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# DEPARTMENTS AND INSTITUTIONS

For the Year 1902.

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AUGUSTA
KENNEBEC JOURNAL PRINT
1903


SQUAW MOUNTAIN.

# FOURTH REPORT

OF THE

# FOREST COMMISSIONER

OF THE

# STATE OF MAINE

# 1902

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AUGUSTA
KENNEBEC JOURNAL PRINT
1902

STATE OF MAINE

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*To His Excellency, John F. Hill, Governor of Maine:*

I herewith submit my first report as Forest Commissioner for the year ending November 30, 1902, as required by the act of 1891, chapter 100, creating a Forest Commission.

EDGAR E. RING,

*Forest Commissioner.*

# REPORT OF FOREST COMMISSIONER.

In the preparation of my first annual report as Forest Commissioner of the State of Maine, I have sought with diligent care to secure such information concerning the amount of standing timber in the Maine forests, as in my judgment, might be depended upon for its reliability and its accuracy; and I submit the deductions made therefrom with faith and confidence that they will meet the approbation of those interested in the vital and important question of forest preservation in our State.

To obtain a reasonably accurate estimate of the standing timber, and particularly the merchantable spruce, for either pulp or saw logs, throughout the State, was a task of no small magnitude. By merchantable timber I mean trees that are nine inches in diameter breast high. Realizing that mere guess work would be of little value to the timberland or mill owners of Maine, I employed expert scalers and explorers early in the season to aid in the work of securing reliable and authentic information concerning the location, quality and the amount of standing timber ready for the woodsman's axe or saw.

The work was divided according to the State water sheds, more attention being paid to the four great river systems, the St. John, Penobscot, Kennebec and Androscoggin, than to the minor systems near the coast. Certain territory was assigned to each explorer. The explorers travelled many miles, personally looked over some of the townships and interviewed surveyors who had made actual surveys, and obtained figures from the owners of the land. With the understanding that the estimates furnished were to be used in getting at an aggregate of the standing timber in the State and not separate townships, the owners of the land have invariably assisted in the search for information on the subject. To them and to all others who have aided in this work I feel greatly indebted.

In many cases the estimates of the growth on townships have been verified by obtaining figures from more than one explorer familiar with the territory, and then perhaps getting the owner's figures to aid in basing the actual stand. This method meant a much more accurate estimate than could otherwise be obtained.

As it is well understood it would be an almost endless undertaking and mean an outlay of many thousands of dollars to get an actual survey and exploration of the whole State, but by the method employed I believe the estimates obtained to be as nearly correct as it is possible by any means outside of an actual survey, and much nearer than any estimate ever obtained in the past.

The results of these explorations are very satisfactory and show that there are standing in the forests of Maine at this time, twenty-one billion, two hundred and thirty-nine million (21,239,000,000) feet of spruce, besides large quantities of pine, cedar, hemlock, poplar and various species of hardwoods.

From deductions made by Ralph S. Hosmer, a field assistant of the United States bureau of forestry, who has been making experiments in this State during the past summer, and whose excellent report is published herewith, it is learned that the annual growth is sufficient to warrant the cutting of six hundred and thirty-seven million (637,000,000) feet of spruce timber in the State of Maine each year without depleting the supply.

It is clearly apparent, therefore, that the forests of the State are amply able, by careful cutting, to meet the needs and requirements of the pulp and saw mills for an indefinite period, unless devastating fires and ruinous wind storms occur to cause damage and injury to the timber now standing and in process of growth.

From my knowledge of the conditions existing in the timber producing regions of Maine, supplemented by the competent judgment of many men versed in woodcraft, whose services I have been able to command, I am satisfied that the supply of available material to carry on our present pulp and lumber manufacturing establishments, and such others as may be built as time goes on, is sufficient and ample; and I firmly believe that there is no immediate danger of a timber famine in this State, provided the necessary precautions against wasteful cutting and forest fires are carefully observed.

The State of Maine is large in area, containing 31,500 square miles of territory. Of this area 21,000 square miles is forest

land. There are 9,471,050 acres taxed by the board of State assessors as wholly wild land, but this does not include all of the lumber producing land of the State. Of the plantations taxed as incorporated towns at least one-half of their area is wild land; and in addition there is in nearly every incorporated township from a few hundred to several thousand acres of timberland, which, in the aggregate adds very materially to our lumber producing territory.

It is also true that in addition to the land in the old incorporated towns that is actually timber producing at the present time, there are large areas once used for agricultural purposes that have been allowed to go back to woodlands. In many instances the second growth is small and of little or no value for manufacturing purposes at present, but each year a certain percentage becomes available, and in the course of a series of years a large amount of lumber will be supplied from this source.

There is as large a territory of this character to furnish future supply as is likely to be deforested meanwhile. There is little chance, however, that any considerable portion of our wild lands will ever become deforested unless as a result of large forest fires, because comparatively little of it is suitable for agricultural purposes. Very little land is being stripped to such an extent that it will not furnish another crop of lumber from the undersized trees of the present stand in a comparatively few years.

Actual deforestation, except from forest fires, as I have stated, can never take place to any considerable extent in Maine, as the agricultural lands are very largely occupied. On the other hand, there is likely to be a constant increase in our lumber producing areas, on account of there being so little profit in cultivating dry, stony ground for farm crops, and more or less of such lands are reverting to forest growth each season. On the whole, it is safe to reckon that there will be from eleven to twelve million acres of land in this State that will be lumber producing for all time.

Very nearly all the lumber of Maine which has been used in the manufacture of pulp and paper has been taken from the drainage of the Androscoggin, Kennebec and Penobscot rivers. The proportion has been 42 per cent from the Androscoggin; 33 per cent from the Kennebec, and 25 per cent from the Penobscot. Practically there has been none taken from the St. John's drainage or from the southeastern portion of the State in Washington and Hancock counties, both being large wild land regions.

The total average of these three systems, from which the whole pulp lumber consumed in the State has been taken, is about 4,741,000 acres, leaving more than one-half of the entire wild land region from which no pulp wood of any consequence has ever been removed.

The average rate of increase or annual growth of spruce in the State varies according to the character of the soil and whether the trees have been thinned so as to allow light and air to penetrate the forests, the actual percentage ranging from two to four per cent. If three per cent is taken as the average, which may be regarded as a conservative estimate, there should be an annual increase of about 637,000,000 feet.

The pulp mills, as now established, consume about 275,000,000 feet of spruce per year, besides considerable poplar, pine and hemlock, which are not considered in this calculation. This leaves for saw-mill purposes about 362,000,000 feet, if we cut the annual increase alone, with other conditions remaining the same as in the past; but with improved methods of cutting and managing wild lands, which are being carefully studied, I am satisfied that the percentage of increase will gradually rise to at least four per cent, which would add materially to our annual supply without decreasing the actual stand of lumber.

Thus, taken as a whole, I fail to discover that there is any indication of a decrease in the supply of spruce in this State on account of the pulp and paper industry. Without doubt, they are cutting in certain sections in excess of the annual increase, and yet, despite this fact, there is little doubt that the stand of spruce is practically the same as it was ten years ago.

There is quite a large amount of lumber brought from New Hampshire and Canada each year for manufacture in Maine mills, but every season a much larger quantity of Maine lumber is run down the St. John river to be manufactured in the province of New Brunswick. Therefore it may reasonably be asserted that the saw mills and pulp mills combined are not consuming more timber than the total annual increase.

While my efforts to obtain a fair and reliable estimate of the standing timber in the forests of the State have been mainly directed to the ascertainment of the amount of the spruce supply, I have not lost sight of the fact that there are other woods growing upon Maine soil which are of inestimable value to the land

owner and to the manufacturer. In the Kennebec section large quantities of poplar, valuable in the production of the best grades of paper, are found. Sapling pine and even pine of older growth may still be found in many sections of the State. Other varieties of soft wood grow upon our hills and in our valleys and all must be considered in determining the total value of the forest resources of our State.

No small amount of Maine's timber wealth is found in its forests of white birch. Little is said or written of the white birch growth in the State, but one has only to look into the matter a little to learn that upwards of 35,000,000 feet of white birch timber are taken annually from our forests. The white birch area is a wide belt that extends entirely across the State. No estimate has ever been made of the amount of this wood now standing, but it is safe to say that the quantity now available and the future growth will undoubtedly be sufficient to keep running for many years all the hard wood mills now in existence and all the new ones that may be put in from time to time.

White birch is used largely by the hardwood novelty mills of the State, yet its greatest utilization is in the manufacture of spools. The spool factories of Maine annually produce about 800,000,000 spools, valued at more than $1,000,000. Besides being used in the production of spools much white birch is cut into spool bars for shipment to Europe. Other hard woods are used to a greater or less extent in the manufacture of small articles, but the consumption of white birch leads the field in this particular line.

