year of their life. These screens are made by nailing laths on a couple of light frame pieces, alternating a lath with an open space of the same width. The screens should be set on stakes eighteen inches above the seedbed after it is prepared and kept there during the first year. Instead of lath screens a simple shade can be made by placing a light cover of brush across a framework. Weeding should be done as often as needed and the seedlings should be mulched with leaves during the winter, especially if the soil is subject to the action of the frost in the springtime. If strong, sturdy plants are required the seedlings should be transplanted into nursery rows for one year.

Planting: Seedlings will have reached a sufficient size for planting by the end of the second year. Planting should be carried out in the spring as soon as the frost has come out from the soil. The first step is to take up the seedlings from the nursery. They should be lifted out with a spade, the dirt shaken off, counted, tied in bunches of fifty, puddled, and packed in a basket or box with the roots well surrounded with wet moss. Puddling is the dipping of the roots in a mixture of loam and water thick enough so that a moist film of earth sticks to the roots after they are dipped. This puts them in the best condition for withstanding any subsequent dryness after they are set out. It is usually best to dig a considerable number of seedlings at one time in preparation for the planting and after transporting to the final site to heel in those which are not desired for planting at once. Heeling-in consists simply of placing the seedlings in a trench, packing the earth closely about the roots and leaving the tops out. They may remain in this position for several weeks provided they have their tops partially shaded.

If the plants have remained heeled in for some time they should again be puddled before planting. The planting should be done in more or less regular rows six feet apart and the plants six feet apart in the rows. Some desire a denser stand and plant five by five. In the former case it requires 1210 seedlings per acre, in the latter 1742. In an average situation one man can dig 800 to 1000 holes per day or he can plant same number of seedlings.

The tools necessary for planting vary according to the nature of the soil. On rocky land a grubhoe is the best tool for digging the holes. On old pasture land which is not very stony a round or square pointed spade is a good tool. For setting the seedling the trowel and the hands and feet are all that are needed. After the spade or grubhoe has been used a few thrusts of the trowel by the one planting prepares the hole, the seedling is held in position by the left hand while the right hand scoops in a little earth. Both hands may then be used to press this earth firmly about the roots of the little seedling, then the balance of the earth is placed about the plant and pressed down firmly on each side with the foot. The seedling should be placed at a little greater depth than it had in the seedbed in order to allow for the settling of the earth. The whole operation of planting one seedling should occupy less than a minute.

The following estimate is based upon practical experience in numerous situations, but will vary to a certain extent in practice owing to the widely different conditions existing in various sections in the State.

Cost of growing one thousand two-year seedlings	$1.50 to $2.50
Cost per thousand of taking up and planting	$3.50 to $5.00
Total cost	$5.00 to $7.50

SUMMARY OF OBSERVATIONS.

1. White pine woodlots are rapidly being cut with no regard to securing another crop of the same kind. Much cut-over land is becoming barren or covered with a growth of inferior trees.

2. A study of the life history of this tree shows that ample provision can be made with no outlay to the owner so that natural seeding will take place.

3. The scattered seed tree method provides well for a new young growth of pine.

4. The planting of pine provides an increasing asset for the owner of non-agricultural land hitherto unproductive and increases the wealth of the State as a whole wherever waste lands are thus improved by planting pine.

A PRIMER OF FORESTRY.

By GIFFORD PINCHOT, Chief of the U. S. Forest Service.

THE LIFE OF A TREE.

The object of forestry is to discover and apply the principles according to which forests are best managed. It is distinct from arboriculture, which deals with individual trees. Forestry has to do with single trees only as they stand together on some large area whose principal crop is trees, and which therefore forms part of a forest. The forest is the most highly organized portion of the vegetable world. It takes its importance less from the individual trees which help to form it than from the qualities which belong to it as a whole. Although it is composed of trees, the forest is far more than a collection of trees standing in one place. It has a population of animals and plants peculiar to itself, a soil largely of its own making, and a climate different in many ways from that of the open country. Its influence upon the streams alone makes farming possible in many regions, and everywhere it tends to prevent floods and drought. It supplies fuel, one of the first necessaries of life, and lumber, the raw material, without which cities, railroads, and all the great achievements of material progress would have been either long delayed or wholly impossible. The forest is as beautiful as it is useful. The old fairy tales which spoke of it as a terrible place are wrong. No one can really know the forest without feeling the gentle influence of one of the kindliest and strongest parts of nature. From every point of view it is one of the most helpful friends of man. Perhaps no other natural agent has done so much for the human race and has been so recklessly used and so little understood.

THE PARTS OF A TREE.

In order rightly to understand the forest, something must first be known about the units of which it is made up. A tree, then, is a woody plant growing up from the ground usually

with a single stem. It consists of three parts: First, the roots, which extend into the ground to a depth of 3 or 4 feet, or still farther when the soil is not too hard and they do not find moisture enough near the surface. They hold the tree in place, and take up from the soil water and certain mineral substances which the tree needs in its growth. Second, the trunk, stem, or bole, which supports the crown and supplies it with mineral food and water from the roots. Third, the crown itself, with its network of branches, buds, and leaves, in which the food taken up by the tree from the soil and air is worked over and made ready to assist in the growth of the whole plant. The crown has more to do with the life of the tree than its other parts, for the most important processes in the reproduction of the tree and the digestion of its food take place in the crown. For this reason, and because we can control its shape and size more easily and directly than that of the roots or trunk, the crown is of special interest to the forester. It is almost exclusively with the crowns that he has to deal in tending a crop of trees and preparing the way for the succeeding generation. As they stand together in the forest, the crowns of the trees form a broken shelter, which is usually spoken of as the leaf canopy, but which may better be called the cover.

THE FOOD OF A TREE.

The materials upon which a tree feeds are derived from the soil and the air. The minute root hairs which spring from the rootlets take up water from the ground, and with it various substances which it holds in solution. These are the earthy constituents of the tree, which reappear in the form of ashes when any part of it is burned. The water which contains these materials goes straight from the roots to the leaves, in which a most important process in the feeding of the tree takes place. This process is the assimilation or taking up and breaking up, by the leaves, of carbonic acid gas from the air. It goes on only in the presence of light and heat, and through the action of chlorophyll, a substance from which the leaves and the young bark get their green color.

Plants containing chlorophyll are the chief means by which mineral materials are changed into food, so that nearly all

plant and animal life depends upon them. Plant cells which contain chlorophyll break up the carbonic acid gas with which they come in contact, retain the carbon, one of its elements, and send back the other, oxygen, into the air. Then, still under the influence of the sunlight, they combine the carbon with the oxygen and hydrogen of the water from the roots into new chemical compounds, in which nitrogen and the earthy constituents mentioned above are also present; that is to say, the food materials which reach the tree through the roots and leaves are first digested in the leaves somewhat as food is digested in the human body, and are then sent to all living parts of the roots, stem, and crown, where they pass through another process of digestion, and are then either used at once in growth or stored away until the proper moment arrives. This is the general rule, but it is believed that in some cases food taken up by the roots can be used without first being digested in the leaves.

THE COMPOSITION OF WOOD.

Wood is made up chiefly of carbon, oxygen, and hydrogen. When perfectly dry, about half its weight is carbon, and half oxygen and hydrogen, in almost the same proportion as in water. It contains also about 1 part in 100, by weight, of earthy constituents, and nitrogen to the same amount. When wood is burned, all these materials disappear into the air except the earthy constituents. Now the nitrogen and water taken up by the roots were originally in the air before they reached the ground. It is true, therefore, that when wood is burned those parts of it which came from the air go back into it in the form of gas, while those which came from the soil remain behind in the form of ashes.

HOW THE TREE BREATHES.

Besides giving out oxygen in assimilation, trees also take in oxygen from the air through their leaves, and through the minute openings in the bark called lenticels, such as the oblong raised spots or marks on the young branches of Birch and Cherry and many other trees. All plants, like all animals, breathe; and plants, like animals, breathe in oxygen and

breathe out carbonic acid gas. This process of respiration or the breathing of the tree goes on both day and night, but it is far less active than assimilation, which takes place only in the light. Consequently more carbonic acid gas is taken into the tree than is given out, and the surplus carbon remains to be used in growing.

TRANSPIRATION.

The leaves give out not only the oxygen derived from the decomposition of carbonic acid gas taken from the air and carbonic acid gas produced in breathing, but also great quantities of water vapor. The amount of water taken up by the roots is very much larger than is required to be combined with carbon and the earthy constituents in the leaves. In order that fresh supplies of earthy constituents in solution may reach the leaves rapidly, the water already in them must be got out of the way. This is effected by transpiration, which is the evaporation of water from all parts of the tree above gound but principally from the leaves. Even where the bark is very thick, as on the trunks of old Oaks and Chestnuts, transpiration goes on through the lenticels in the bottoms of the deep cracks. It sometimes happens, especially in spring before the leaves come out, that transpiration can not get rid of the water from the roots as fast as it rises, and that it falls in drops from the buds, or later on even from the leaves themselves.

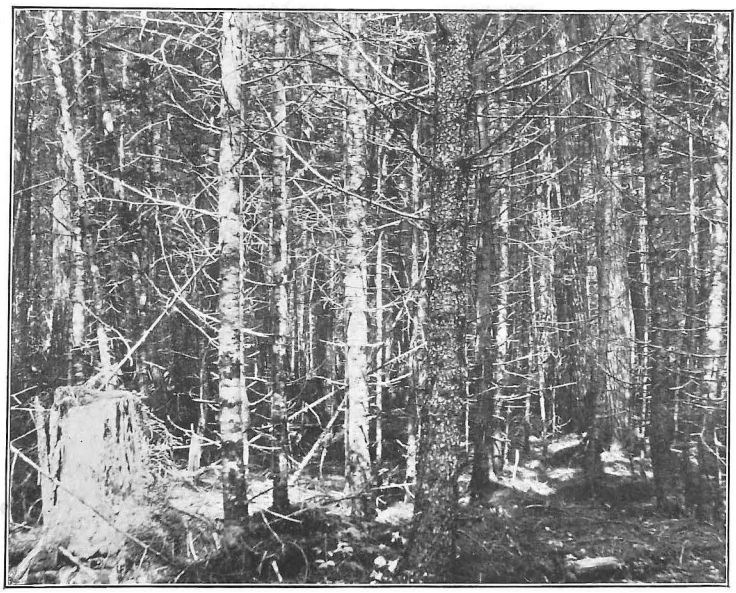
THE GROWTH OF A TREE.

The addition of new material in the way described in the preceding pages is the foundation of growth. Except in the buds, leaves, fruit, and the twigs less than a year old, this material is deposited in a thin coat over the whole tree between the wood and the bark. The new twigs grow in length by a kind of stretching, but only during the first year. Thus it is only by means of these youngest twigs that a tree increases in height and in spread of branches. After the first year their length is fixed, younger twigs stretch out from the buds, and the older ones grow henceforth only in thickness. The fresh coat of new material mentioned above covers them year by year. There are two layers in this coat, separated by a third one of tender forming tissues called the cambium, in which the actual

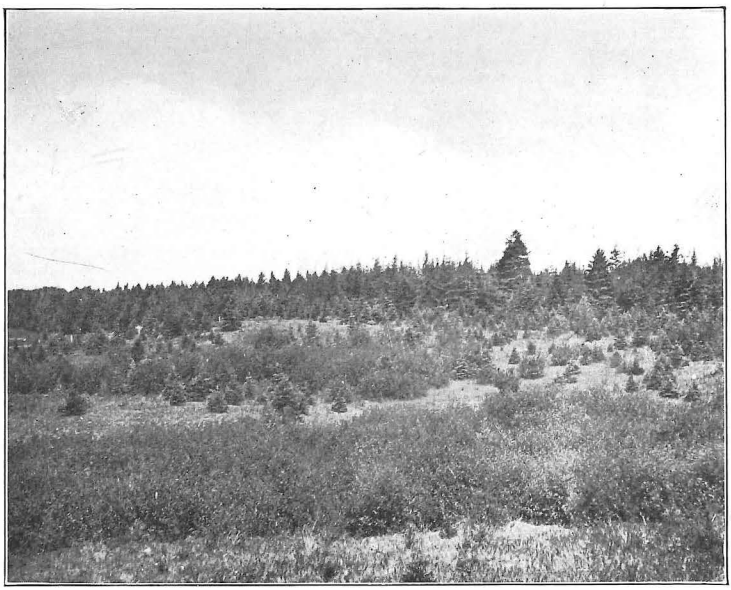
making of the new substance goes on. The inner side of the cambium layer forms new wood, the outer side new bark. Besides the true cambium, which forms both wood and bark, there is another cambium which makes the corky outer bark, and nothing else. This cork cambium may encircle the whole tree, like the true cambium, as in the Red Cedar, or it may form little separate films in the bark, but in either case it dies from time to time, and is re-formed nearer the wood.

THE STRUCTURE OF WOOD.

Wood is chiefly made up of very small tubes or cells of various kinds, which have special uses in the life of the tree. Some conduct water from the roots to the crown, some store away digested food, and others merely strengthen the structure of the wood and hold it together. The wood of cone-bearing or coniferous trees (like the Pines and Spruces) has but few kinds of cells, while that of the broadleaf trees (such as Oaks and Maples) is much less simple. But in each case some of the cells have thick walls and small openings, and others wide openings and very thin walls. In climates which have regularly one season of growth and one of rest, like our own, the cells of the layer of new wood formed each year at the inner surface of the cambium are arranged in a definite way. When growth begins in the spring, and the fresh twigs and leaves put out, there is a great demand for water in the crown to supply these moist green new parts of the tree. Water rises in most trees through the newer layers of the wood, and especially through the last ring. Consequently, at first the tree makes thin-walled cells with wide openings, through which water can rise rapidly to the ends of the branches. Later on, when the demand for water is not so great, and there is plenty of digested food to supply building material, the cells formed are narrow and thick-walled. Thus the summer wood in each year's growth is heavier, stronger, and darker in color than the spring wood. In the wood of many broadleaf trees, such as Oak and Chestnut, the spring wood is also marked by a band of open tubes of larger size called ducts. In others, such as Maple and Beech, these ducts are scattered through the whole season's growth, and in all coni-



Lowland type. Spruce, balsam fir, cedar and few hardwoods



MAINE FARMER PRESS, AUGUSTA

The encroachment of the forest on an old field, spruce, balsam fir and white pine, Washington County

fers, as for example the Pines and Cedars, they are entirely wanting. But the differences in hardness and color between the growth of spring and summer are still present. It is sometimes possible to see the line which separates the growth of two seasons in the bark, as in the case of common cork, which is the outer bark of the Cork Oak, a native of southern Europe.