In addition to the information to be found in the foregoing, I have endeavored to obtain full and complete descriptions of the various river systems of the State, their territorial area, volume of water power and other facts relative to their value as timber producing sections, which I have incorporated into a chapter under the title of "The River Systems of Maine," and which is made an important feature of this report. A perusal of this branch of the report cannot fail to be of special interest to all who have a desire to inform themselves regarding the actual condition and location of the forest supply of Maine. Each section is described with the greatest care and the information presented is of the most reliable character.

A valuable feature of this report is the article on the "Greatest Enemies of the Forest," in which has been collected important references to forest fires, wind storms, wasteful cutting and other dangers likely to deplete and perhaps destroy our valuable timber resources. This portion of the report will appeal to those who know the results of these unfortunate inroads upon the natural product, and who have an inclination to assist in guarding against the evils so clearly set forth.

Another important part of this report is the article treating of the "Principles of Practical Forestry." This portion of the report comprises a resume of what is being done in many states, by the government of the United States and by foreign countries, looking to the advancement of forestry in its practical as well as in its scientific character.

The information contained in this report will be found of great value, not only to those directly engaged in the business of cutting and manufacturing the timber products of Maine, but also to every citizen who has at heart the welfare and prosperity of our State.

# THE RIVER SYSTEMS OF MAINE.

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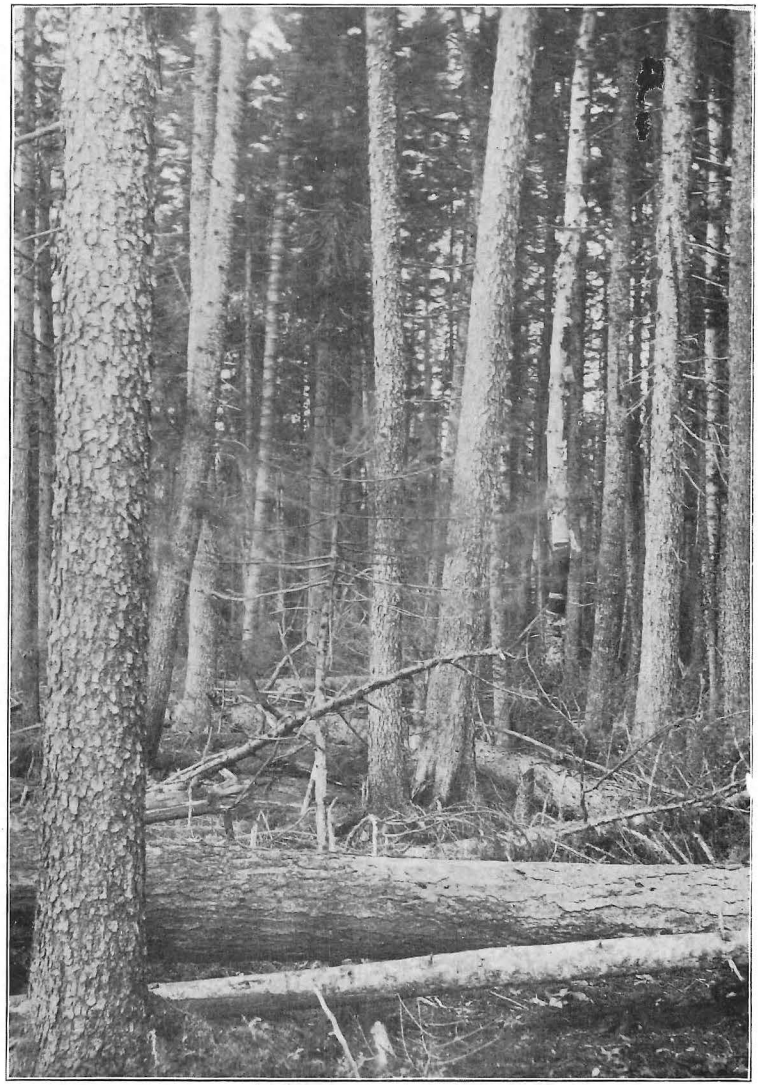
## Important facts dealing with the timber growth, territorial areas and volume of water power.



Handsome growth of spruce, Winchell's Landing, Fish River R. R.

# THE RIVER SYSTEMS OF MAINE.

In the following pages will be found a complete description of the several river systems of the State, showing their location, territorial area, amount of standing timber, according to accurate information furnished by scalers and explorers, and other important facts bearing upon the condition of the timber resources of the State.

## THE ST. JOHN RIVER SYSTEM IN MAINE.

The St. John river system in Maine comprises all the territory lying north of Chamberlain lake and extending from the east to the west line of the State. It includes the greater portion of Aroostook county and small portions of the upper parts of Piscataquis and Somerset counties. It is so designated because the St. John river is the natural outlet for all the timber cut in this territory, which must find its way down the Allagash and Fish rivers into the St. John and thence into the province of New Brunswick where it is manufactured into lumber or ground into pulp. In this system there are about 7,400 square miles of territory and in the western portion, especially that part bordering upon the upper St. John and the Allagash rivers there are great tracts of virgin spruce that have never known the woodman's axe.

The length of this territory across its southern border is 117 miles, while the greatest breadth is 90 miles. With one exception it is the most elevated drainage area in Maine. Its height, however, is comparatively even over its whole extent, and has no extreme elevation in any part. In the eastern or lower portion, near the St. John river, the face of the country is very nearly level, and at a distance it is moderately hilly. The country

bordering on the Aroostook river is flat, while highlands of low elevation diversify its aspect in the mid-district about the mouth of the St. Francis and Allagash rivers. Beyond these streams the valley of the upper St. John is quite level nearly to the boundary highlands on the west and southwest.

The total length of the St. John in Maine is estimated at 211 miles including the more important meanderings. Its total length from its source to the sea is about 450 miles, so that it will be seen that the St. John river flows through Maine for nearly one-half its entire length. The highest elevation of the river is at the junction of the St. John and the Woolastaquaguam, which is about 750 feet. The total number of lakes in the St. John basin in Maine appearing upon the official map of the State is 206. The number of streams in the system is 1524, of which the St. Francis in part, the Aroostook, Allagash and Fish rivers are the largest.

The natural drainage of this entire territory above Eagle or Heron lake is toward the north, but the fall is slight, being less than four feet to the mile. At the eastern portion the slope is about two and one-half feet to the mile, while on the west the slope is slightly above one and one-half feet to the mile.

Throughout the greater portion of the system lumber operations have been carried on for many years by operators from the lower Canadian provinces. They have operated upon the various waters tributary to the St. John and have cut many billions of feet of timber and taken the same into the provinces there to be manufactured into lumber, and brought back to this country to compete in the markets with the product of our own mills. The fact that the water shed of this vast territory, rich in timber resources, is toward the St. John river, and the further fact that until very recently there has been no way by which timber cut in this section could be transported to the mills within our own borders explains the reason for this condition. Within a few years, however, railroads have been built through portions of the territory and more are in process of construction, thus promising a great change in the methods of transporting the timber product to mills, both lumber and pulp, in our own State, or to those near by. In the future it may reasonably be expected that the growth of railroad construction in the St. John river system of Maine will be sufficient to take care of the entire product of the territory,

thus preventing its shipment out of the country to be manufactured by the people of a foreign land.

Too much stress cannot be laid upon the value of railroad transportation as an adjunct to the successful handling of the timber product of the State of Maine. In these days of rapid development in the utilization of forest products the old-time method of driving timber through lakes and rivers from the places where cut to the places of manufacture is considered too slow for the enterprising, sagacious and far-seeing manufacturers of the present day. It is not too much to expect that before ten years the greater part of stock needed by our pulp, paper and lumber mills will be transported by rail from the forests to the doors of the mills. Nor is it too much to anticipate that lumber mills and pulp mills also will be erected in this territory where material is so plenty and that railroads will be built to transport the manufactured articles to the markets of the country.

The valley of the St. John above the mouth of the Allagash is about 90 miles long by 30 miles wide, or 2,700 square miles, twice the size of the Allagash valley. The principal tributaries are Little Black, Tulandic, Chimmeaticook, Big Black, Northwest Branch and Baker Lake stream, all of which being on the northwest except the last. The river is about 130 miles long from the mouth of the Allagash to its head. For the most part the valley is level, although some portions are quite hilly and broken on the southeast side. The land below Seven Islands is quite high to the divide between that river and the Allagash. At or near Seven Islands is a pass or valley, in fact, two, one on either side of a high ridge of land extending from Long lake on the Allagash to or near the Seven Islands. Through this pass a railroad could be located, thus connecting the two valleys. Its length would be about fourteen miles.