If the trunk or branch of an Oak tree is cut smoothly across, thin whitish lines may be seen running from within outward. Some of these lines begin in the center of the tree, and others in each one of the annual rings. These are the medullary rays, which make the silver grain in quartered Oak and other woods. They exist in all kinds of trees, but in many, as, for example, in the Chestnut and in most conifers, they are so fine as hardly to be seen with the naked eye. Seasoning cracks which run across the rings of growth always follow the lines of these rays, while others most often follow along some annual ring.

ANNUAL RINGS.

It is correct to speak of these rings of gowth as "annual rings," for as long as the tree is growing healthily a ring is formed each year. It is true that two false rings may appear in one year, but they are generally so much thinner than the rings on each side that it is not hard to detect them. Very often they do not extend entirely around the tree, as a true ring always does if the tree is sound. Whenever the growth of a tree is interrupted and begins again during the same season, such a false ring is formed. This happens when the foliage is destroyed by caterpillars and grows again in the same season, or when a very severe drought in early summer stops growth for a time, after late frosts, and in similar cases.

HEARTWOOD AND SAPWOOD.

An annual layer once formed does not change in size or place during the healthy life of the tree, except that it is covered in time by other younger layers. A nail driven into a tree 6 feet from the ground will still be the same height after it is buried under 20 or 50 or 100 layers of annual growth.

But in most trees, like the Oaks and Pines, the wood becomes darker in color and harder after it has been in the tree for some years. The openings of its cells become choked so that the sap can no longer run through them. From living sapwood, in which growth is going on, it becomes heartwood, which is dead, because it has nothing to do with growth. It is simply a strong framework which helps to support the living parts of the tree. This is why hollow trees may flourish and bear fruit. Sapwood rots more easily than heartwood, because it takes up water readily and contains plant food, which decays very fast. Not all trees have heartwood, and in many the difference in color between it and the sapwood is very slight. Since water from the roots rises only in the sapwood, it is easy to kill trees with heartwood by girdling them, provided all the sapwood is cut through. But in those which have no heartwood the tubes of the older layers of wood can still convey water to the crown, and when such trees are girdled it is often several years before they die.

A great many theories have been proposed to account for the rise of water into the tops of tall trees, some of which, as in the big trees of California, may be over 300 feet from the ground. But none of these theories are quite satisfactory, and it must be admitted that we do not yet know how the trees supply their lofty crowns with the water which keeps

TREES IN THE FOREST.

The nature of a tree, as shown by its behavior in the forest, is called its silvicultural character. It is made up of all those qualities upon which the species as a whole, and every individual tree, depends in its struggle for existence. The regions in which a tree will live, and the places where it will flourish best; the trees it will grow with, and those which it kills or is killed by; its abundance or scarcity; its size and rate of growth —all these things are decided by the inborn qualities, or silvicultural character, of each particular kind of tree.

THE VARIOUS REQUIREMENTS OF TREES.

Different species of trees, like different races of men, have special requirements for the things upon which their life depends. Some races, like the Eskimos, live only in cold

MAINE FARMER PRESS, AUGUSTA

Poplar reproduction in foreground. Nearly mature trees in background

regions. Others, like the South Sea Islanders, must have a very warm climate to be comfortable, and are shortlived in any other. So it is with trees, except that their different needs are even more varied and distinct. Some of them, like the Willows, Birches, and Spruces of northern Canada, stand on the boundary of tree growth within the Arctic Circle. Other species grow only in tropical lands, and can not resist even the lightest frost. It is always the highest and lowest temperature, rather than the average, which decides where a tree will or will not grow. Thus the average temperature of an island where it never freezes may be only 60 degrees while another place, with an average of 70 degrees, may have occasional frosts. Trees which could not live at all in the second of these places, on account of the frost, might flourish in the lower average warmth of the first.

In this way the bearing of trees toward heat and cold has a great deal to do with their distribution over the surface of the whole earth. Their distribution within shorter distances also often depends largely upon it. In the United States, for example, the Live Oak does not grow in Maine, nor the Canoe Birch in Florida. Even the opposite sides of the same hill may be covered with two different species, because one of them resists the late and early frosts and the fierce midday heat of summer, while the other requires the coolness and moisture of the northern slope. On eastern slopes, where the sun strikes early in the day, frosts in the spring and fall are far more apt to kill the young trees, or the blossoms and twigs of older ones, than on those which face to the west and north, where growth begins later in the spring, and where rapid thawing, which does more harm than the freezing itself, is less likely to take place.

REQUIREMENTS OF TREES FOR HEAT AND MOISTURE.

Heat and moisture act together upon trees in such a way that it is sometimes hard to distinguish their effects. A dry country, or a dry slope, is apt to be hot as well, while a cool northern slope is almost always moister than one turned toward the south. Still the results of the demand of trees for water can usually be distinguished from the results of their need of warmth, and it is found that moisture has almost as

great an influence on the distribution of trees over the earth as heat itself. Indeed, within any given region it is apt to be much more conspicuous, and the smaller the region the more noticeable often is its effect, because the contrast is more striking. Thus it is frequently easy to see the difference between the trees in a swamp and those on a dry hillside near by, when it would be far less easy to distinguish the general character of the forest which includes both swamp and hillside from that of another forest at a distance. In many instances the demnad for water controls distribution altogether. For this reason the forests on the opposite sides of mountain ranges are often composed of entirely different trees. On the west slope of the Sierra Nevada of California, for example, where there is plenty of moisture, there is also one of the most beautiful of all forests. The east slope, on the contrary, has almost no trees, because its rainfall is very slight, and those which do grow there are small and stunted in comparison with the giants on the west. Again, certain trees, like the Bald Cypress and the River Birch, grow only in very moist land; others, like the Mesquite and the Pinyon or Nut Pine, only on the driest soils; while still others, like the Red Cedar and the Red Fir, seem to adapt themselves to almost any degree of moisture, and are found on very wet and very dry soils alike. In this way the different demands for moisture often separate the kinds of trees which grow in the bottom of a valley from those along its slopes, or even those in the gullies of hillsides from those on the rolling land between. A mound not more than a foot above the level of a swamp is often covered with trees entirely different from those of the wetter lower land about it.

Such matters as these have far more to do with the places in which different trees grow than the chemical composition of the soil. But its mechanical nature—that is, whether it is stiff or loose, fine or coarse in grain, deep or shallow—is very important, because it is directly connected with heat and moisture and the life of the roots in the soil.

REQUIREMENTS OF TREES FOR LIGHT.

The relations of trees to heat and moisture are thus largely responsible for their distribution upon the great divisions of the earth's surface, such as continents and mountain ranges,

as well as over the smaller rises and depressions of every region where trees grow. But while heat and moisture decide where the different kinds of trees can grow, their influence has comparatively little to do with the struggles of individuals or species against each other for the actual possession of the ground. The outcome of these struggles depends less on heat and moisture than on the possession of certain qualities, among which is the ability to bear shade. With regard to this power trees are roughly divided into two classes, often called shade-bearing and light-demanding, following the German, but better named tolerant and intolerant of shade. Tolerant trees are those which flourish under more or less heavy shade in early youth; intolerant trees are those which demand a comparatively slight cover, or even unrestricted light. Later in life all trees require much more light than at first, and usually those of both classes can live to old age only when they are altogether unshaded from above. But there is always this difference between them: the leaves of tolerant trees will bear more shade. Consequently those on the lower and inner parts of the crown are more vigorous, plentiful, and persistent than is the case with intolerant trees. Thus the crown of a tolerant tree in the forest is usually denser and longer than that of one which bears less shade. It is usually true that the seedlings of trees with dense crowns are able to flourish under cover, while those of light-crowned trees are intolerant. This rough general rule is often of use in the study of forests in a new country, or of trees whose silvicultural character is not known.

TOLERANCE AND INTOLERANCE.

The tolerance or intolerance of trees is one of their most important silvicultural characters. Frequently it is the first thing a forester seeks to learn about them, because what he can safely undertake in the woods depends so largely upon it. Thus tolerant trees will often grow vigorously under the shade of light-crowned trees above them, while if the positions were reversed the latter would speedily die. The proportion of different kinds of trees in a forest often depends on their tolerance. Thus Hemlock sometimes replaces White Pine in Pennsylvania, because it can grow beneath the Pine, and so be ready to fill the

opening whenever a Pine dies. But the Pine can not grow under the Hemlock, and can only take possession of the ground when a fire or a windfall makes an opening where it can have plenty of light. Some trees, after being overshaded, can never recover their vigor when at last they are set free. Others do recover and grow vigorously even after many years of starving under heavy shade. The Red Spruce, in the Adirondacks, has a wonderful power of this kind, and makes a fine tree after spending the first fifty or even one hundred years of its life in reaching a diameter of a couple of inches.

The relation of a tree to light changes not only with its age, but also with the place where it is growing, and with its health. An intolerant tree will stand more cover where the light is intense than in a cloudy northern region, and more if it has plenty of water than with a scanty supply. Vigorous seedlings will get along with less light than sickly ones. Seedlings of the same species will prosper under heavier shade if they have always grown under cover than if they have had plenty of light at first and have been deprived of it afterwards.

THE RATE OF GROWTH.

The rate of growth of different trees often decides which one will survive in the forest. For example, if two intolerant kinds of trees should start together on a burned area or an old field, that one which grew faster in height would overtop the other and destroy it in the end by cutting off the light. Some trees, like the Black Walnut, grow rapidly from their earliest youth. Others grow very slowly for the first few years. The stem of the Longleaf Pine, at 4 years old, is usually not more than 5 inches in length. During this time the roots have been growing instead of the stem. The period of its rapid growth in height comes later.

The place where a tree stands has a great influence on its rate of growth. Thus the trees on a hillside are often much smaller than those of equal age in the rich hollow below, and those on the upper slopes of a high mountain are commonly starved and stunted in comparison with the vigorous forest lower down. The Western Chinquapin, which reaches a height of 150 feet in the coast valleys of northern California, is a mere shrub at high elevations in the Sierra Nevada. The same thing often appears

in passing from the more temperate regions to the far north. Thus the Canoe Birch, at its northern limit, rises only a few inches above the ground, while farther south it becomes a tree sometimes 120 feet in height.

THE REPRODUCTIVE POWER OF TREES.

Another matter which is of the deepest interest to the forester is the reproductive power of his trees. Except in the case of sprouts and other growth fed by old roots, this depends first of all on the quantity of the seed which each tree bears; but so many other considerations affect the result that a tree which bears seed abundantly may not reproduce itself very well. A part of the seed is always unsound, and sometimes much the larger part, as in the case of the Tulip Tree. But even a great abundance of sound seed does not always insure good reproduction. The seeds may not find the right surroundings for successful germination, or the infant trees may perish for want of water, light, or suitable soil. Where there is a thick layer of dry leaves or needles on the ground, seedlings often perish in great numbers because their delicate rootlets can not reach the fertile soil beneath. The same thing happens when there is no humus at all and the surface is hard and dry. The weight of the seed also has a powerful influence on the character of reproduction. Trees with heavy seeds, like Oaks, Hickories, and Chestnuts, can sow them only in their own neighborhood, except when they stand on steep hillsides or on the banks of streams, or when birds and squirrels carry the nuts and acorns to a distance. Trees with light, winged seeds, like the Poplars, Birches, and Pines, have a great advantage over the others, because they can drop their seeds a long way off. The wind is the means by which this is brought about, and the adaptation of the seeds themselves is often very curious and interesting. The wing of a Pine seed, for example, is so placed that the seed whirls when it falls, in such a way that it falls very slowly. Thus the wind has time to carry it away before it can reach the ground. In heavy winds Pine and other winged seeds are blown long distances—sometimes as much as several miles. This explains how certain kinds of trees, like the Gray Birch and the White Pine, grow up in the middle of open pastures, and

how others, such as the Lodgepole Pine, cover great areas, far from the parent trees, with young growth of even age.

THE SUCCESSION OF FOREST TREES.

Such facts help to explain why, in certain places, it happens that when Pines are cut down Oaks succeed them, or when Oaks are removed Pines occupy the ground. It is very often true that young trees of one kind are already growing unnoticed beneath old trees of another, and so are ready to replace them whenever the upper story is cut away.

PURE AND MIXED FOREST.

The nature of the seed has much to do with the distribution of trees in pure or mixed forest. It is the habit of some trees to grow in bodies of some extent containing only a single kind; in other words, in pure forest. The Longleaf Pine of the South Atlantic and Gulf States is of this kind, and so is the Lodgepole Pine of the West. Conifers are more apt to grow in pure forest than broadleaf trees, because it is more common for them to have winged seeds. The greater part of the heavy-seeded trees in the United States are deciduous, and most of the deciduous trees grow in mixed forest, although there are some conspicuous exceptions. But even in mixed forests small groups of trees with heavy seeds are common, because the young trees naturally start up beneath and around the old ones. A heavy seed, dropping from the top of a tall tree, often strikes the lower branches in its fall and bounds far outside the circle of the crown. Trees which are found only, or most often, in pure forest are the social or gregarious kinds; those which grow in mixture with other trees are called scattered kinds. Most of the hardwood forests in the United States are mixed; and many mixed forests, like that in the Adirondacks, contain both broadleaf trees and conifers. The line between gregarious and scattered species is not always well marked, because it often happens that a tree may be gregarious in one place, and live with many others elsewhere. The Western Yellow Pine, which forms, on the plateau of central Arizona, perhaps the largest pure Pine forest of the earth, is frequently found growing with other species in the mountains, especially in the Sierra Nevada of central California.

Trees which occupy the ground to the exclusion of all others do so because they succeed better, under the conditions, than their competitors. It may be that they are able to get on with less water, or to grow on poorer soil, their rate of growth or power of reproduction may be greater, or there may be some other reason why they are better fitted for their surroundings. But the gregarious trees are not all alike in their ability to sustain themselves in different situations, while the differences between some of the mixed-forest species are very marked indeed. Thus Black Walnut, as a rule, grows only in rich, moist soil, and Beech only in damp situations. Fire Cherry, on the other hand, is most common on lands which have been devastated by fire, and the Rock Oak is most often found on dry barren ridges. The Tupelo of Black Gum and the Red Maple both grow best in swamps, but it is a common thing to find them also on dry stony soils at a distance from water. The knowledge of such qualities as these is of great importance in the management of forest lands.

REPRODUCTION BY SPROUTS.

Besides reproduction from seed, which plays so large a part in the struggle for the ground, reproduction by sprouts from old roots or stumps is of great importance in forestry. Trees differ very much in their power of sprouting. In nearly all conifers except the California coast Redwood, which has this ability beyond almost every other tree, it is lacking altogether. The Pitch or Jack Pine of the Eastern United States has it also to some extent, but in most places the sprouts usually die in early youth, and seldom make merchantable trees. In the broadleaf kinds, on the other hand, it is a general and very valuable quality. Young stumps, as a rule, are much more productive than old ones, although some prolific species, like the Chestnut, sprout plentifully in old age. Other species, like the Beech, furnish numerous sprouts from young stumps and very few or none at all from old ones, and still others never sprout freely even in early youth.

THE LIFE OF A FOREST.

The history of the life of a forest is a story of the help and harm which the trees receive from one another. On one side every tree is engaged in a relentless struggle against its neigh-

bors for light, water, and food, the three things trees need most. On the other side, each tree is constantly working with all its neighbors, even those which stand at some distance, to bring about the best condition of the soil and air for the growth and fighting power of every other tree.

A COMMUNITY OF TREES.

The life of a community of trees is an exceedingly interesting one. A forest tree is in many ways as much dependent upon its neighbors for safety and food as are the inhabitants of a town upon one another. The difference is that in a town each citizen has a special calling or occupation in which he works for the service of the commonwealth, while in the forest every tree contributes to the general welfare in nearly all the ways in which it is benefited by the community. A forest tree helps to protect its neighbors against the wind, which might overthrow them, and the sun, which is ready to dry up the soil about their roots or to make sun cracks in their bark by shining too hotly upon it. It enriches the earth in which they stand by the fall of its leaves and twigs, and aids in keeping the air about their crowns, and the soil about their roots, cooler in summer and warmer in winter than it would be if each tree stood alone. With the others it forms a common canopy under which the seedlings of all the members of this protective union are sheltered in early youth, and through which the beneficent influence of the forest is preserved and extended far beyond the spread of the trees themselves. But while this fruitful cooperation exists, there is also present, just as in a village or a city, a vigorous strife for the good things of life. For a tree the best of these, and often the hardest to get, are water for the roots and space and light for the crown. In all but very dry places there is water enough for all the trees, and often more than enough, as for example in the Adirondack forest. The struggle for space and light is thus more important than the struggle for water, and as it takes place above ground it is also much more easily observed and studied.

Light and space are of such importance because, as we have seen, the leaves can not assimilate or digest food except in the presence of light and air. The rate at which a tree can grow

and make new wood is decided chiefly by its ability to assimilate and digest plant food. This power depends upon the number, size, and health of the leaves, and these in turn upon the amount of space and light which the tree can secure

THE LIFE OF A FOREST CROP.

The story of the life of a forest crop is then largely an account of the competition of the trees for light and room, and, although the very strength which enables them to carry on the fight is a result of their association, still the deadly struggle, in which the victims are many times more in number than those which survive, is apt alone to absorb the attention. Yet the mutual help of the trees to each other is always going quietly on. Every tree continually comforts and assists the other trees, which are its friendly enemies.

The purpose of the present chapter is to follow the progress of a forest crop of uniform age from the seed through all the successive phases of its life until it reaches maturity, bears seed in its turn, and finally declines in fertility and strength until at last it passes away and its place is filled by a new generation. The life history which we are about to follow, as it unfolds itself through the course of several hundred years, is full of struggle and danger in youth, restful and dignified in age. The changes which pass over it are vast and full of the deepest interest, but they are very gradual. From beginning to end one stage melts insensibly into the next. Still, in order to study and describe them conveniently, each stage must have limits and a name.

THE SEVEN AGES OF A TREE.

A very practical way of naming and distinguishing trees is the following, which will be used in referring to them hereafter in this discussion. Young trees which have not yet reached a height of 3 feet are seedlings. They are called seedlings in spite of the fact that any tree, of whatever age, if it grew from a seed, is properly called a seedling tree. Trees from 3 to 10 feet in height are small saplings, and from 10 feet in height until they reach a diameter of 4 inches they are large saplings. Small poles are from 4 to 8 inches in diameter, and large poles from 8 to 12 inches in diameter. Trees from 1 to 2 feet through

are standards, and finally, all trees over 2 feet in diameter are veterans.

It is very important to remember that all these diameters are measured breast high, or at the height of a man's chest, about 4 feet 6 inches from the ground. In forestry this is, roughly speaking, the general custom.

HOW THE CROP BEGINS.

Let us imagine an abundant crop of tree seeds lying on the ground in the forest. How they came there does not interest us at present; we do not care to know whether they were carried by the wind, as often happens with the winged seeds of many trees, such as Pines and Maples, or whether the squirrels and birds dropped and planted some of them, as they frequently do acorns and chestnuts, or whether the old trees stood closely about and sowed the seed themselves. We will only suppose them to be all of one kind, and to be scattered in a place where the soil, the moisture, and the light are all just as they should be for their successful germination, and afterwards for the later stages of their lives. Even under the best conditions a considerable part of the fallen seed may never germinate, but in this case we will assume that half of it succeeds.

As each seed of our forest germinates and pushes its first slender rootlet downward into the earth, it has a very uncertain hold on life. Even for some time afterwards the danger from frost, dryness, and excessive moisture is very serious indeed, and there are many other foes by which the young seedlings may be overcome. It sometimes happens that great numbers of them perish in their earliest youth because their roots cannot reach the soil through the thick dry coating of dead leaves which covers it. But our young trees pass through the beginning of these dangers with comparatively little loss, and a plentiful crop of seedlings occupies the ground. As yet, however, each little tree stands free from those about it. As yet, too, the life of the young forest may be threatened or even destroyed by any one of the enemies already mentioned, or it may suffer just as severely if the cover of the older trees above it is too dense. In the beginning of their lives seedlings often require to be protected by the shade of their elders, but if this

protection is too long continued they suffer for want of light, and are either killed outright or live only to drag on stunted and unhealthy lives.

THE FOREST COVER ESTABLISHED.

The crop which we are following has had a suitable proportion of shade and light during its earliest years, and the seedlings have spread until their crowns begin to meet. Hitherto each little tree has had all the space in the air and soil that it needed for the expansion of its top and roots. This would have been entirely good, except that meanwhile the soil about the trees has been more or less exposed to the sun and wind, and so has become dryer and less fertile than if it had been under cover, and consequently the growth has been slow. But now that the crowns are meeting, the situation becomes wonderfully changed. The soil begins to improve rapidly, because it is protected by the cover of the meeting crowns and enriched by the leaves and twigs which fall from them.

THE BEGINNING OF THE STRUGGLE.

In so far the conditions of life are better, and in consequence the growth, and more especially the height growth, begins to show a marked increase. On the other hand, all the new strength is in immediate demand. With the added vigor which the trees are now helping each other to attain comes the most urgent need for rapid development, for the decisive struggle is at hand. The roots of the young trees contend with each other in the soil for moisture and the plant food which it contains, while in the air the crowns struggle for space and light. The latter is by far the more important battle. The victors in it overcome by greater rapidity of growth at the ends of the branches, for it is by growth there, and there only, that trees increase in height and spread of crown. Growth in this way was going on unchecked among the young trees before the crowns met, but now only the upward-growing branches can develop freely. The leaves at the ends of the side branches have now less room and, above all less light, for they are crowded and thrust aside by those of the other trees. Very often they are bruised by thrashing against their neighbors

when the wind blows, or even broken off while still in the bud. Leaves exposed to such dangers are unhealthy. They transpire less than the healthy, undisturbed leaves of the upper part of the crown, and more and more of the undigested food from the roots goes to the stronger leaves at the top as the assimilating power of the side leaves dwindles with the loss of light. The young branches share the fortunes of their leaves and are vigorous or sickly according to the condition of the latter. For this reason the growth of the tops increases, while that of the lower lateral branches, as the tops cover them with a deeper and deeper shade, becomes less and less. Gradually it ceases altogether, and the branches perish. This process is called natural pruning, and from the time when it begins the existence of the young forest, unless it should be overtaken by fire or some other great calamity, is practically secure.

GROWTH IN HEIGHT.

At this time, as we have seen, the crowns of all the young trees are growing faster at the tops than at the sides, for there is unlimited room above. But some are growing faster than others, either because their roots are more developed or in better soil than those of the trees about them, because they have been freer from the attacks of insects and other enemies, or for some similar reasons. Some trees have an inborn tendency to grow faster than others of the same species in the same surroundings, just as one son in a family is often taller than the brothers with whom he was brought up.

Rapid growth in height, from whatever cause it proceeds, brings not only additional light and air to the tree which excels in it, but also the chance to spread laterally, and so to complete the defeat of its slower rivals by overtopping them.

THE STRUGGLE CONTINUED.

Those trees which have gained this advantage over their neighbors are called dominant trees, while the surviving laggards in the race are said to be overtopped when they are hopelessly behind, and retarded when less badly beaten. Enormous numbers of seedlings and small saplings are suppressed and killed during the early youth of the forest. In the young crop

which we are following many thousands perish upon every acre. Even the dominant trees, which are temporarily free when they rise above their neighbors, speedily come into conflict with each other as they spread, and in the end the greater portion is overcome. It is a very deadly struggle, but year by year the differences between the trees become less marked. Each separate individual clings to life with greater tenacity, the strife is more protracted and severe, and the number of trees which perish grows rapidly smaller. But so great is the pressure when dense groups of young trees are evenly matched in size and rate of growth that it is not very unusual to find the progress of the young forest in its early stages almost stopped, and the trees uniformly sickly and undersized, on account of the crowding.

The forest we have been following has now passed through the small-sapling stage, and is composed chiefly, but not exclusively, of large saplings. Among the overtopped and retarded trees, which often remain in size classes which the dominant trees have long since outgrown, there are still many low saplings. Even between the dominant trees, in a healthy forest, there are always great differences. Increase in height is now going on rapidly among these high saplings, and either in this stage or the next a point is reached when the topmost branches make their longest yearly growth, which is one way of saying that the trees make their most rapid height growth as large saplings or small poles. Later on, as we shall see, these upper branches lengthen much more slowly, until, in standards and veterans, the growth in height gradually diminishes, and in very old trees finally ceases altogether.

NATURAL PRUNING.

While the trees are pushing up most rapidly the side branches are most quickly overshaded, and the process of natural pruning goes on with the greatest vigor. Natural pruning is the reason why old trees in a dense forest have only a small crown high in the air, and why their tall, straight trunks are clear of branches to such a height above the ground. The trunks of trees grown in the open, where even the lower limbs have abundance of light, are branched either quite to the ground or to within a short distance of it. But in the forest not only are the lower side branches continually dying for want of light, but the tree rids

itself of them after they are dead and so frees its trunk from them entirely. When a branch dies the annual layer of new wood is no longer deposited upon it. Consequently the dead branch, where it is inserted in the tree, makes a little hole in the first coat of living tissue formed over the live wood after its death. The edges of this hole make a sort of collar about the base of the dead branch, and as a new layer is added each year they press it more and more tightly. So strong does this compression of the living wood become that at last what remains of the dead tissue has so little strength that the branch is broken off by an ice storm or by the wind, or even falls of its own weight. Then in a short time, if all goes well, the hole closes, and after a while little or no exterior trace of it remains. Knots, such as those which are found in boards, are the marks left in the trunk by branches which have disappeared.

THE CULMINATION OF GROWTH.

While the young trees are making clean trunks so rapidly during the period of greatest yearly height growth they are also making their greatest annual gains in diameter, for these two forms of growth generally culminate about the same time. A little later, if there is any difference, the young forest's highest yearly rate of growth in volume is also reached. For a time these three kinds of growth keep on at the same rate as in the past, but afterwards all three begin to decrease. Growth in diameter, and in volume also, if the trees are sound, goes on until extreme old age, but height growth sinks very low while the two others are still strong. For many years before this happens the struggle between the trees has not been so deadly, because they have been almost without the means of overtopping one another. When the end of the period of principal height growth is reached the trees are interfering with each other very little, and the struggle for life begins again in a different way. As the principal height growth ceases, and the tops no longer shoot up rapidly above the side branches, the crowns lose their pointed shape and become comparatively flat. The chief reason why trees stop growing in height is that they are not able to keep the upper parts of their crowns properly supplied with water above a certain distance from the ground. This distance varies in different kinds of trees, and with the health and vigor

of the tree in each species, but there is a limit in every case above which the water does not reach. The power of the pumping machinery, more than any other quality, determines the height of the tree.