In Township 13, Range 15, below the Seven Islands a dam could be constructed ten or twelve feet high and flow the slack water about Seven Islands. This would control the upper waters of the St. John and all the lumber cut above. This is the only place on the upper St. John river where logs can be held successfully. In Township 13, Range 14, below Seven Islands there are two good water powers. The rapids at this place are strong, the banks on the east side are quite high and steep, while on the west side the rise is gradual. It would require a dam about 330

feet long and the water could be used twice in one-half mile. These water powers would furnish about 4,000 horse power each, but as there are not enough reservoirs or lakes above, the power would not be continuous for the whole year; yet it would be sufficient to manufacture all the lumber on the river.

Good water powers can also be had at Big Black Rapids where the rise is of ledge formation. At the Little Black Rapids another power could be utilized, the best on the upper St. John. The banks at the head of these rapids are quite steep and a high dam could be built. The St. John falls on an average about two and one-half feet per mile, so that the water powers are not so extensive, and the lack of storage renders them of less value than those on the Allagash. The most of the lumber on the St. John in Maine is located above the mouth of the Allagash. This territory is not so well timbered as is the Allagash section, and it has been more extensively cut, as it has been accessible from the St. Lawrence river, and that part of the valley has been settled quite largely.

As the logs cut in this section have been for the St. John market, the timber has not been cut very close. The whole valley ought to cut annually from 75,000,000 to 100,000,000—the cut this year will be about 50,000,000. The cedar in this valley is of prime quality and there is a large quantity throughout the valley. With a railroad connecting this valley with the Allagash from Seven Islands, then down the river to the head of the Big Black Rapids the product of the whole valley could be handled and the manufactured lumber easily and cheaply taken to market.

The valley or basin of the Allagash river is about fifty-five miles long and thirty-five miles wide, and has an area of 1,475 square miles. This section comprises forty-one townships, or 944,000 acres. Of this territory, 13,000 square miles, comprising thirty-six and one-half townships, or 832,000 acres, are located above Allagash falls, situated in Township No. 15, Range 11, fourteen miles from the junction of the Allagash with the St. John river. The length of the river is a little over 100 miles. Walter Wells in his "Water Power" of Maine estimates the discharge of water from this river at 57,720,000,000 feet per year. The Allagash river falls from Chamberlain lake to the mouth about 308 feet, or an average of about four feet per mile. There are 127 square miles of lake surface available for reservoirs.

Spruce timber averaging 75 feet in height near new railroad, Fish River.

These would hold over 40,000,000,000 cubic feet of water; about 30,000,000,000 cubic feet below Chamberlain lake and 10,000,000,000 cubic feet above the outlet of that lake. This storage is ample to supply the entire fall of the river and give a uniform flow of water for the whole year.

Three dams on the main river, one at the foot of Churchill lake, one at Long lake and another at Round lake, with others at the foot of Musquacook, Chemquasabamticook, Priestly, Harrow, Pleasant and Spider lakes, which are on branches of the main river, would be all the dams required for storage purposes. It might not be necessary to build more than the three dams on the main river, as they would afford valuable water powers in addition to their value for storage.

At the outlet of Chamberlain lake there is now a dam in good condition, which gives ten feet head on that lake and is sufficient to control the entire water fall above the outlet. By means of this dam the water of the upper Allagash is turned into Telos lake, through which it goes into the East Branch of the Penobscot river during the driving season. After this the gates are opened and the water is allowed to flow down the Allagash. The gates are again closed in March, so that but a small portion of the water above the outlet of Chamberlain lake goes down the Allagash river.

The average rainfall in the State of Maine is forty-three inches; the estimated evaporation is twenty-five inches, thus leaving eighteen inches to find its way into the sea. All estimates of horse power are laid upon this basis. It is a well settled principle that the evaporations in a territory covered with a heavy evergreen forest is not so great as in a more open country. In this valley the water does not have a long distance to flow before being used, so that the evaporation would not be quite so much as twenty-five inches.

The river at Allagash falls runs through a narrow gorge from eighty to 100 feet wide with almost perpendicular ledge sides about twelve feet high at the head of the falls and forty-five feet high at the foot. The total fall is thirty-three feet in 200 feet. A dam could be built at the head of the falls twelve feet high and about 100 feet long on solid ledge. This would increase the available head to forty-five feet. Above the falls the

river is quite rapid, then almost dead water for three miles. It is quite wide and filled with islands. It can be flowed several feet and would make a secure storage for many millions of logs. A canal could be cut through the ledge for a distance of about 500 feet, or the water could be conveyed in penstocks to the lower basin, or better still mills could be located near the head of the falls and the logs taken from the pond above.

The volume of water which passes these falls during the year is 43,490,304,000 cubic feet, not including the rainfall above the outlet of Chamberlain lake, which, if added, would make 54,362,880,000 cubic feet. Without Chamberlain lake this volume of water would give with forty-five feet head 8,220 horse power for 313 days of twenty-four hours each in a year, or 16,440 horse power for the same number of days of twelve hours each. With the water of Chamberlain lake there would be secured 10,270 horse power for twenty-four hours a day throughout the year, or 20,540 horse power for twelve hours a day.

To make this power available for the whole year would require the building of at least three dams on the main river, as stated above, which could be used for manufacturing as well as for storage and which would be worth all the wood cost on account of the additional power they would develop.

There is little doubt that the Allagash falls when fully developed will furnish the best water power in the whole county of Aroostook.

The volume of water which passes the foot of Round lake is 29,690,496,000 cubic feet per year, and this is without the Chamberlain lake water. By the construction of a dam twenty feet high at this point 2,490 horse power for twenty-four hours a day, or twice that amount for twelve hours a day could be obtained. With the water of Chamberlain lake 3,400 horse power for twenty-four hours a day, or 6,800 horse power for twelve hours a day could be secured.

The volume of water that passes the foot of Long lake in Township 12, Range 13, is 26,355,088,000 cubic feet per year without Chamberlain lake water. By the construction of a dam twenty feet high at this point 2,210 horse power for twenty-four hours a day, or 4,420 horse power for twelve hours a day could be afforded. With the Chamberlain lake water the horse power for twenty-four hours a day woud be increased to 3,120, and for twelve hours a day to 6,240.

A short distance below Churchill lake at a place known as "Chase's Rips," are the remains of an old dam, which was built many years ago to back the water to Chamberlain lake, a distance of twenty miles. This dam was twenty-one or twenty-two feet high, 250 feet from bank to bank, with a wing on the west side 285 feet long, and one on the east side 150 feet long, making a total length of 685 feet. A few years after this dam was built a portion of it for about ninety feet on the west side of the river was cut away and the toe-piling removed, so that at this point the channel of the river is only ninety feet wide. This was done by workmen in the employ of one John Glazier. They were driving pine timber on the lower Allagash and were hung up for water. They cut the dam away, thus enabling Glazier to take his drive out. The dam was never rebuilt. The east end of it was nearly destroyed by fire. A new dam can be built on the old site. It should be built as high or higher than the old dam, and would give sixteen feet head or more on Churchill lake; fourteen feet on Eagle or Heron lake and flow twenty-six square miles of lake and bogs, thus giving with one dam a reservoir capacity of nearly 10,000,000,000 cubic feet. The river falls in Chase's Rapids from the dam to the Devil's Elbow eighty feet.

The volume of water which passes this point in a year is 11,708,928,000 cubic feet without any from Chamberlain lake. With that from Chamberlain it would be nearly doubled. A canal can be constructed on the west side of the river which would give with the dam fifty-five feet head. This would give 2,680 horse power for twenty-four hours a day throughout the year, and double that amount for twelve hours a day. With the water from Chamberlain lake this canal would furnish 5,190 horse power for twenty-four hours a day, and double that amount of power for twelve hours each day.

A dam can be built at the head of Devil's Elbow twenty-five feet high with thirty feet available head. This would give 1,490 horse power for twenty-four hours, or 2,980 horse power for twelve hours a day for 313 working days in the year. With the water from Chamberlain lake this would furnish 2,860 horse power for twenty-four hours a day, or double that amount for twelve hours each day.