THE END OF THE STRUGGLE.

Now that the tree can no longer expand at the top, it must either suffer a great loss in the number of its leaves or be able to spread at the sides; for it is clear that not nearly so many leaves can be exposed to the light in the flattened crown as in the pointed one, just as a pointed roof has more surface than a flat one. It is just at this time, too, that the trees begin to bear seed most abundantly, and it is of the greatest importance to each tree that its digestive apparatus in the leaves should be able to furnish a large supply of digested food. Consequently the struggle for space is fiercely renewed, only now the trees no longer attempt to overtop one another, having lost the power, but to crowd one another away at the sides. The whole forest might suffer severely at this point from a deadlock such as sometimes happens in early youth were it not for the fact that the trees, as they grow older, become more and more sensitive to any shade. Many species which stand crowding fairly well in youth can not thrive in age unless their crowns are completely free on every side. Each of the victors in this last phase of the struggle is the survivor of hundreds (or sometimes even of thousands) of seedlings. Among very numerous competitors they have shown themselves to be the best adapted to their surroundings.

Natural selection has made it clear that these are the best trees for the place. These are also the trees which bear the seed whence the younger generations spring. Their offspring will inherit their fitness to a greater or less degree, and in their turn will be subjected to the same rigorous test, by which only the best are allowed to reach maturity. Under this sifting out of the weak and the unfit, our native trees have been prepared, through thousands of generations, to meet the conditions under which they must live. This is why they are so much more apt to succeed than species from abroad, which have not been fitted for our climate and soil by natural selection.

The forest which we saw first in the seed has now passed through all the more vigorous and active stages of its life. The

trees have become standards and veterans, and large enough to be valuable for lumber. Rapid growth in height has long been at an end, diameter growth is slow, and the forest as a whole is increasing very little in volume as time goes on. The trees are ripe for the harvest.

Out of the many things which might happen to our mature forest we will only consider three.

DEATH FROM WEAKNESS AND DECAY.

In the first place, we will suppose that it stands untouched until, like the trees of the virgin forest, it meets its death from weakness and decay.

The trees of the mature primeval forest live on, if no accidents intervene, almost at peace among themselves. At length all conflict between them ends. The whole power of each tree is strained in a new struggle against death, until at last it fails. One by one the old trees disappear. But long before they go, the forerunners of a new generation have sprung up wherever light came in between their isolated crowns. As the old trees fall, with intervals, often of many years, between their deaths, young growth of various ages rises to take their place, and when the last of the old forest has vanished there may be differences of a hundred years among the young trees which succeed it. An even-aged crop of considerable extent, such as we have been considering, is not usual in the virgin forest, where trees of very different ages grow side by side, and when it does occur, the next generation is far less uniform. The forest whose history has just been sketched was chosen, not because it represents the most common type of natural forest, but because it illustrates better than any other the life and progress of forest growth.

The wood of a tree which dies in the forest is almost wholly wasted. For a time the rotting trunk may serve to retain moisture, but there is little use for the carbon, oxygen, and hydrogen which make up its greater part. The mineral constituents alone form a useful fertilizer, but most often there is already an abundance of similar material in the soil. Not only is the old tree lost, but ever since its maturity it has done little more than intercept, to no good purpose, the light which would otherwise have given vitality to a valuable crop of younger trees. It is only when the ripe wood is harvested properly and in time that the forest attains its highest usefulness.

DESTRUCTIVE LUMBERING.

A second thing which may happen to a forest is to be cut down without care for the future. The yield of a forest lumbered in the usual way is more or less thoroughly harvested, it is true, but at an enormous cost to the forest. Ordinary lumbering injures or destroys the young growth, both in the present and for the future, provokes and feeds fires, and does harm of many other kinds. In many cases its result is to annihilate the productive capacity of forest land for tens or scores of years to come.

CONSERVATIVE LUMBERING.

The methods of forestry, on the other hand, maintain and increase both the productiveness and the capital value of forest land; harvest the yield far more completely than ordinary lumbering, although less rapidly; prepare for, encourage, and preserve the young growth; tend to keep out fires; and in general draw from the forest, while protecting it, the best return which it is capable of giving.

The application of these methods is the third possibility for the crop just described. There are still many places in the United States where transportation is so costly that, as yet, forestry will not pay from a business point of view. Elsewhere right forest management is the wisest, safest, and most satisfactory way of dealing with the forest.

THE PRACTICE OF FORESTRY.

Next to the earth itself the forest is the most useful servant of man. Not only does it sustain and regulate the streams, moderate the winds, and beautify the land, but it also supplies wood, the most widely used of all materials. Its uses are numberless, and the demands which are made upon it by mankind are numberless also. It is essential to the well-being of mankind that these demands should be met. They must be met steadily, fully, and at the right time if the forest is to give its best service. The object of practical forestry is precisely to make the forest render its best service to man in such a way as to increase rather than to diminish its usefulness in the future. Forest management and conservative lumbering are other names for

practical forestry. Under whatever name it may be known, practical forestry means both the use and the preservation of the forest.

THE USES OF THE FOREST.

A forest, large or small, may render its service in many ways. It may reach its highest usefulness by standing as a safeguard against floods, winds, snow slides, moving sands, or especially against the dearth of water in the streams. A forest used in this way is called a protection forest, and is usually found in the mountains, or on bleak, open plains, or by the sea. Forests which protect the headwaters of streams used for irrigation, and many of the larger windbreaks of the Western plains, are protection forests. The Adirondack and Catskill woodlands were regarded as protection forests by the people of the State of New York when they forbade, in the constitution of 1895, the felling, destruction, or removal of any trees from the State Forest Preserve.

A farmer living directly on the produce of his land would find his woodlot most useful to him when it supplied the largest amount of wood for his peculiar needs, or the best grazing for his cattle. A railroad holding land which it did not wish to sell would perhaps find it most useful when it produced the greatest number of ties and bridge timbers. In both cases the forest would render its best service by producing the greatest quantity of valuable material. This is the central idea upon which the national forests of France are managed.

The greatest return in money may be the service most desired of the forest. If a farmer wished to sell the product of his woodlot instead of consuming it himself, his woodland would be useful to him just in proportion to its net yield in money. This is true also in the case of any owner of a forest who wishes to dispose of its product, but who can not, or will not, sell the forest itself. State forests, like those in the Adirondacks, often render their best service, in addition to their usefulness as protection forests, by producing the greatest net money return.

Regarded as an investment of capital, a forest is most useful when it yields the highest rate of interest. A forest whose owner could sell it if he chose, but prefers to hold it as productive capital, is useful in proportion to the interest it yields on

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Nearly pure stand of poplar. Trees 4-6 inches in diameter

the money invested in it. Thus, an acre of sprout land may be worth only $5, while the investment in adjoining land stocked with old trees may be $50 an acre. This is the view which controls the management of State forests in Germany. Lumbermen also regard timberland as an investment, but usually they take no care except for the yield at the moment. They disregard the future yield altogether, and in consequence the forest loses its capital value, or may even be totally destroyed. Well managed forests, on the other hand, are made to yield their service always without endangering the future yield, and usually to its great advantage. Like the plant of a successful manufacturer, a forest should increase in productiveness and value year by year.

Under various circumstances, then, a forest may yield its best return in protection, in wood, grass, or other forest products, in money, or in interest on the capital it represents. But whichever of these ways of using the forest may be chosen in any given case, the fundamental idea in forestry is that of perpetuation by wise use; that is, of making the forest yield the best service possible at the present in such a way that its usefulness in the future will not be diminished, but rather increased.

FOUR REQUIREMENTS FOR THE BEST SERVICE.

A forest well managed under the methods of practical forestry will yield a return in one of the ways just mentioned. There are, however, four things a forest must have before it can be in condition to render the best service.

The first of these is protection, especially against fire, overgrazing, and thieves, for without such protection no investment is secure and the most skillful management is of little effect.

The second is strong and abundant reproduction. A forest without young growth is like a family without children. It will speedily die out.

The third requirement is a regular supply of trees ripe for the ax. This can be secured only by the right proportion of each of the smaller sizes constantly coming on in the growing forest. Thus, a farmer in need of fuel might be much inconvenienced to find no trees on his woodlot big enough for cordwood, and it would not help him to know that twenty years later he would

have an oversupply. In the same way a larger forest may yield only a very irregular and unsatisfactory product if at one time there are too many ripe trees and at another too few. For example, if 100 acres become fit to cut this year, and 200 next year, and after that none at all until 500 acres become ripe fifteen years later, it is easy to see that the yield would come at very irregular and perhaps very inconvenient times. But a forest of 10,000 acres, composed of 100 even-aged groups of trees of every age from 1 to 100 years, each group 100 acres in extent would plainly be able to furnish every year 100 acres of 100-year-old trees ready for the ax. In such a forest the right proportion of young trees would always be coming on.

The fourth requirement is growing space enough for every tree, so that the forest as a whole may not only produce wood as fast as possible, but the most valuable sort of wood as well. If the trees stand too far apart, their trunks will be short and thickly covered with branches, the lumber cut from them will be full of knots, and its value will be small. If, on the other hand, the trees stand too closely together, although their trunks will be tall and clear of branches, they will be small in diameter, and for that reason low in value. With the right amount of growing space, trees grow both tall and of good diameter, and their trunks supply lumber of higher price because it is wide and clear.

THE YIELD OF A FOREST.

One of the central ideas of forestry is that the amount of wood taken from any healthy forest and the amount grown by it should be as nearly equal as possible. If more grows than is cut, then the forest will be filled with overmature, decaying trees; but if more wood is cut than is grown, then the supply of ripe trees will be exhausted, and the value of the forest will decline. To make the cut equal to the growth does not mean that the volume of wood grown each year on every acre should be cut from that acre, but that the total growth of all the acres, for one or for a number of years, should be cut from the forest in the corresponding period. Thus, if the growth or increase is 100 cords a year, that amount might be harvested yearly by cutting every tree on a small area, by cutting fewer trees per acre on a larger area, by distributing the cut every year over the

whole surface of the forest, or by cutting 1,000 cords in any one of these ways once in ten years.

There are many different methods of finding what is the annual increase of wood in a forest. One of the simplest is to count the number of trees upon an acre and select an average tree, then to cut it down, measure its cubic contents, and find its age by counting the annual rings. That done, the yearly increase of the average tree may be found by dividing its cubic contents by the years of its age. Finally, since we have found the yearly increase per tree and the number of trees per acre, it is easy to find the average yearly increase per acre. It is unfortunate that this simple and easy process is not always reliable, because it is hard to find either an average acre or an average tree.

The yield of a forest is the amount of wood that is taken from it in a given time. When a forest is put under conservative management, one of the most important steps is to decide how much timber can safely be taken from it; in other words, to determine the yield. There are three principal ways of doing so.

The first, and the least used, is to fix the yield at a certain number of mature trees. By this plan the yield of a certain forest might be 100 pines, 260 spruces, and 180 hemlocks, each of a given diameter, every year.

The second way is to fix the yield at a certain amount or volume of wood. Thus, the yield of a large forest might be fixed at 25,000,000 feet board measure every ten years, and that of another smaller one at 750 cords every year.

The third way is to settle upon a certain number of acres to be cut over yearly or once in a given number of years. By this method the yield of a forest of 600 acres might be fixed at 6 acres of mature timber a year, and that of another at 300 acres every twenty-five years. The time between two successive cuttings on the same area must be long enough to allow the young trees left standing to mature. That time is found by studying the rate of growth in diameter.

This method of determining the yield by area is much the most practicable of the three for the forests of the United States, and in general it is the simplest and most widely useful of all, because it does away with the difficult task of determining the yearly increase in wood.

The objects in handling forests are so various that sometimes no single one of these methods is satisfactory, and then combinations of them are of great use. Thus, by combining the method by volume and the method by area the annual yield of a forest might be established at 250 board feet per acre. This yield might be cut from the forest every year, or it might be allowed to accumulate for twenty years, and then 5,000 board feet per acre might be cut.

SILVICULTURAL SYSTEMS.

After the yield has been found it must be cut not only without injury to the future value of the forest, but in such a way as to increase its safety and usefulness. To this end certain ways of handling forests, called silvicultural systems, have grown up. They are based on the nature of the forest itself, and are chiefly imitations of what men have seen happen in the forest without their help.

From the point of view of forest management, one of the principal differences between trees is whether they spring directly from seed or are produced as sprouts from stumps or roots already in the ground. A forest composed of seedling trees is called a Seed Forest, or more commonly but less suitably, a Seedling or High Forest. One composed of sprouts is spoken of as a Sprout or Coppice Forest, or, more often, simply as Coppice, or as Sprout land. Seed Forests are usually composed of coniferous trees, which rarely sprout, or of broadleaf trees allowed to reach large size. Sprout Forests are common wherever broadleaf trees are cut while they are still young, for the sprouting power usually diminishes with age. Sprouts never reach so great a height and diameter as seedling trees, although in youth they grow much faster; and they are apt to be unsound, because the old stumps decay and infect the sprouts which spring from them.

SIMPLE COPPICE.

It often happens, as in Pennsylvania or New Jersey, that a fire sweeps over the second-growth hardwood lands and kills all the young trees down to the ground; but the roots remain alive, and from them spring young sprouts about the bases of the burned trunks. After several years a second fire may follow

and kill back the sprouts again, and other fires may continue at intervals to burn over the land, each followed by a new crop of sprouts. When a farmer does with the ax what is often done by fire he is using the system of Simple Coppice. Let us suppose a farmer has a woodlot covered principally with chestnut sprouts which he wants to manage for the steady production of railroad ties. He knows that chestnut sprouts are usually large enough for ties at the age of 35 years. In order to insure a steady yield of trees fit for ties, he divides the whole woodlot into thirty-five parts of equal productive capacity, and cuts one part clean every year. All the new sprouts that spring up on the part cut in any year are of the same age. At the end of thirty-five years, when the whole woodlot has been cut over, the thirty-five parts form a series of even-aged groups of sprouts from 1 to 35 years old. Every year the sprouts on one part reach the age of 35 years and are ready for cutting.

Simple Coppice is a very useful silvicultural system, and the easiest of all to apply. The chief requirements for its success are good reproduction from the stumps, proper thinning (where thinning can be made to pay), and enough young seedlings among the sprouts to replace exhausted stumps with vigorous young ones. Stumps from which the sprouts have been cut many times finally grow weak and lose their power of sprouting.

In cutting sprouts it is important not to loosen the bark on the stumps, for that impairs their sprouting power, and to make the cut as near the ground as possible. Stumps cut level with the surface sprout best of all. In Simple Coppice, well handled, the reproduction takes place of itself without the need of further attention from the forester.

Many thousands of acres of American woodland, especially in New England, New York, Pennsylvania, and New Jersey, and in other places where chestnut is the principal tree, are treated under a rough system of Simple Coppice.

STORED COPPICE.

Among the trees which will produce only fuel, fence posts, or railroad ties there often stand in a woodlot others which would yield much larger returns if they were allowed to reach a greater age and size than the trees about them. If there were some white oaks scattered through the chestnut coppice just described,

it might be well to let them grow large enough for the production of high-priced material like quartered oak lumber. In that case it would be necessary at the time of cutting the sprouts to select and leave standing a certain number of white oaks on every acre. As many of them as survived the increased exposure to wind and sun following the sudden removal of their neighbors would remain as standards over the young sprouts. The white oak standards thus chosen would remain uncut during two, three, four, or sometimes even five successive crops of sprouts, and would form stout trunks with little taper, clear of branches almost to the full height reached by the sprouts.

This is the silvicultural system called Stored Coppice, or sometimes Coppice under Standards. The successful management of a forest under it depends largely upon the choice of the standards. They should be seedlings, for seedlings make the best trees, or the most vigorous and healthy sprouts if seedlings can not be found, and they should be distributed as regularly as possible over the ground. The standards should be numerous enough at first to allow for heavy loss from wind and shock when the sprouts are cut away, but they should never be allowed to suppress the lower story of growth.

Stored Coppice is a very useful system where the principal demand is for small material, like fuel, ties, and fencing, but where some large timber also is required. It was developed chiefly by the French, who use it with admirable results.

SEED OR HIGH FOREST.

By far the most useful and important forests are, as a rule, those which spring directly from seed, such as the pine forests of the Southern States, and the great hardwood forests of the Mississippi Valley. Such forests are called Seed Forests. The Seed Forest systems are of many kinds, some of which are peculiarly adapted for the management of certain forests in the United States. Just as the Sprout Forest systems are chiefly useful to produce fuel, posts, ties, and trees of small size, so the Seed Forest systems are producers of sawlogs and large timbers.

REGULAR SEED FOREST.

When a tract of woodland is destroyed by fire in one of the Rocky Mountain States, it often happens that the seeds of the lodgepole pine are scattered over it by the wind in prodigious numbers. The seeds germinate abundantly, seedlings spring up, and in a very few years a young even-aged forest of lodgepole pine covers the ground. As it grows older fires destroy patches of it here and there, and in time every patch is covered again with a younger generation of even age. After many years the forest which sprang up after the first fire has become broken into a number of even-aged patches without uniformity in size or regular gradations in age.

Now let us suppose that this land was taken in hand by the Government when the lodgepole pine first came in, and that the lodgepole reaches its maturity at 80 years. If the Government forest officers had divided such a forest into eighty parts, and then had cut the timber from one part each year, after a time they would have had eighty divisions, each covered with even-aged forest, but differing in age among themselves from 1 to 80 years. Every year one part would reach the age of 80 years and would be cut, and evidently the other seventy-nine parts would always be stocked with trees from 1 to 79 years old.

When the trees on one of the eighty divisions just mentioned become ripe for the ax, provision must be made for a new crop. This would be a very simple matter if the forest on that division could be reproduced naturally in one year, but that is practically impossible. Such rapid reproduction can be got only by planting, which is chiefly useful in the United States for making new forests and restoring injured forests, not for renewing old ones. Reproduction from the seed of the old trees is the only kind we need consider here. In order to bring it about a few ripe trees are first cut down, to prepare a seedbed by giving light to the soil, and to fit the seed trees to bear more abundantly by giving the crowns more room. Then, when a good crop of seed is likely to appear, a few more trees are removed to give the future seedlings light enough for healthy growth, but not enough to expose them to danger from frost, drought, or the choking of grass and weeds, for young trees just starting in life are very sensitive and easily destroyed. Finally, as the young

trees grow taller and stronger, what remains of the old crop is gradually cut away. When it is all gone, usually from ten to twenty years have passed since the reproduction cuttings were begun.

This is the system of Regular Seed Forest. It is difficult to apply, and unsafe except in experienced hands. It has often been necessary to plant large areas at great expense because reproduction cuttings in Regular Seed Forest have failed. The transportation of the timber is frequently expensive, because it must be spread over a number of years. On the other hand, when it is well applied this system produces the highest type of forest, full of tall straight trunks clear of branches, and consequently yields a high grade of timber and a large return in money.

TWO-STORIED SEED FOREST.

After a forest fire in Maine it frequently happens that the first tree to cover the ground is the popple, or quaking aspen. It is a slender, short-lived tree, intolerant of shade, with a light crown. After the popple has grown for some years, spruce seedlings spring up under the friendly cover, and rapidly follow the popple in height. There grows up in this way a forest composed of an upper and a lower story of growth, in which, as so often happens, the lower story is of more importance.

The system of Two-Storied Seed Forest is useful when a tolerant tree like the spruce is to be grown under the shade of an intolerant tree like the aspen. In countries where forestry is well developed it is usual to plant young trees of tolerant species under older intolerant trees, to make a cover for the soil and to prevent the growth of grass and weeds. Forests which closely resemble two-storied seed forests are common in the United States, but usually as the result of fire or careless cutting. Such are, for example, the forests of pine over oak in the Southeastern United States, and of birch, beech, and maple under white pine in Michigan, Wisconsin, and Minnesota. It often happens, as in the case of the spruce and aspen, that both stories can not live on in good health together, and that the upper one must die or be cut away if the lower is to prosper.

SELECTION FOREST.

When a stand of aspen dies away from a young crop of spruce, the ground is no longer completely shaded, and there is light and room for other kinds of trees to come in. Thus, birch and maple seeds may be blown in by the wind and beechnuts carried and planted by squirrels, and eventually the pure stand of spruce is changed into a mixed forest of various ages. As the trees grow older, some of the spruce may be destroyed by beetles or thrown by the wind, and some of the broadleaf trees may die from fungous disease. Into the openings made by the death of older members of the forest fall the seeds from which younger members spring. So little by little the forest loses its even-aged character and there comes into existence what is called a Natural or Selection Forest, in which trees of all ages are everywhere closely mixed together. Most virgin forests are selection forests.

The silvicultural system called Pure Selection is applied to forests of this kind. It is used chiefly for protection forests in places where it is desirable to keep the cover always unbroken; elsewhere it is out of place. Under this system the annual increase of the forest must be found before the yield can be determined. Then the fully mature trees are cut in every part of the forest every year. The cost of logging is high, for where single trees are taken here and there, roads or other means of transport must be very numerous and costly in proportion to the amount of the cut.

LOCALIZED SELECTION.

Logging under the system just mentioned is so expensive as to prevent its application in the United States, except for woods like cherry and black walnut, which have a special and unusual value. But if, instead of taking the yield from every part of a selection forest, a comparatively small area is cut over each year, the cost of logging may be very greatly reduced. Such a method is admirably adapted to certain forest regions in the United States, as, for example, to the Adirondack Mountains of New York, where the forest is composed about equally of coniferous and broadleaf trees. The conifers are the more valuable, and among them the principal lumber tree is the spruce.

The Bureau of Forestry has found by many careful measurements that if all spruce trees 12 inches and over in diameter are cut from certain portions of the Adirondack forest, the younger spruce will grow up and replace the original stand of timber in about twenty years. But this will not happen unless the rules for cutting are faithfully observed, nor will it happen more than once unless enough old trees are left standing for seed. Such a forest may then be divided into twenty parts, and the merchantable timber about 12 inches in diameter may safely be cut from one division every year. By the time the last of the twenty divisions has been cut over, the first will have upon it a stand of mature spruce equal in quantity to that of twenty years before. The yield of the whole forest in spruce for a single year may be cut each year from one-twentieth of the whole area. If all the divisions were cut over five times in the life of a mature tree, then one-fifth of the standing timber would be taken from each division at each cutting. Thus, if it took one hundred years for a tree to become ripe for the ax, the cutting (at intervals of twenty years) would return five times during the life of the tree, at its twentieth, fortieth, sixtieth, eightieth, and one hundredth years.

This is the system of Localized Selection. It is simple and easy to apply, and even if mistakes occur they are not apt to have dangerous consequences. It is very elastic and has many forms, and it is well adapted to many different kinds of forest. Logging is cheap, because the area cut over in any one year is small, and the reproduction is provided for by natural seeding in the openings of the forest.

THE GROUP SYSTEM.

It often happens that all the trees of a small group in the forest are killed by fire or insects at about the same time. In the opening thus made the ground is quickly covered with young growth, which extends back under the old trees as far as the light will permit. The seedlings are usually tallest, strongest, and most numerous directly under the middle of the opening, and gradually decrease at the sides. If the wind should throw some trees at the edges of such an opening, the young growth would gradually extend, and if the same thing should continue to happen, in the end all the old trees would

have disappeared and their places would have been taken by young growth. The Group System is an imitation of this process.

Under the Group System openings are made here and there in the forest by cutting away ripe trees. As the reproduction proceeds, the old trees about the openings are gradually cut away, and the groups of young growth, spreading from the original openings like drops of oil on water, finally meet.

This is one of the simplest and most useful of all the systems, and when the openings are made small at first no other is so safe. It is especially adapted to small pieces of forest, such as woodlots, because it is simple, and because it assures the safety of the forest even with very little skill or care on the part of the owner.

THE STRIP SYSTEM.

In nearly every wooded region of the United States a tornado occasionally destroys the trees in a long and narow belt through the forest. Fire often follows and clears the strip by burning up the fallen timber. Seeds then fall in the opening, carried from the trees on either side, the seeds germinate and grow, and the reproduction of the forest takes place.

When the ax takes the place of the tornado and the timber is logged instead of being burned, the Strip System is applied. Reproduction follows from trees on either side, as before. The Strip System consists in cutting long narrow openings in the mature timber instead of the circular openings of the Group System, to which it is similar in many ways. It is simple and effective when natural reproduction is good, and well suited for extensive operations in places where careful work is impossible. The strips are usually not over 100 yards in width. Where the soil is dry, they are run east and west to protect the young growth against the sun, and are comparatively narrow. If there is serious danger of windfall, they lie at right angles to the direction of the wind.

These are the more important of the silvicultural systems. They have many modifications, and indeed each forest may require a special form of its own, which must be devised or adapted for it by the forester. But whatever the form, the object is always to use the forest and provide for its future at the same time.

IMPROVEMENT CUTTINGS.

Very many forests in the United States, and especially many woodlots, are in poor condition and unfit for the immediate application of any silvicultural system. They need to be put in order, and for that purpose Improvement Cuttings are usually required. In the end these cuttings should remove all trees which the forest is better without, but they should be made gradually, so as not to open the cover too much and expose the soil to the wind and the sun. In general, it is unwise to cut more than 25 per cent of the poles and older trees in a dense mature forest, or to cut oftener on the same ground than once in five years. Improvement Cuttings of course should never fall on trees which are to form the future crop, but they should remove spreading older trees over promising young growth; poor trees which are crowding more valuable ones; unsound trees whose places will be taken by others of greater value, or which are themselves becoming less valuable from year to year; and seed trees of undesirable species likely to reproduce themselves, if reproduction of more useful kinds is well assured. The great majority of woodlots need such cutting, and when they do, whatever wood is taken from them should be cut in this way.

WORK IN THE WOODS.

The products of the forest are among the things which civilized men can not do without. Wood is needed for building, for fuel, for paper pulp, and for unnumbered other uses, and trees must be cut down to supply it. It would be both useless and mistaken to try to stop the cutting of timber, for it could not cease without great injury, not to the lumbermen only, but to all the people of the nation. The question is not of saving the trees, for every tree must inevitably die, but of saving the forest by conservative ways of cutting the trees. If the forest is to be preserved, the timber crop now ripe must be gathered in such a way as to make sure of other crops hereafter.

In general, it is true that the present methods of lumbering are unnecessarily destructive and wasteful. This is not because lumbermen are more greedy of gain or less careful of public interests than other business men, for they are not. It happens partly because in this country, compared with France and

Germany and other densely populated regions, there is so much timber in proportion to the population that it does not pay the lumberman to take anything more than the better parts of the trees he fells. The lumberman can not do his work unless he does it at a profit, and he must do it, for lumber is indispensable. Consequently, although much of the waste in lumbering is not only unnecessary, but actually costly to the lumberman, for the present it is impossible to avoid waste altogether. It will be easier to do so when the methods and advantages of conservative lumbering, which is forestry, are better known to the American lumbermen, and are therefore in more general use. Although rough conservative methods have often been practiced in the past, the success of the lumbermen who made the trial was generally but partial, because their knowledge of the forest was partial also. They were often deceived by underestimates of the capacity for tree growth of the lands they were handling, because accurate measurements were wanting, and they seldom made full use of the reproductive power of the forest. More recent attempts, based on better knowledge, have been successful in almost every case.