It is about one and one-quarter miles from the head to the foot of Chase's Rips or Rapids. On the west side is a level bench

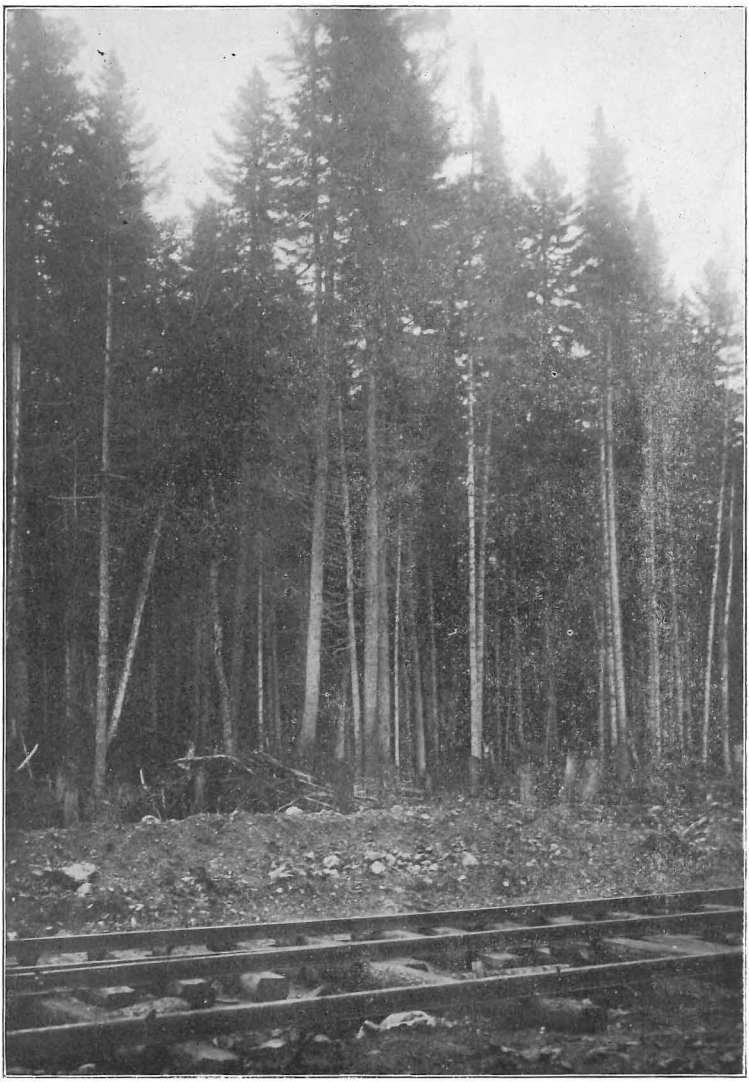
which extends down the river where a canal could be excavated and mills built below, or several dams could be built and separate powers made. Ten large tributaries empty into Churchill, Harrow and Eagle lakes, each from ten to twenty miles in length. This is the center of a large tract of the best timbered section in the State.

The five dams on the main river would give 34,180 horse power for twelve hours each working day in the year. If the water from Chamberlain lake was added, these dams would furnish 50,000 horse power for every working day of twelve hours in the year. It would not be very expensive to develop this power, and it would be distributed throughout the whole valley, using 170 of the 308 feet fall of the river.

There are 175 square miles of water shed below Allagash falls. This section was mostly burned over in 1881, leaving 1,300 square miles above. Divided into sections, they could be controlled by dams located at suitable places.

There are 832,000 acres above Allagash falls, comprising about thirty-six and one-half townships. The land is nearly all green. A large portion has never been cut for spruce or cedar, and it contains some of the best spruce tracts in the State. A very low estimate of the spruce alone ten inches at top, twenty feet long would be two and one-half thousand per acre, or two billion feet. Many townships in this territory have not been cut over for more than thirty years, and then only for pine, so that to-day there is a large quantity of pine timber standing in the valley.

A prominent lumberman who has operated on Chamberlain lake states that he thinks the land in the vicinity of Eagle lake would cut 5,000 feet per acre, while another operator sets it at 8,000. The annual growth is large near Musaskis lake. Logs were cut there twenty-four feet long, twelve inches at top and eighteen inches on the stump that were sixty-five years old. One of the most experienced explorers in Maine, who has visited the Allagash valley and knows the locality thoroughly, says that the annual growth of spruce in the valley will aggregate 75,000,000 feet. This may seem large, but careful examination warrants the statement. For the next twenty years, according to the judgment of experienced woodsmen, it would require a cut of 75,000,000 to 100,000,000 per year to get over the whole ground and remove what logs are now standing. After that the tract



Showing Dense Growth of Spruce in Aroostook. Trees 60 to 80 feet high. Fish River Railroad shows in foreground.

would cut 50,000,000 to 75,000,000 each year forever. The annual growth equalling the cut.

In addition to the spruce now standing there are large quantities of cedar and pine. The cedar land has never been cut upon, and there are some of the finest cedar forests to be found in the country. The quality is far superior to that on the southern slope. It will take many years to exhaust it.

Below Allagash falls where the country was burned over in 1881 the land is coming up to a second growth, largely of white birch and poplar. In twenty years this will be large enough to cut. The lower valley is quite rough having some small mountains and high ridges, but on the whole it is a good country to operate in. In some localities there are excellent farming lands, but as a rule, it is a timber country.

Careful estimates made during the past season, taking each town by itself, from recent explorations, show that there are standing to-day on the land in the townships which drain into the St. John river system in Maine, six billion, nine hundred forty-two million (6,942,000,000) feet of spruce; four hundred twenty-seven million (427,000,000) feet of pine, and one billion, eight hundred thirty million (1,830,000,000) feet of cedar. This is exclusive of about two hundred million (200,000,000) feet located on the headwarters of the Allagash which will be turned into the East Branch of the Penobscot by a company now operating on those waters.

The spruce was estimated at a size of nine inches and upwards, breast high. It was impossible to get an accurate estimate of the hard woods in this system, but it is enough to say that there are immense quantities waiting for transportation facilities to make them valuable.

I have given much space to the St. John river system in Maine, from the fact that comparatively few realize the great value to the State of the forests in Northern Maine, which can only be utilized by the construction of railroads which each year are stretching out into the wilderness and opening new avenues of wealth.

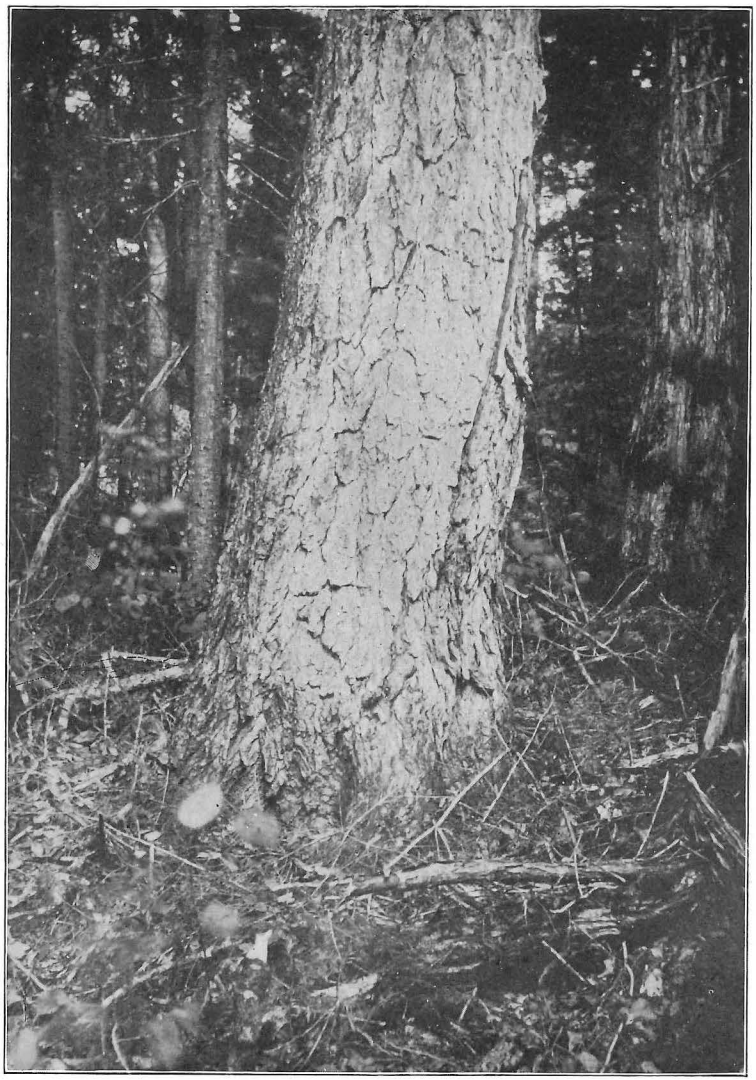
## THE PENOBSCOT RIVER SYSTEM.

The Penobscot river system is almost wholly situated in the geographical centre of Maine. Beginning at the southern extremity of the St. John river system in Maine it extends for quite a distance from the eastern to the western boundaries of the State, and then reaches down through the central portion of Maine, taking practically the whole of Penobscot county, portions of Aroostook, the greater part of Piscataquis, some of the western parts of Washington and Hancock and most of Waldo county. This territory is drained by the Penobscot river from Chesuncook lake, near its northern border, to Penobscot bay where the waters of the river join the great Atlantic ocean.

The greatest length of the Penobscot basin is from north to south. From Ox Bow plantation in Aroostook county to St. George in the county of Knox; the distance is 160 miles. The greatest width is across the State from Amity in the southeastern corner of Aroostook county to Sandy Bay in Somerset county, on the Canadian border, a distance of about 115 miles.

The total area of the Penobscot section is 8,200 square miles. It is, therefore, the largest river district located wholly within the State. More than 800 square miles discharge their surplus water into the main river below its lowest water power at Bangor. It is not quite so elevated as some other portions of the State, although the northern portion is high, especially at the head waters of the West Branch, where the elevation is from 1,600 to 2,000 feet.

The basin of the Penobscot is mountainous from the sea to above the head of tide. It is gently undulating to the northward and throughout the region of the East and Mattawamkeag branches until it is insensibly blended with the valley of the Aroostook. On the main river the land is more broken and is covered with lakes, ponds, streams, hills, valleys and detached parks. The Katahdin mountain, the highest in Maine, lies upon the left bank. West of this mountain the valley becomes merged with that of the Kennebec on the south and the Allagash on the north and terminates on the northwest at the highland boundaries of the State and in the swamps and lagoons which



A big hemlock three and one-half feet in diameter.

form the common reservoir of the St. John and the Penobscot. The valley as a whole is uniform in its topographical features.

The length of the river from its headwaters to the open sea, including the local windings, is about 300 miles. The main water power section extends from Lake Chesuncook to Bangor, a distance of 120 miles, the fall being 900 feet; or from Lake Mattagaum to Bangor, 115 miles and a fall of 850 feet.

The annual water discharge of the Penobscot basin is estimated at 320,000,000,000 cubic feet.

The number of lakes and ponds in the basin of the Penobscot, represented upon the State map, is 467. This number is above the average, taking into consideration its territorial area.

More than 2,500,000 acres of timberland are drained by the Penobscot river in the territory above Old Town, extending to the Canadian lines on both the eastern and western borders of the State.

The timber now standing in this section consists mainly of spruce, although the amount of cedar to be found in all parts is quite large. In the Piscataquis valley, as well as in the lower West Branch region, large quantities of white birch are to be found. From the most careful estimates obtainable it is safe to state that in the Penobscot system there is now standing five billion, one hundred and sixty-six million (5,166,000,000) feet of spruce; four hundred and thirty-eight million (438,000,000) feet of cedar, and one hundred and fifty-three million (153,000,000) feet of pine.

The fertility of the soil in this section makes it one of the most rapid timber producing territories in the State, so that by a system of economical cutting and guarding against forest fires many years must elapse before the supply of available timber is appreciably reduced.

## THE KENNEBEC RIVER SYSTEM.

The Kennebec river system lies west of the centre of the State, extending from Moosehead lake to the sea, and including the whole of Kennebec and portions of Somerset, Franklin, Waldo, Lincoln and Sagadahoc counties. The entire length is 145 miles and the breadth is seventy-five miles. The area is 5,800 square miles.

The elevation from the sea to the head of the basin is generally rising, and in some places quite hilly. Moosehead lake is 1,023 feet higher than at tide water, Augusta, and at the southwest head of Moose river, one of the principal tributaries of the Kennebec, the altitude is 3,113 feet higher than at Augusta. The northeast part of the basin is very rough, and the territory as a whole is broken and diversified. Some of the loftiest elevations in Maine, next to Katahdin, are located in this territory.

From Moosehead lake to Augusta, which covers the whole power portion of the river, the distance is 112 miles and the fall is about nine feet to the mile. The estimated annual discharge of the river aggregates 226,000,000,000 cubic feet.

There are 311 lakes and ponds and 1,084 streams represented on the State map. The river has its source in Moosehead lake, the largest sheet of water in the State, being thirty-five miles long by twelve miles wide. The principal tributaries are the Dead and Moose rivers.

The upper section is heavily timbered, principally with spruce, regardless of the fact that extensive cutting has been going on for many years. There are approximately 1,500,000 acres of timber land in this system. From the reports of the explorers who have been employed during the past season to ascertain as nearly as possible the exact amount of spruce in this section it is found that there are three billion, eight hundred and eighty-three million (3,883,000,000) feet now standing, ready and suitable for cutting for lumber or pulp.

## THE SYSTEM OF THE ANDROSCOGGIN.

The Androscoggin river system is the smallest of the four principal systems in the State in territorial area, but it is a section of great importance to the timber interests of Western Maine. The fact that the Androscoggin river not only drains one of the most productive portions of Maine but quite a section of the neighboring state of New Hampshire makes it worthy of being classed among the large river systems of the State.

The greatest length of the system from the ocean to the remotest sources of the river is 110 miles, while the greatest breadth from Randolph, N. H., to Fayette, Me., is seventy miles. The square dimensions in Maine number about 2,750 square miles; in New Hampshire, 850 square miles, making a total of 3,600 square miles. Of this nearly the whole is located above the lowest mill privilege, and contributes to the water power of the main river. The elevation is higher than any other district in the State, the height at the head of the river being some 3,000 feet. As a natural result the water power is very large. It is estimated that the yearly precipitation of moisture upon this basin, including both the Maine and New Hampshire portions, is nearly 338,000,000,000 cubic feet.

The Androscoggin river takes its origin and is entitled to its name only from the point of confluence of the Magalloway and Umbagog lake waters. The number of the streams in the system is 669, of which 543 are in Maine. The length of the river proper is 157 miles. From the remotest sources of the Magalloway it is 200 miles. Its most valuable water power section, from Rumford Falls to the head of tide water at Brunswick, is seventy-five miles long; but it is a water power river from the lakes to Brunswick, a distance of 150 miles.

A few years ago Rumford Falls was a small village of a few hundred souls. The wonderful water power at this place is now partially utilized, several pulp and paper mills and other valuable manufacturing establishments have been put in operation, and a flourishing city of 6,000 people has grown up where a quarter of a century ago only a few straggling houses were in existence. The full development of the natural resources of this place has not yet been accomplished. At Jay, Livermore Falls, Auburn,

Lewiston, Lisbon Falls, Pejepscot and Brunswick are large mills manufacturing pulp, paper, cotton and woolen goods, the power for which is derived from the Androscoggin river.

In the northern portion of this section are valuable tracts of timber lands, despite the fact that a great deal of cutting has been done throughout this territory within the past score of years. Still, from the best and most careful estimate secured by this office there is now standing in the Androscoggin river system in Maine about three billion, two hundred and forty-eight million (3,248,000,000) feet of spruce ready for the woodsman's saw or axe.

## OTHER MAINE RIVER SYSTEMS.

Beside the four river systems of the State, described in the preceding pages of this report, the St. John in Maine, the Penobscot, the Kennebec, and the Androscoggin, there are several other river systems of more or less importance to the timber interests of Maine. There are ten of these systems, beginning at the New Brunswick border and extending along the southern coast of the State to the New Hampshire line, and though none of the systems are richly covered with timber yet in the aggregate their timber resources are of much value and must be reckoned in the estimate of the amount now standing in the whole State.

In the territory included in these systems there is a considerable amount of sapling pine, large quantities of which are being annually manufactured into box boards, thus giving employment to many men during the greater portion of the year. Lumbering in these sections has been carried on to a much greater extent than in the larger river systems of the State and hence the supply of standing timber now available is not so extensive as it is in Maine's northern and western portions. In the language of the lumberman, these sections have been harder cut than have those in the interior of the State. As a consequence, and because much of the land has been cleared for agricultural purposes and for the uses of cities and towns, the timber supply is not so large, per square mile of territory, as it is in the other sections. And yet, in Washington and Hancock counties

View of Fish River, from Winchell's Landing on Fish River Railroad. Largely growth of spruce.

and in portions of Oxford and York counties, there is quite an amount of spruce timber ready for the axe or saw of the woodsman. A very accurate estimate places the amount at two billion (2,000,000,000) feet of spruce now available in the ten river sections not included in the four big systems of the State.

While this amount is small, compared to the amount of spruce standing in the St. John, Penobscot, Kennebec and Androscoggin regions, it is still of prime importance when added to the grand total.