Lumbermen in America are second to none in skill and ingenuity, in the perfection of their tools, and in the effectiveness of the methods they have devised. The nations of Europe, although they have given far more attention to forestry than we, are very much behind the United States in these respects. So it is not surprising that Americans have been slow to change their methods, especially when methods and lumbermen alike have often been attacked as wrongly and intemperately as the foreign methods have been praised and recommended. German methods would be as much out of place in America as American methods in Germany. What American foresters should do and are doing is to combine the general principles of forestry, which are true all the world over, with American methods of lumbering. The product will be a system of forestry especially adapted to the United States. The foundations of such a system are already laid.

CONSERVATIVE LUMBERING.

Something was said in the last chapter about the systematic methods of conservative lumbering. With the gradual understanding and application of these methods by American lumber-

men, already well begun, and with the work in the woods rightly carried out, there is but one reason why the great majority of the forests now standing in the United States should not in the end be lumbered steadily and systematically, or why they should fail to yield a steadily increasing return. That reason is the rapid destruction of the forests themselves. There is grave danger that the best of our forests will all be gone before their protection and perpetuation by wise use can be begun. The spread of a working knowledge of practical forestry is likly to be too slow.

CONSERVATIVE LUMBERING AND ORDINARY LUMBERING.

Conservative lumbering is distinguished from ordinary lumbering in three ways:

First. The forest is treated as a working capital whose purpose is to produce successive crops.

Second. With that purpose in view, a working plan is prepared and followed in harvesting the forest crop.

Third. The work in the woods is carried on in such a way as to leave the standing trees and the young growth as nearly unharmed by the lumbering as possible.

A forest working plan is intended to give all the information needed to decide upon and carry out the best business policy in handling and perpetuating a forest. It gives this information in the form of a written statement, which covers some or all of the following topics. It shows the present stand and condition of the forest, and gives rules for the selection and marking of trees to cut, for making the reproduction sure, and for the protection of young and old standing trees during the logging. The working plan also predicts the future yield of the forest, basing its prediction on careful measurements which show how many standing trees of different diameters will be left per acre after the first cutting, and how fast these young trees grow. Finally, it estimates the future return in money, taking into account the taxes, interest, and other expenses on one side, and the future crop on the other. In order to make this estimate entirely safe, it is usually based on the present price of stumpage, although its future value will certainly be much higher.

FELLING THE TREES.

The difference between the practical work under ordinary lumbering and under conservative lumbering is chiefly in the selection of the trees to cut, in felling them, and in the first part of their journey from the stump to the mill. Under a working plan the trees to cut are chosen in such a way that when they are gone the forest will suffer but little from their absence, because their places will be taken by others as quickly as possible. Usually the trees selected are first stamped with a marking hatchet to prevent mistakes, and then the next step is to cut them down.

The amount of harm done to the forest by the cutting depends considerably upon the season of the year when the work in the woods is carried on. Less damage results to the young growth and the trees left standing if the lumbering is done after the growing season is over than if it goes on in the spring and summer, while the bark is loose and the leaves and twigs are tender.

A tree may be felled either with the ax or with the saw. In either case the first thing to consider is the height above the ground at which the cut is to be made. High stumps needlessly waste the best timber in a sound tree. Low stumps are slightly more difficult to cut, and therefore a little more expensive, but the additional cost is more than balanced by the gain.

The measurements made by the Bureau of Forestry have shown that the loss from cutting high stumps on a tract of 100,000 acres in the Adirondacks, yielding on an average 15 standards per acre, would be 30,000 standards, or at a stumpage value of 50 cents per standard, would be $15,000.

The second thing to consider in felling a tree is how to get it down without breaking or splitting the trunk. On rocky, uneven ground this is often a hard thing to do, but unless it can be accomplished the tree would, as a rule, better be left untouched.

Most important of all for the perpetuation of the forest, each tree must be thrown where it will not unnecessarily injure other trees or crush in its fall the young seedlings on which the future of the forest depends. It happens very commonly in ordinary lumbering that vigorous, sound young trees are split and ruined

in great numbers by old trees falling upon them, when it would be perfectly easy, and almost or quite as convenient, to throw the latter where they would do little or no harm.

Finally, it must cost as little as possible to fell each tree, for to be successful conservative lumbering must pay.

SWAMPING AND SAWING.

When the trees are down, their lower branches are chopped off and the trunks are sawed into logs. In falling, a tree is very apt to bend and hold down beneath its trunk and branches many younger trees, which will spring up straight again if they are quickly released, but which otherwise will be killed or permanently hurt. Therefore it is very important to work up both the trunk and the top of each tree as soon as it is cut down, and so prevent it from destroying the young trees which should take its place. Except when they are to be burned, even the branches of tops which can not be used should ordinarily be cut away enough to let the tops sink close to the ground, where they will rot as speedily as possible. Dry crowns propped clear of the ground by their branches rot slowly, burn fiercely, and are very dangerous in case of fire.

SKIDDING.

When the trunks have been sawed into logs, the latter are dragged away by horses, mules, or oxen, or in some cases by a long wire rope which is wound on the drum of a donkey engine. This is called "skidding the logs." In this way they are collected in piles called "rollways," or assembled in "yards," or otherwise made ready for the next step in their progress to the mill.

Care is needed in skidding not to rub or tear the bark from valuable standing trees, or to break the young growth down, for much harm is quickly done in this way. Promising young trees are often cut because it is easier to use them for corduroy or skids, or for other purposes in the logging than to take others less straight or less conveniently at hand, or because they are somewhat in the way, or even from habit, when it would really be easier to let them alone. A very little care in preserving young growth makes an astonishing difference in the future value of a forest.

Reproduction of conifers under hardwoods

MAINE FARMER PRESS, AUGUSTA

Slash left after the logging. A source of danger from fire

TRANSPORTATION.

After the skidding, the logs may be transported to the sawmill in many different ways. Sometimes they are loaded on sleds and drawn over carefully made ice roads to a logging railroad or to the bank of a stream. When the stream is not swift or deep enough to carry the logs of itself, splash dams are built, in which great quantities of water are held back for a time. When such a dam is opened the water is set free, and great numbers of logs may be driven far down the stream by the sudden flood. In larger streams the logs are sometimes made into rafts, or they may be driven singly down the river. The log drivers who do this work learn to balance themselves on the floating, rolling logs, and walk on them almost as easily as on the solid ground. Sometimes locomotives drag the logs behind them over the ties, or they are hauled on cars which run over poles cut in the woods instead of over metal rails; often they are rolled into slides built of other logs, and either move downhill by their own weight or are dragged along by horses, cattle, or steam. In southern swamps the logs are sometimes swung up by a wire rope suspended from the trees, and so are loaded on the great flatboat which carries them to the mill.

AT THE MILLS.

At the mills the logs are cut into lumber by various kinds of saws. Of these the circular saw is still very widely used, although the wide bite or kerf which it cuts in the log makes it very wasteful of timber. A large circular saw makes a kerf a quarter of an inch wide, so that in cutting four one-inch boards enough wood to make a fifth board is ripped into sawdust. Band saws are far less wasteful, for they are thinner and make a narrower kerf. Hence they are taking the place of the circular saws, although they do not work so rapidly. Many mills, in addition to their band saws or circulars, use gang saws, which cut out several boards at the same time.

Besides lumber the best sawmills produce great quantities of lath and shingles, made either from small logs called "bolts," cut specially for that purpose, or from slabs, edgings, and other pieces of wood which might otherwise be wasted. But in spite

of every effort to prevent waste in the mill, by using sawdust and other refuse for fuel, and in other ways, very many thousands of tons of wood a year are thrown into great burners as the cheapest method of getting it out of the way.

When the lumber has been sawed it may be piled and seasoned in the yard or kiln dried before it is sent to market or sold at the mill. Some sawmills on Puget Sound are built on piles over the water, so that the lumber is loaded into vessels directly from the saws. Others load their product on the cars and distribute it by rail. Still others on the Pacific slope float their timber away in a narrow wooden trough called a flume, through which flows a rapid stream of water. These flumes are sometimes over 40 miles in length, and cost almost as much to build as a railroad. Many sawmills have connected with them planing mills or woodworking factories of other kinds, so that the rough lumber from their saws is changed into the form of a finished product before it reaches the market.

WASTE IN LUMBERING.

This is very briefly the way in which a tree gets into the market at the end of its life. At every step there is some waste. Although it may be sound throughout, the lumbermen in the woods can take but a portion of it, often leaving a part of the trunk and all of the top to rot on the ground. When each log comes to the saw there is a further loss of nearly all the slabs and edgings and all the sawdust that is not used for fuel. On the average it is doubtful whether more than half of the cubic contents of a standing tree is finally used. As prices rise and as conservative lumbering comes to be generally practiced, the greater part of this enormous loss will be avoided, but it can probably never cease altogether.

PLANTING.

It has often been proposed to plant trees in order to repair the damage done to the forests by the lumbermen. Tree planting is most useful in all the treeless or scantily wooded portions of our country where planted trees will grow, and wherever forests have been very severely injured or destroyed, but it is generally far too expensive to take the place of conservative

lumbering in regions already forested. An acre of growing natural forest can be bought in nearly every forested part of our country for less than it would cost to plant, 4 feet apart, an acre of seedlings a few inches high. The true way to save the forests is not to plant new ones, but to protect and rightly use those which are standing now. The extension of the forest to regions which are without it is a most important task, but it must not be confounded with the conservative use of the forests now standing. For such use there is no substitute whatever.

THE WEATHER AND THE STREAMS.

The central point of public interest in forestry in the United States was until recently the influence of forests on climate. It is natural that the connection between the immense forests and vast plains and the wonderfully various climates of this continent should have awakened attention. It is a matter which is easily written and talked about without any thorough understanding of forestry itself, and in this it differs from other branches of the subject. In dealing with the weather it touches a thing which affects the daily life of everyone, and which, to very many, holds the balance between poverty and prosperity. It is therefore unfortunate that so much of the writing and talking upon this branch of forestry has had little definite fact or trustworthy observation behind it. The friends and the enemies of the forest have both said more than they could prove. Both have tried to establish the truth of their opinions by referring to observations of temperature and rainfall which cover too short a time to prove anything, or by heresay and general impressions, which are not to be trusted in such matters. Such discussions make nothing clear except that the pith of the matter has not been reached by either party.

FORESTS AND CLIMATE.

The discussion of forest influence on climate began in this way. When the French revolution broke out in 1789, the old restrictions on the management of private forests were done away. A wholesale cutting of these timberlands promptly followed, and as early as 1792 the consequences began to be observed. The question of forests and climate was then raised

for the first time; but questions of this kind can not be answered without long and careful observations. Such observations were begun by Becquerel in France and Krutsch in Germany about the middle of the last century, but it was not until 1867 that a satisfactory way of making them was devised. This was the system of double stations—one within the forest, the other at a distance in the open. It was first put in operation by Professor Ebermayer, now of the Bavarian Forest School. By this means the amount of moisture and heat in the forest may be compared with that in the open, and in the end a full and satisfactory answer will probably be reached.

In order to find how great the influence of forests on climate may be, we must first see what are the factors which make climate. Then we may ask which of these factors can be affected by the forest, and in what way.

The climate of any place on the earth's surface results from the action of the sun's heat upon it. Climate is the average condition of the weather. It depends, first of all, on the distance of a place from the equator and its elevation above the sea. Secondly, it depends on the distribution of land and water, the relief of the land, whether flat, hilly, or mountainous, and the character of the surface covering. These are all connected with the temperature in a special manner. Lastly, it is affected by the winds and the moisture of the atmosphere. Now, it is clear that of all these factors of climate the forest can influence only the wind, the moisture, and the surface covering; but heat (with which the surface covering has so much to do), moisture, and wind are the three things which change when we say that the weather changes. These are just the points where a change due to the forest would have most effect on daily life. The influence of the forest is exerted upon them in two ways:

First. The forest cover intercepts the rain and the rays of the sun, checks the movement of the air, and reduces the radiation of heat at night.

Second. The waste from the trees and from certain plants which grow only in their shade forms the forest floor, which has much to do with the movement of water on the ground and within it. The influence of the forest cover and the forest floor appears in the temperature of the air, the evaporation of water, the rainfall, and the course of the rain water after it has reached the earth.

EFFECT OF FOREST COVER ON TEMPERATURE.

So far as the influence of the forest is concerned, the temperature of the air is affected chiefly by the forest cover. The leaves, which compose the greater part of the cover, contain from 50 to 70 per cent of water. More heat is required to raise the temperature of a pound of water one degree than for a pound of almost any other substance, and so it happens that bare soil or rock exposed to the rays of the sun becomes heated many times faster than the water in the leaves. While the heated rock or soil was warming the air about it the forest cover would still be absorbing heat and keeping the air below it cool. The leaves of the cover also tend to cool the air by transpiration, which is the evaporation of water from the leaves. This is true because heat is required to change water into water vapor, and a part of the sun's heat is taken up for this purpose. In these two ways the forest cover acts somewhat like a surface of water.

The growth of the tree itself also helps to cool the air. When the leaves take carbonic-acid gas from the air they break it up and force its corbon into new chemical compounds, which are then stored away as new material in the tree. So with water and the other substances upon which the plant feeds. But the elements are less at ease in these new compounds, and heat is required to force them to make the change. When we burn wood for fuel we are simply getting back again the heat which was used to bring about this change. So we may say roughly that the air about the tree during its lifetime has been deprived of as much heat as would be given off if the whole tree were burned.