These ten river systems may be described as follows: The St. Croix river system is seventy miles long, fifty miles wide, and contains 800 square miles in Maine territory. The Dennys, which includes the Pemaquan, is thirty-three miles long, fifteen in breadth, and is 375 miles in area. The East and West Machias rivers are independent rivers, and the territory drained by them is forty-eight miles in length, twenty-eight miles in breadth and contains 800 square miles. The Narraguagus takes in the Pleasant and Tunk rivers, with 550 square miles of territory, the greatest length being forty miles and the greatest width being twenty-seven miles. The Union river basin is seventy miles long and twenty miles broad, and contains 750 square miles. The St. George, Sheepscot and Medomak comprise the next system with 800 square miles of territory. This system is fifty miles long and thirty miles wide in the broadest parts. The greatest length of the Presumpscot system is fifty-two miles and the greatest width is eighteen miles. It contains 520 square miles. The Saco basin has 800 square miles in Maine. Its length from the ocean to Mt. Washington in New Hampshire is seventy-four miles and its greatest width is thirty miles. The Mousam river system comprises 260 square miles, the greatest length being thirty-two miles and the greatest width twenty-seven miles. The Piscataqua river divides the State from New Hampshire. In this system there are 240 square miles of territory in Maine. The length is forty-three miles and the width twenty-three miles.

It will thus be seen that in these ten river systems there are 5,895 square miles of territory. The larger cities of Maine and many good-sized towns are located within this area, and the amount of standing timber is small as compared with the more thickly-wooded sections to the north and west. And yet about

one-tenth of the entire timber resources of the State is located within this territory.

In describing the various river systems of Maine I have endeavored to be as specific as possible, for I believe that next to showing the amount of standing timber within the confines of the State it is essential to show the water facilities that may be utilized in getting the timber to market.

# GREATEST ENEMIES OF THE FOREST.

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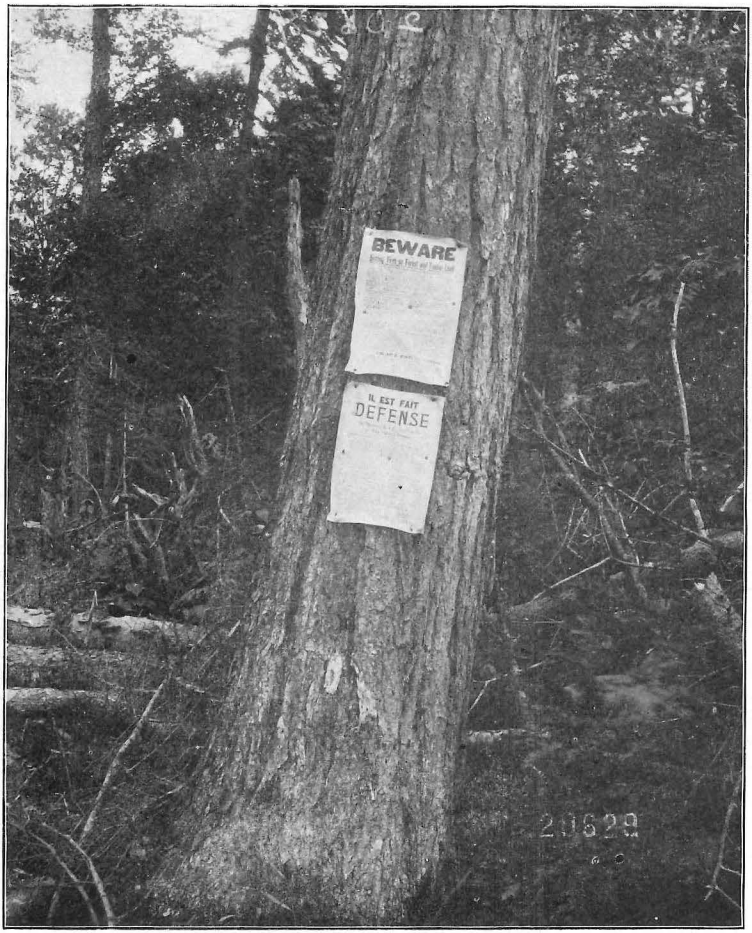
Fire, wind, wasteful cutting. Sketches of memorable fires and heavy wind storms greatly damaging Maine forests.




FIRE PROTECTION.

State Fire Laws posted on a Hemlock on the road leading to a lumber camp.

## GREATEST ENEMIES OF THE FOREST.

### FIRE.

Of the enemies of the forest the greatest and certainly the most to be dreaded, is the Demon Fire, whose source may be the smallest match carelessly thrown aside before being extinguished, but whose extent of damage, is, when once well started in a forest, almost beyond computation, such damage depending largely upon the condition of the forest and ground, available aid for fighting same, and the nearness of a heavy rain.

While the State has been particularly fortunate in the past few years in escaping widespread damage from forest fires, the horrors and loss occasioned by the big fires of 1825 are liable to occur in any dry season.

History brings down to us records of two fires of gigantic proportions in the year 1825, one known as the Miramichi fire occurring in New Brunswick and the other starting in the heavily wooded section near the Piscataquis valley in our own State.

It was early in the afternoon of October 7, 1825, that the Miramichi fire was started at a place about sixty miles above the town of Newcastle on the Miramichi river in New Brunswick. In nine hours it had destroyed a belt of forest eighty miles long and twenty-five miles wide. Over 2,500,000 acres were burned over and nearly every living thing was swept in the path of the fire. Even the fish were afterwards found dead in heaps on the river banks, so heated had become the water in the rivers along its course. Five hundred and ninety buildings were burned, and a number of towns, including Newcastle, Chatham and Douglastown, were destroyed. One hundred and sixty persons perished, and nearly a thousand head of stock.

It was also in October and on the same day in the same year that occurred the Maine fire, which is sometimes referred to as

the Miramichi fire, but it was a different fire, being separated from the other by many miles. August and September of that year had been particularly dry and a severe drought prevailed throughout the Piscataquis and Penobscot valleys.

Carelessness in setting fires to clear land was observed on every hand, in spite of the fact that the conditions were ripe for one of the worst forest fires in the history of the State, and it was not until thousands of acres of land had been burned over and many thousands of dollars worth of damage done, did those who were so eager to clear their lands, realize their folly.

A heavy wind prevailed and the fire travelled through the heavy growth of timber at a fearful rate, the flames lapping up everything with which they came in contact in their maddened course. It became of too great volume to be fought and the settlers were overpowered.

Passing across the towns of Shirley and Elliottsville, the fire on the north took in Katahdin Iron Works and township Long A, passing eastward to cross the West Branch of the Penobscot below the Twin lakes. Leaving unharmed the district east of Sebois and Endless lakes, it swept down to the main Penobscot in the town of Chester, burning more or less through all the towns along the west side of the river down to the line of Old Town. On the west the fire line took in parts of Kingsbury, Mayfield and Wellington, touching Harmony on its northeast corner and included all of Cambridge and Ripley. The territory covered by the fire is estimated at about 1,300 square miles.

A third great fire which destroyed much timber and valuable property occurred in 1837; starting on the meadows of the Seboeis river, spreading northerly and burning the northwest portion of Patten and more than half of the two towns north, sweeping westerly to the East Branch of the Penobscot and north through township eight in the sixth range and so out into Aroostook county. The fire originated through the careless setting on fire of a lot of hay in the meadows of Seboeis by a man named Chase who had been sent into that region to look after poachers.

## CAUSES OF FIRE.

The causes of forest fires are many and varied. In a dry season a match carelessly thrown aside by one passing through the woods may ignite dry and inflammable material which in a short time, especially if there is much wind, will rapidly spread. The thoughtlessness of the sportsman in not carefully extinguishing his camp fire, in his great hurry to get after game, is responsible for a large per cent of the fires. Others are caused in clearing land for pasturage and tillage purposes. The number set maliciously is very small.