The effect of the cooler air of the forest is felt to some distance in the open country. During the day, in calm summer weather, when the air is warmer than the tree tops, it is gradually cooled by contact with the cooler leaves and twigs. In cooling it becomes heavier and falls toward the ground. A rising current of warmer air is formed to supply its place, and so the colder air flows off along the surface into the open country and causes local breezes. At night the air currents are reversed. The air in the forest is then warmer than the air outside, because the cover checks the radiation of heat, and so the colder air

moves from the open country toward the woods. In these ways the influence of the forest is felt at a distance.

The amount of this cooling of the air has been measured in certain places. It is naturally found to be greatest in summer; while in winter and at night the air in the tree tops is a little warmer than in the open. It is important to add that the cooling effect of the forest is greater than the average in the mountains, and less in the plains.

EXTREMES OF HEAT AND COLD.

The extremes of heat and cold are moderated by the forest. Observations on this point have been made, for example, in Bavaria and Württemberg. They showed that the lowest temperature of every day in the year was higher, on an average, by nearly 2° in the forest, while the highest temperature was lower by nearly 4°. The greatest heat of the day in the summer was 7½° less in the forest than outside. Prussian observations showed that for ten years the greatest heat of the day in July was, on an average, nearly 6° lower in the forest, and the greatest cold of the night in January nearly 3° less than outside. It should not be forgotten that the latitude, the elevation, and the exposure had a powerful influence on these differences, which are also greatly affected by the kind of trees and the density of the forest.

It must be borne distinctly in mind that the figures given above are reliable only for the places in central Europe where they were observed. But the principles on which they depend are just as true in America as they are in Europe. Natural laws are the same the world over. It is safe to conclude, then, that in the United States the forest modifies the temperature of the air in certain ways and for certain reasons, both of which we have seen. Just how great this influence is in different parts of this continent it is as yet impossible to tell. But it is probably greater on the average than these observations indicate, for two reasons: First, the extremes of heat and cold, moisture and dryness, are much greater here than in central Europe, and changes are more sudden; second, in most of the double stations mentioned above the station outside the forest was within less than a mile of it, and thus likely to be influenced

by the cooler air currents flowing from it; that is, the real effect of the presence or absence of woods over large stretches of country is probably greater than these observations show.

A system introduced in Austria is expected to give a clearer idea of the distance to which the forest influence reaches. It consists of lines of stations beginning in the center of a large forest and extending step by step into the open country beyond.

MOISTURE IN FOREST AIR.

The moisture of the air is greater in the forest than outside. The absolute quantity of water vapor in a cubic foot of air is generally the same in both places, but the forest air is cooler, and therefore its relative humidity is greater. Relative humidity is the amount of vapor actually in the air, expressed as so much per cent of all it could hold at the same temperature. The amount of water that the air can hold changes when the temperature changes, but in such a way that air cooled until it is only half as warm as before can hold much less than half as much vapor. If a hot and a cold stream of air, both saturated with water vapor, meet and mix, the mixture can no longer hold as much vapor as the two streams separately, and a part is condensed, usually in the form of rain or snow. German and Swiss observations have shown that the average humidity is greater in the forest by from 3 to 10 per cent. This difference increases with the altitude above sea level and the density of the forest cover. The increase of humidity explains why dew is more frequent in the neighborhood of the forest than at a distance.

EVAPORATION.

The water which falls to the earth from the atmosphere had first to be evaporated, so that year by year the quantity of water which the air takes from the surface of the globe by evaporation is the same as that which falls upon it in the shape of rain, hail, snow, and dew. The effect of the forest on this great movement of water is to detain more of it on those portions of the earth which are sheltered by trees. It does this partly by tending to increase the rainfall, but its effect in lessening the loss of water through evaporation is probably much more important. The colder and moister air of the forest has less capacity for

taking up water vapor than that of the open country. It is also quieter, which means that the winds are less active in replacing saturated air with air which can still take up more water. The forest acts powerfully in checking the force of the winds because the elastic swaying of the twigs and branches is a very effective hindrance to the movement of the air. Strong winds, although they are often dangerous in themselves, do most harm by drying up the moisture in the soil and in the plants which grow from it. Thousands of miles of windbreaks have been planted by farmers in the western parts of this country to protect their crops and homes against the wind. These windbreaks serve a most useful purpose, but they are naturally far less effective in preventing evaporation than the forest itself. So great is the power of the latter that direct observations made in Bavaria and Prussia showed that evaporation from a free surface of water in the forest was only 40 per cent of that in the open.

The presence or absence of leaf mold has a powerful effect on the amount of evaporation from forest soil. The experiments of Dr. Ebermayer, a famous German forest meteorologist, showed that evaporation from forest soil without a layer of mold was 47 per cent of that from soil in the open, while with a layer of mold it was less than half as much, or 22 per cent. The greater the altitude above the sea the greater is the effect of the forest in preventing evaporation. This is a powerful reason for preserving mountain forests at the headwaters of streams, especially in the Rocky Mountain regions of the United States. Evaporation is there so active that great banks of snow lying in the full glare of the sun often disappear without melting even enough to moisten the ground on the hillsides below them. Vast quantities of water evaporate in this way without ever reaching the streams. Measurements made by the Bureau of Forestry show that evaporation from snow may be four or five times as great as from water under like circumstances.

RAINFALL.

The causes of rain are for the most part wholly beyond the reach of influence from the forest. Such are the great currents of warm and cold water in the ocean, the direction of the prevailing winds, and the presence or absence of mountain ranges.

But there are two reasons which lead us to believe that forests do affect the rainfall. These are their colder and moister air, and the resistance which they offer to the motion of the winds. A great number of observations has been made in different parts of the world to discover how much the rainfall really is affected by the forest, but for several reasons no generally accepted result has yet been reached. In the first place, accurate observations on railfall are not easy to make. The height above the ground at which a rain gauge is placed affects it very seriously. A variation of 10 feet in height will often make more difference in the amount of rain caught than most observers claim for the whole action of the forest. The rainfall of two stations at unequal heights above sea level is sometimes wrongly compared, because the difference in rainfall may be caused by the difference in altitude. Finally, the best observations that have been made point to different conclusions. For example, measurement taken in Prussia go to show that there is an increase of rain over the forest, and that it is greater the higher the station. Thus, near the level of the sea it was only 1.25 per cent greater than over the open country, while at altitudes between 2,000 and 3,000 feet it reached 43 per cent. Observations made at Nancy, in France, which lies about 700 feet above the sea, show an average yearly increase of 16 per cent. The Bavarian observations, on the contrary, do not indicate more rain over the forest. The best evidence at hand fails to show a decrease in rainfall over the United States in the last hundred years, in spite of the immense areas of forest that have been burned and cut. But it should not be forgotten that most of those areas have grown up again, first with brush, and afterwards with trees, so that the proportion of land covered with leaves is still very large in all that part of the country which was once under forest. In India, again, a large amount of statistics has been collected which leads to the conclusion that forests do influence rainfall. The truth probably is that more rain falls over the forest than over open country similarly placed, but how much more it is impossible to say. The excess falls chiefly in the form of summer showers. One of the best authorities has estimated the difference at 10 per cent.

FALLEN RAIN.

Whatever doubt there may be about the action of the forest in producing rain, there is none about its effect on rain water after it has fallen. When rain falls over a dense forest from less than one-tenth to about one-fourth of it is caught by the trees. A small part of this water may reach the ground by running down the trunks, but the greater part of it is evaporated and so increases the humidity of the air. That which passes through the crowns falls upon the forest floor, which sometimes has an absorbing power so great that it can hold for a while a rainfall of 5 inches. Yet this water does not remain in the porous floor, but in the end runs off into the streams, or is evaporated, or sinks into the ground. That which gets into the ground is either taken up by the roots or goes to feed the springs and watercourses.

Rain which falls over a bare slope acts differently. It is not caught by the crowns nor held by the floor, nor is its flow into the streams hindered by the timber and the fallen waste from the trees. It does not sink into the ground more than half as readily as in the forest, as experiments have shown. The result is that a great deal of water reaches the streams in a short time, which is the reason why floods occur. It is therefore true that forests tend to prevent floods. But this good influence is important only when the forest covers a large part of the drainage basin of the stream. Even then the forest may not prevent floods altogether. The forest floor, which has more to do with the fallen rain water than any other part of the forest, can affect its flow only so long as it has not taken up all the water it can hold. That which falls after the forest floor is saturated runs into the streams almost as fast as it would over bare ground.

An unforested drainage basin in the San Bernardino Mountains of southern California was found by the Bureau of Forestry to discharge the rain it received more than twice as rapidly as similar forested basins near by. In consequence, the stream in the former went dry, while the streams in the latter were still flowing abundantly.

In these ways it happens that in mountain countries, where floods are most common and do most harm, the forests on the

higher slopes are closely connected with the prosperity of the people in the valleys below.

Water in motion was nature's most powerful tool in shaping the present surface of the earth. In places where the slopes are steep, the structure of the ground loose, and the rainfall abundant, water may work very rapidly in cutting away the heights and filling the valleys. The destruction of the forest in such a region exposes the surface to the direct action of falling rain and is certain to be followed by the formation of torrents. The danger is greatest when the soil has been laid bare by the browsing and the hoofs of grazing animals, among which sheep and goats are especially destructive, or where the forest floor has been burned away.

When these conditions are both present, as in parts of the Sierra Nevada Mountains of California, of the Cascade Range in Oregon, and in many other parts of the West, the prosperity of the valleys is in serious danger. Fire and overgrazing on the mountains combine to endanger the future water supply of irrigated or irrigable areas in the valleys below. When rain falls over mountains which have so been deprived of their natural protection it is no longer caught and held back by the trees and the forest floor. The roots, which were once the strongest means of binding the soil together, now are gone and leave it without protection against the rushing water. Heavy rains or sudden thaws swell the streams with marvelous quickness, and give them a wonderful power to cut away their banks. Where the waterway is very steep such a flood often carries with it many times its own weight of earth and stones. As it nears the valley it breaks from its bed and makes new channels, or spreads over the lowlands. The current loses its swiftness, and its load of stones and sterile earth sinks to the bottom, the heavier pieces first. Where it falls the beds of rivers are filled up and fertile lands are covered with pebbles and sand.

For a time after such a flood the streams are usually low, because the water which should have fed them for weeks or months has run off in a few days. This may be quite as serious a matter for the farmers as the destruction of their fields, as for example in places like southern California, where the crops depend on irrigation with the water of streams which rise in the mountains. Torrents have begun to form there in the

San Bernardino Mountains, and have already carried stones and sand into the orange groves and even into the towns of the San Gabriel Valley. Before the water of the San Gabriel River was so largely taken out for irrigation it was rapidly cutting away the fertile land on either side of its shifting bed, and it seemed likely that serious loss of property would follow. This is the direct result of fire and grazing in the mountains.

The pasturage of sheep in the Alps of southern France was the chief cause of the destructive torrents with which the French Government has been struggling for many years. The direct loss to the French people has been enormous, and in addition the work of correction alone has cost upward of $35,000,000. Although wonderfully successful hitherto, it is still far from finished.

FORESTRY ABROAD AND AT HOME.

Except China, all civilized nations care for the forest. Until recently the United States ranked nearly with China in this respect, and our country still remains far behind the progressive modern nations in nearly all that relates to the protection, preservation, and conservative use of the forest. Japan has a well-developed forest service and a national forest school. In Austria, Italy, and Norway and Sweden government forestry is a well-established portion of the national life. Turkey, Greece, Spain, and Portugal give attention to the forests. Russia, dealing like ourselves with vast areas of forests in thinly peopled regions, but by methods wholly different from our own, is drawing enormous revenues from the systematic care and use of the forests. In Germany the scientific treatment of forests has reached, perhaps, its highest development. The foresters of France have perfected a most practical and effective general system of forestry, and have created the difficult art of controlling the floods of mountain torrents by planting trees. The Republic of Switzerland, by the use of methods most instructive to citizens of the United States, has developed a type of government forestry policy more worthy of our attention and imitation than any other in Europe. In Australia and New Zealand forestry has already made important advances. In Canada the English have made real progress in forestry; the government sells the timber from its forests, but retains possession of the lands and employs fire guards; at the Cape of Good Hope they

have an excellent forest service; in British India they have met and answered many questions which still confront the American forester, and in a little more than thirty years have created a forest service of great merit and high achievement. The United States has scarcely yet begun.

THE FOREST IN EARLY TIMES.

In very early times the forest was preserved for the game it contained. Forestry then meant the art of hunting, and had very little to do with the care of trees. Even the word forest, which really comes from the Latin *foris,* meaning out of doors, was thought in England to be derived from the fact that it was a place given up to wild animals *for rest.* But gradually the forest came to be considered more than the game, and the serious study of forestry began.

MODERN FORESTRY.

Forestry as a science is of comparatively recent origin, although a work in which all the European trees are described was one of the earliest printed books. Until the end of the eighteenth century forestry was discussed chiefly by men who were either scholars or practical woodsmen, but who were not both. Then appeared Hartig and Cotta, two men who united these points of view, and their writings are at the base of the whole modern growth of the subject. Both were German. Each covered the whole field as it was then understood, and together they exerted an influence which has not been approached by any other authors since. From Germany their teachings spread to France, and early in the nineteenth century their doctrines were introduced into the French Forest School at Nancy by Lorentz, who, with his successor, Parade, was the founder of modern forestry in France.

Under the feudal system, which was finally destroyed in France by the revolution of 1789, the forest was the property of the feudal lord. In order to make the life of their serfs, who were useful both as taxpayers and as fighting men, easier, and so increase their number, he gave them the privilege of taking from his forest the wood which they required. For similar reasons the wealthy religious houses, like that of the Grande

Chartreuse, made grants of land and of rights in the forest. But after a time the number of peasants increased so much that their wants absorbed nearly the whole produce of the woodlands. Then it was found necessary to limit the prescriptive rights to forest products by restricting them to certain parts of the forest, or to make an end of them by exchanging them for the absolute ownership of smaller areas. Thus many of the communities, to which, and not to individual peasants, these rights belonged, came to possess forests of their own. But the communes, as they were called, managed their forests badly, and about three hundred years ago the Government was forced to intervene. Under the management of officers of the Government forest service, the results from the communal forests have been excellent. At present these forests not only supply fuel to the villages which own them, but in some cases they produce enough to pay all the village taxes as well.