## THE EFFECT OF FIRES.

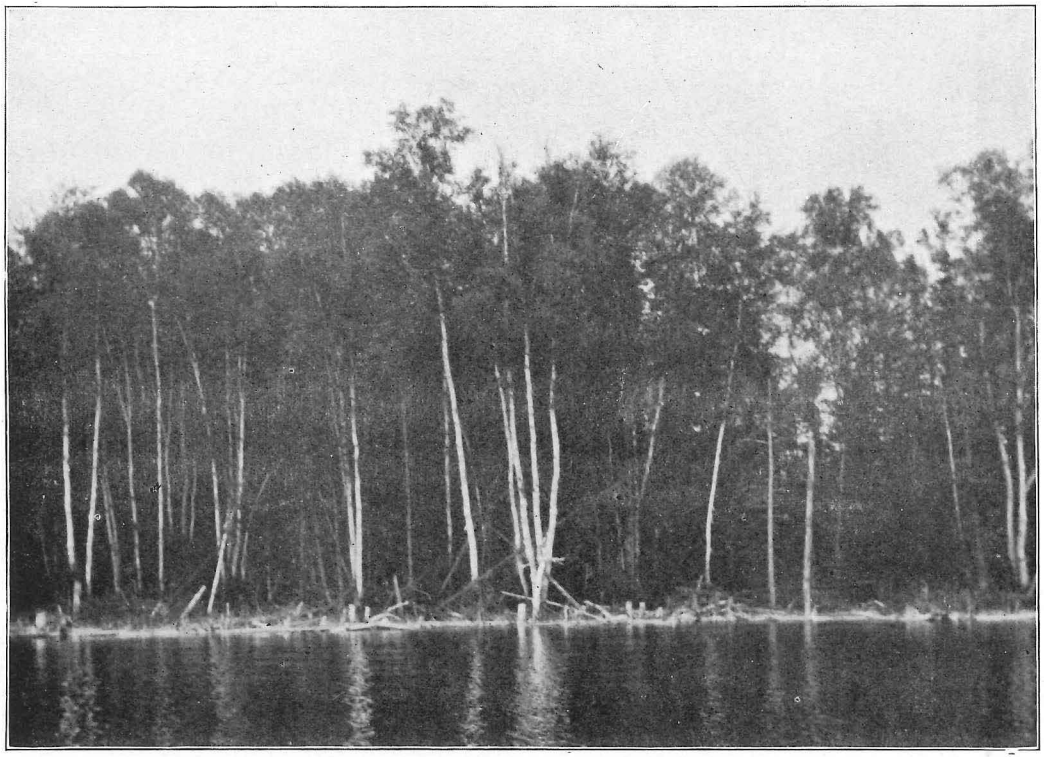
The effect of fires is widespreading. In localities where today stands a handsome growth of timber, located perhaps near an excellent water power, with all the inducements for a saw or pulp mill, tomorrow may be valueless through the destructiveness of a fire which could not be foretold, but which might have been easily averted had more care been taken. A burned over section may again grow up, but in the meantime the woodsman has lost many a winter's work while the land owner will probably never live to see his land reforested to the value represented before swept by fire. It is not only the destruction of the forests themselves in loss of wood and timber, but it has its effect upon the fisheries and the game.

## FOREST FIRE RECORD OF 1901.

Early in the spring of 1902 blanks were sent out from this office to the selectmen of the towns and the assessors of the plantations included in the heavily wooded sections of the State, with a request that answers be made, in the best judgment of officers receiving blanks, to the following questions:

1. How many forest fires have occurred in your vicinity, or on lands in which you are interested, during the year 1901? If none, so state and return this blank.
2. On what township did the fire occur?
3. About what date did it start?
4. How long did it burn?
5. What caused it?
6. How much territory did it burn over?
7. How much of it was in green timber?
8. How much of the burned section had been burned before?
9. How long is it since the previous burning?
10. What kinds of timber were burned?
11. In your judgment, how much timber of each kind was destroyed by the latter fire?
12. What amount of damage was done?
13. Did the fire go out itself or was it put out?
14. To what extent was it fought?
15. What measures were found to be most effective in fighting fires?

Returns were received from 196 towns and plantations. Of that number fires were reported from twenty-two of the places, the heaviest being on No. 40 in Hancock county where over a million feet of timber was destroyed at a loss of over $4,000. On most of the towns the area burned was green timber, having never previously suffered from fire. In most cases the fires were fought and put out by hard work supplemented by rain.



White Birch and Poplar grown up after early fires on the shore of Cupsuptic Lake.

## FIRES OF 1901.

Numerous answers were given to the question, What measures were found to be the most effective in fighting fires? Water was used where it could be obtained easily but the favorite method seemed to have been digging trenches and setting back fires.

The most extended and perhaps the best advice in the line came from W. R. Allan, of Dennysville, one of Washington county's staunch citizens and a man who has had considerable experience with the timber growth of the State. He says:

"Get to the fire as soon after it starts as possible. Find out on which side of the fire is the best timber; begin to fight it on that side first. Watch the fire until it is all out. Give one man charge of the work.

"Take men enough even if the fire is small. Begin and make a trench around the fire, cut the old logs and roots all out of the trench so that the fire will not run under them; cut down any and all old dry trees and stubs that could feed the fire on the side of the trench nearest the fire, or in fact anywhere they can be gotten at.

"Station men along the trench as fast as it is made, to keep the fire back, and have a man put in charge of them so that they will keep walking. Don't depend upon water without it is near and plenty. Stick to the trench! Above all things don't give up but fight! fight!! fight!!! Give your men plenty to eat and have one man or more to keep them in drinking water. Don't forget to give the men axes and shovels so that there will be no lack of tools with which to work. I have been in this business more or less for over thirty years."

### SUMMARY OF FIRES.

From the questions given above and the answers to the same the following tabulated deductions have been carefully drawn:

## AROOSTOOK COUNTY.

| Towns. | Days burning. | Cause. | Area burned. | Area in green timber. | Area previously burned and time since. | Amount and kinds of timber burned. | How extinguished. | Amount of damage. | Measures most effective in fighting fires. |
|---|---|---|---|---|---|---|---|---|---|
| Bridgewater | 14 | Unknown | 100acres | All | None | 100,000 mixed | Put out | $400 | Pails, water. |
| Cyr | 8 | Clearing land | 400acres | All | None | 4,000 spruce, 500 cedar, 700 hardwood | Put out | 1,000 | Water. |
| Hammond | 1 | Clearing land | 3 acres. | All | | Hardwood, spruce | Put out | 30 | Buckets, water |
| Limestone | 1 | Fisherman | 400acres | ⅔ | ⅓ 8 years ago | 800,000 spruce, 100,000 birch | Rain | Heavy | |
| Monticello | 1 | Clearing land | 40 acres | All | None | 30,000 spruce, 30,000 fir, 5,000 cedar | Burned out | $250 | |
| Oxbow | 1 | Clearing land | ½ acre | All | None | Mixed | Put out | | |
| Perham | 2 | Incendiary | 50 acres | All | None | Spruce and cedar | Rain | 100 | |
| Smyrna | 3 | Burning brush | 100acres | All | None | Spruce and cedar | Put out | Light | Shovels, water. |
| Van Buren | 3 | Clearing land | 300acres | All | None | 500,600 spruce, 100,000 fir, 50,000 cedar | Rain | $1,000 | |
| Westfield | 2 | Clearing land | 200acres | All | None | Spruce, cedar and hardwood | Rain | 1,000 | Water. |
| **WASHINGTON COUNTY.** | | | | | | | | | |
| Columbia Falls | 4 | Locomotive | 5 acres | None | None | | Put out | | Trenching. |
| Dennysville | 2 | Locomotive | 8 acres | All | None | Spruce, pine and fir | Put out | $75 | Trenching. |
| No. 10 | 4 | Berry pickers | 2 acres | None | All 20 years ago | None | Put out | | Water. |
| Grand Lake Str. | 7 | Unknown | 100acres | 80 acres | 20 acres 8 years ago | 20,000 hemlock, 10,000 cedar, 30,000 spruce | Rain | 300 | Trenching. |
| No. 14 | 8 | Unknown | 5 acres | All | None | 10,000 spruce, 10,000 hemlock | Rain | 25 | Trenching. |
| Steuben | 5 | Locomotive | 75 acres | 20 acres | 30 acres 2 years ago | Mixed | Rain | 100 | Trenching and setting back fires. |
| **HANCOCK COUNTY.** | | | | | | | | | |
| Dedham | 5 | Unknown | 75 acres | 10 acres | None | 50 cords hardwood | Rain | $75 | Trenching. |
| No. 40 | 10 | Unknown | 5,000ac's | 1,000 acres | 4,000 ac's 50 yrs. ago | 1,000,000 spruce, pine, cedar and hemlock, 250 acres hardwood | Rain | 4,000 | Trenching. |
| Otis | 2 | Unknown | 10 acres | None | All 10 years ago | | Rain | | |
| Orland | 6 | Camp fire | ⅛ acre | All | None | Hemlock | Put out | Light | Water. |
| **PENOBSCOT COUNTY.** | | | | | | | | | |
| Chester | 14 | Unknown | 25 acres | All | None | Mixed | Put out | $50 | Hauling water. |
| Kingman | 7 | Unknown | 20 acres | None | All 8 years ago | | Rain | | |

## METHODS OF FIGHTING FIRE.

Many are the methods of fighting fire and as to the best method much depends upon the location and condition surrounding the fire. One fact that can be emphasized and that is to *fight* the fire by some method and to commence the fighting as soon as possible after a fire is discovered, as delays are dangerous, oftimes a fire which could have been stopped with very little exertion at first, resulting in heavy losses as it spreads almost beyond control.