Germany.

Germany still holds the high position in forest science which began with Hartig and Cotta. The German forest schools, of which there are seven of the higher grades, are still among the very best, and the study of forestry, both in the schools and in the forest experiment stations, is eagerly pursued. The forests in Prussia, Saxony, and other German States are admirably managed, and yield important returns. The total value of the German forests, public and private, is said to be about $4,500,000,000.

France.

Forestry in France has long been associated with the names of famous men. Henry of Navarre and his friend and minister, Sully; Palissy, the great potter, who called the neglect of the forest prevalent in his time "not a mistake, but a calamity and a curse for France;" Colbert, the minister of Louis XIV; the botanist Duhamel du Monceau; Buffon, the celebrated naturalist, are among the men to whom France owes the rise and progress of her present excellent forest policy. Their peculiar service was to lay the foundation, both in law and in public opinion, upon which modern forestry in France now rests.

The forests of the French Government are admirably managed. They cover only about 2,750,000 acres, but they yield a

net return each year of more than $2 per acre. Besides handling their national forests with great intelligence and success, the French foresters have done much for the general progress of forestry. They developed the art of reforesting denuded mountains, and were the first to plant trees on moving sand dunes along the seashore. More than 150,000 acres of these dunes, which once were blown about by the wind until they overwhelmed great stretches of fertile ground, and even threatened to bury whole towns, are now covered with forests of pine, and produce great quantities of turpentine, lumber, and charcoal.

Switzerland.

In Switzerland forestry received attention from very early times. Nearly two hundred years before the discovery of America the city of Zurich began to make rules for the protection and management of the Sihlwald, a forest which it still owns, and which now yields an annual return of about $8 per acre. In the Canton of Bern a decree of the year 1592 warned the people against the wasteful use of timber and provided for the protection of the forest along various lines. It also directed that for every tree cut down a young one should be planted in its place. It is curious to find this mistaken prescription for the ills of the forest already in fashion more than three centuries ago. To save the forest every old tree must be replaced by *many* young ones.

The first general forest law of Bern was passed as early as 1725. It embodied the most important principles of wise forest legislation as we know them today. But this was only one of a long series of forest laws in which, from the beginning, the idea of the importance of the forest to others besides its owner became steadily stronger. The citizens of Bern have grown ever more willing to place restrictions on themselves for the benefit of the Commonwealth.

There were great floods in Switzerland in 1834, and they were the cause of a general awakening of interest in forestry. Somewhat later a federal forest commission was appointed. Since the appearance of its final report in 1861 the progress of forestry in Switzerland has been steady. In 1875 a federal forest inspector was appointed, and a year later the first Swiss forest law was passed. This law does not extend to the whole

of Switzerland, but only to the Alps and the steeper foothills. In a country of steep mountains it is of first importance to guard the forests on the higher slopes. Consequently all the forests on these higher lands which serve to protect the lowlands against floods, avalanches, and other similar dangers of wind and weather are put in charge of the Swiss federal forest service.

A great saying of Landolt.—"Our forest laws," said Elias Landolt, a great and simple man, whose name stands first among Swiss foresters, "are intended to work more through instruction, good example, and encouragement than by severe regulations. This method is somewhat slower than one which should involve harsher measures, but the results achieved are more useful and lasting. When forest owners do something because they are convinced of its usefulness it is done well and with an eye to the future, but what they do under compulsion is done carelessly and neglected at the first opportunity. What they have come to learn in this way and have recognized as good will be carried out, and that better and better from year to year."

British India.

For many years after the British conquest forestry in India made very little progress. Much time was wasted in half measures, until in 1856 Dr. (now Sir Dietrich) Brandis was put in charge of the teak forests of Pegu. He acted at once upon the idea of preserving them by making them pay. At first the output of teak had to be somewhat restricted, much against the will of the timber merchants of Rangoon, who protested that the business of their city would be ruined. But after this momentary check the teak trade of Rangoon grew until it was far greater than ever before, and it is now a chief and increasing source of the prosperity of that city.

The appointment of Dr. Brandis was the beginning of the Indian forest service. In 1866 he was made inspector-general of forests, and from that time progress was rapid. The Indian forest service now has nearly 300 superior officers and over 10,000 rangers and forest guards. It has charge of about 200,000 square miles of forest, and produces a net revenue, after all expenses have been paid, of about $3,000,000 a year. In addition, the forests furnish to peasant holders of forest rights

products whose value is estimated to be considerably greater than the whole cost of the forest service. About 30,000 square miles are effectively protected against fire, at an average yearly cost of less than half a cent per acre. These admirable results are especially interesting because India is like the United States in the great extent and variety of her forests and in the number and fierceness of forest fires.

FORESTRY AT HOME.

The forests of the United States cover an area of about 699,500,000 acres, or more than 35 per cent of the surface of the country. Before so large a part of them was destroyed they were, perhaps, the richest on the earth,, and with proper care they are capable of being so again. Their power of reproduction is exceedingly good.

In the Northeastern States, and as far west as Minnesota, once stretched the great white pine forest from which, since settlement began, the greater part of our lumber has come. South of it, in a broad belt along the Atlantic and the Gulf coasts, lies the southern pine forest, whose most important tree, both for lumber and naval stores, is the southern yellow pine. In the Mississippi Valley lies the interior hardwood forest of oaks, hickories, ashes, gums, and other hardwood trees. It is bordered on the west by the plains, which cover the eastern slope of the continental divide until they meet the evergreen Rocky Mountain forest which clothes the slopes of this great range from the Canadian line to Mexico. Separated from the Rocky Mountain forest by the interior deserts, the Pacific Coast forest covers the flanks of the Sierras, the Cascades, and the Coast ranges. Its largest trees are the giant sequoia and the great coast redwood, and its most important timber is the fir.

The forests of the Phillipine Islands cover an area of more than 40,000,000 acres. Their timbers, almost wholly different from those of the United States, are exceedingly valuable, both as cabinet woods and as construction timber. An efficient forest service was organized in 1898, and following its reorganizaton in 1902 a new and excellent forest law was passed in 1904. The Philippine forest service costs but half as much as the revenue received from the forests of the islands.

The island of Porto Rico contains a national forest reserve, the site of which was once covered with valuable hardwoods; but this forest has been much abused. Porto Rico, like the Philippines, has many kinds of wood valuable for cabinet-making.

THE SETTLER AND THE FOREST.

When the early settlers from the Old World landed on the Atlantic coast of North America they brought with them traditions of respect for the forest created by generations of forest protection at home. The country to which they came was covered, for the most part, with dense forests. There was so little open land that ground had to be cleared for the plow. It is true that the forest gave the pioneers shelter and fuel, and game for food, but it was often filled with hostile Indians, it hemmed them in on every side, and immense labor was required to win from it the soil in which to raise their necessary crops. Naturally, it seemed to them an enemy rather than a friend. Their respect for it dwindled and disappeared, and its place was taken by hate and fear.

The feeling of hostility to the forest which grew up among the early settlers continued and increased among their descendants long after all reason for it had disappeared. But even in the early days far-sighted men began to consider the safety of the forest. In 1653 the authorities of Charlestown, in Massachusetts, forbade the cutting of timber on the town lands without permission from the selectmen, and in 1689 the neighboring town of Malden fixed a penalty of 5 shillings for cutting trees less than 1 foot in diameter for fuel. An ordinance of William Penn, made in 1681, required that 1 acre of land be left covered with trees for every 5 acres cleared. But these measures were not well followed up, and the needless destruction of the forest went steadily on.

FIRST STEPS IN FORESTRY.

More than a hundred years later, in 1795, a committee of the Society for the Promotion of Agriculture, Arts, and Manufactures in New York made a report on the best way to preserve and increase the growth of timber. Four years afterwards Congress appropriated $200,000 for the purchase and preservation of timberlands to supply ship timbers for the Navy, and

in 1822, with the same object in view, it authorized the President to employ the Army and Navy to protect and preserve the live oak and red cedar timber of the Government in Florida. Since that time more and more attention has been given to the forests. In 1828 Governor DeWitt Clinton, of New York, spoke of the reproduction of our woods as an object of primary importance, and in the same year the Government began an attempt to cultivate live oak in the South for the use of the Navy. Three years later an act was passed which is still almost the only protection for the much-abused forests of the public domain.

In 1872 the Yellowstone National Park was established, and in 1873 Congress passed the timber-culture act, which gave Government land in the treeless regions to whoever would plant one-fourth of his claim with trees. In 1875, the American Forestry Association was formed in Chicago through the efforts of Dr. John A. Warder, who was one of the first men to agitate forest questions in the United States. In the centennial year (1876) Dr. Franklin B. Hough, perhaps the foremost pioneer of forestry in America, was appointed special agent in the Department of Agriculture. This was the beginning of educational work in forestry at Washington. Soon afterward Congress began to make appropriations to protect the public timber, but nothing was done to introduce conservative forest management. The present Bureau of Forestry in the Department of Agriculture was established as a division in 1881.

About this time forest associations began to be established in the different States, the most influential and effective of which has been that in Pennsylvania. The States also began to form forest boards or commissions of their own.

In 1888 the first forest bill was introduced in Congress. It failed to pass, but in 1891 an act was passed which was the first step toward a true policy for the forests of the nation. The first step toward national forestry is control of the national forests. This act, whose chief purpose was to repeal the timber-culture act, contained a clause which authorized the President to reserve timberlands on the public domain, and so prevent them from passing out of the possession of the Government.

THE PUBLIC DOMAIN.

In all the States and Territories west of the Mississippi except Texas, and in Ohio, Indiana, Illinois, Michigan, Wisconsin, Florida, Alabama, and Mississippi, all the land originally belonged to the Governmnet. This was the public domain. It has gradually been sold or given away until in many of the States it has all or nearly all passed to other owners. But it still includes more than 470,000,000 acres, or nearly one-third of the United States, not including the Territory of Alaska, which has an area of about 350,000,000 acres. A large part of the public domain has been surveyed by the Government and divided first into squares 6 miles on each side, called townships, then into squares of 1 mile, called sections, and these again into quarter sections and smaller divisions. The lines which mark these divisions are straight and at right angles to each other. When any part of the public domain is reserved or disposed of it is usually located by reference to these lines.

FEDERAL FOREST RESERVES.

When the President was given the power to make forest reserves, the public domain still contained much of the best timber in the West, but it was passing rapidly into private hands. Acting upon the wise principle that forests whose preservation is necessary for the general welfare should remain in Government control, President Harrison created the first forest reserves. President Cleveland followed his example. But there was yet no systematic plan for the making or management of the reserves, which at that time were altogether without protection by the Government. Toward the end of President Cleveland's second Administration, therefore, the National Academy of Sciences was asked to appoint a commission to examine the national forest lands and report a plan for their control. The academy did so, and upon the recommendation of the National Forest Commission so appointed, President Cleveland doubled the reserved area by setting aside 13 additional forest reserves on Washington's Birthday, 1897.

The Cleveland forest reserves awakened at once great opposition in Congress and throughout the West, and led to a general discussion of the forest policy. But after several years

of controversy widespread approval took the place of opposition, and at present the value of the forest reserves is rarely disputed, except by private interests impatient of restraint.

The recommendations of the National Forest Commission for the management of the forest reserves were not acted upon by Congress, but the law of June 4, 1897, gave the Secretary of the Interior authority to protect the reserves and make them useful. The passage of this law was the first step toward a national forest service. The second step was the act of Congress, approved February 1, 1905, which transferred the control of the national forest reserves from the Department of the Interior to the Department of Agriculture. This act consolidated the Government's forest work, which had been divided between the General Land Office and the Bureau of Forestry, and secured for the reserves the supervision of trained foresters.

President McKinley and after him President Roosevelt continued to make forest reserves. The latter introduced a system of examining the proposed forest reserves, so that now their boundaries are better located than ever before. Under him great progress has been made by the Government in bringing about the practice of forestry by forest owners and in awakening the great lumber interests, as well as the people in general, to the dangers of forest destruction.

The forest reserves lie chiefly in high mountain regions. They are 62 in number, and cover an area (January 1, 1905) of 63,308,319 acres. They are useful first of all to protect the drainage basins of streams used for irrigation, and especially the watersheds of the great irrigation works which the Government is constructing under the reclamation law, which was passed in 1902. This is their most important use. Secondly, they supply grass and other forage for many thousands of grazing animals during the summer, when the lower ranges on the plains and deserts are barren and dry. Lastly, they furnish a permanent supply of wood for the use of settlers, miners, lumbermen, and other citizens. This is at present the least important use of the reserves, but it will be of greater consequence hereafter. The best way for the Government to promote each of these three great uses is to protect the forest reserves from fire.

STATE FORESTRY.

Many of the States have taken great and effective interest in forestry. Among those which have made most progress are New York and Pennsylvania. New York has a State forest preserve of 1,436,686 acres, and Pennsylvania one of 700,000 acres. Michigan, Minnesota, and other States are rapidly following their example.

In 1892 the first example of systematic forestry in the United States was begun at Biltmore, in North Carolina. It is still in successful operation.

The first professional foresters in the United States were obliged to go abroad for their training, but in 1898 professional forest schools were established at Cornell University in New York, and at Biltmore, in North Carolina, and they were followed by the Yale Forest School in 1900. Others have sprung up since. At present, thorough and efficient training in professional forestry can be had in the United States.

INDEX.