A favorite and usually quite successful method of fighting fires in Maine is by trenching around a fire. A trench two or three feet deep should be dug, care being taken to take out all the old roots and twigs to stop the progress of the fire in the ground, and then with plenty of help the fire can usually be checked by the time it has burned to the trenches.

In places where water is not too far away good service can be done by a bucket brigade. Surface fires can be checked, if of not too much volume, by beating them out with green branches. Dirt or sand thrown upon fire is also one of the best means of putting it out. Setting back fires is also another method of stopping destructive fires. The back fire must be allowed to burn only against the wind and towards the main fire, so that when the two fires meet both must go out for lack of fuel. To prevent it from moving with the wind back fires should be started on the windward side of a road or clearing or some line which it can be kept from crossing. Back fires are sometimes driven beyond control by a change of wind, but the chief danger from their use is caused by persons who, in excitement or fright, light them at the wrong time or in the wrong place. Still, there is no other means of fighting fires so powerful, and none so effective when rightly used. Fire lines, strips kept free from inflammable material, are very useful in checking small fires and of great value as lines of defense in fighting large ones.

## LAW FOR THE PROTECTION OF FORESTS AGAINST FIRE.

The following extracts of the law for the protection of forests against fire, are given for the benefit of those not familiar with the same:

SEC. 3. 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 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. 4. County commissioners of each county in which there are unorganized places shall annually appoint one or more fire wardens as they deem necessary not exceeding ten, for all such unorganized places in any county, whose duties and powers shall be the same with respect to such unorganized places in any county, whose duties and powers shall be the same with respect to such unorganized places as those of fire wardens of towns, and they shall also have the same authority to call out citizens of the county to aid them in extinguishing fires that town fire wardens have to call out citizens of the town. The compensation of such fire wardens shall be paid by the county,

and the compensation of persons called upon by them as aforesaid to render aid, shall be the same as that provided in the case of towns, and shall be paid one-half by the county and one-half by the owners of the lands on which said fires occur.

SEC. 6. It shall be the duty of selectmen in towns within thirty days after this act shall take effect, to cause to be erected 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 towns, 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 dollars fine, or both as provided by law. Signed, Forest Commissioner. The forest commissioner shall furnish owners of wood lands situated within this State when called upon so to do, notices of similar tenor to be posted at the expense of said owners upon their respective lands.

SEC. 8. It shall be the duty of municipal officers in towns, and county commissioners, the latter with respect to unorganized places, to 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. 9. 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, 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 compliance with that part of Sec. 6 instructing the Forest Commissioner to furnish printed notices, there were sent from this office, during the month of May, 1902, over 10,000 notices to the selectmen of the towns, assessors of the plantations and to the owners of timber lands throughout the State. It is the belief of the Commissioner that the larger part of the notices sent out were posted as directed and that such notices are a great aid in preventing fires through carelessness.

Too much stress cannot be laid upon the importance of protecting against fires and the Forest Commissioner is constantly on the alert to assist in all ways he can in such protection. Some timber land owners in the State adopt a wise method in dry seasons by sending one or more men to patrol the territory which they own, and in this way the danger is lessened to a considerable extent, especially in regions through which railroads or county roads pass or in sections frequented by sportsmen. A very good plan has been adopted in New York which consists of the appointment of fire wardens in every town in the forestry bounds. When any man desires to clear his land he must notify the fire warden of his section and the fire warden accompanies the operator to the scene of operations and oversees the transaction. This is made compulsory and as a result the state has very few of those fires, far reaching in their results, that are so often known from land clearing operations.

## DESTRUCTION BY WIND.

Winds or gales are responsible for more or less destruction of our forests. Sections which have been heavily lumbered over, leaving a scanty growth, are the ones most affected.

Except in one instance, in recent years, no gales occurred to cause any widespread damage. On the night of the 12th and morning of the 13th of November, 1883, a gale swept across the State destroying hundreds of millions feet of spruce and pine, and numerous quantities of other valuable growth.

The towns in Piscataquis county suffered the most, as the loss in this county alone was estimated at upwards of one-half billion feet of spruce and pine, while the hardwoods were damaged equally in proportion to growth. In this region trees

WINDFALL ON STEEP SLOPE.

The effect of cutting only the large trees on exposed slope.

began to fall about 11 o'clock and continued for about four hours.

Townships in Penobscot and Aroostook counties also suffered heavily and not more than one per cent of the timber blown down was saved. A peculiar feature noticeable in Piscataquis, Aroostook and Penobscot counties was that the stands in the valleys suffered more than the mountain tracts.

In the western section of the State the worst period of the wind was from 3 to 6 o'clock A. M. of the 13th. It was an unusually hard wind all the afternoon of the 12th but not sufficiently hard to do much damage. After dark it increased to a gale and by 3 A. M. was blowing in gusts, a veritable tornado. Its direction was from the S. W. W. and N. W.

Fruit and shade trees were badly damaged, in some cases elms two feet in diameter being snapped off like pipe stems; but the great damage was to the forests. In some sections only single trees and small patches were blown down, but over large areas, the whole, or nearly the whole growth, both hardwood as well as black growth, being prostrated, some of these comprising several thousand acres.

Some of the timber, where it was not too thick, or was easy of access, was cut during the two following winters, but not over two per cent was saved through western Maine. These places are now pretty well rotted down, leaving the surface one billowy sea of "cradle knolls." Many of these blowdowns were burned over during the next three summers; these have largely grown up to poplar and white birch. Where not burned the after-growth is mostly white birch, mixed with spruce, fir, hemlock or pine according to locality.

The damage was all east of the Appalachian mountain system, and as a rule in Oxford county, did not cover more than fifteen to twenty miles from its western to eastern limits. In the northern part of Franklin county it extended farther east. Its southern limit in western Maine and eastern New Hampshire was on the Saco river, above and including Fryeburg. Large sections were blown down in Bartlett, Jackson, Conway and Chatham on the Saco and Brans Purchase on Wild river, and Shelburne on the Androscoggin in New Hampshire, which is estimated to have aggregated nearly 20,000 acres.

Fryeburg suffered heavily, mostly to its second growth pine, but as this is a thickly settled town, the areas, although numer-

ous, were not large. Stow, Lovell and Stoneham also suffered heavy loss, mostly to spruce, hemlock and hardwood. North of there on the Androscoggin, Batchelder's Grant, Mason and Fryeburg Academy Grant had several thousand acres either blown down or badly damaged. North of the Androscoggin river, Riley, Gilead and Newry had at least 6,000 acres of fine timber, mostly spruce, destroyed. Bethel had several million of pine blown down, most of which was saved, but the extra cost of getting it out, together with the very low prices prevailing, for the next two years, left but little stumpage.

Farther north, Andover, Andover North and West Surpluses, Roxbury, Byron, E Township and No. 6, suffered very badly, especially the three latter. On all three towns not less than 8,000 acres of the best spruce in western Maine was laid flat and at least one-half as much more on other sections of the same towns. Madrid and Redington escaped more lightly, but Mt. Abram township was at least one-third destroyed.

The timber blown down did not by any means constitute the whole damage. First, there were a great many trees partially blown down that have since died, and by being lodged against others, greatly injured them; second, the fires which in so many cases follow the blowdowns swept through large areas of standing timber, destroying that.

The estimate of the loss in Oxford and Franklin counties by the big gale of 1883 is not less than one billion feet of soft wood, to which must be added the damage to the hardwood growth.

## WASTEFUL CUTTING.

Ranking next and almost equal to fire, careless and wasteful cutting can be reckoned as an enemy to the forest. The tendency to this carelessness and wastefulness is perhaps not as great today as a few years ago, yet there is a big margin for improvement and the sooner the land owner realizes it just so much sooner will one of the problems of forest preservation be solved.

In going through old choppings stumps can be found from three to six feet high containing much of the best timber of the tree, and in most cases had more care been taken in felling and getting more of the butt there would have been a saving of from five to ten per cent.

Such conditions are found where the old method of chopping is adhered to. There is wasted besides the stump which is left to decay, the kerf made by the cutting, which is anywhere from eight to fourteen inches in length according to the size of the tree.

The more modern method of sawing prevents this waste and is being adopted by all the larger operators in the State. It is always important in lumbering to cut at the lowest point practicable. The timber in the butt is almost invariably of the first quality. It is clear and free from knots, and, if sound in the heart, is worth more to the manufacturer than any other part.

Another element of waste is leaving in the woods a large portion of the tops which could be worked into pulp. Not only is the top lost to the operator but it is left in the woods to decay and make the best of material for feeding forest fires. For percentage of loss in careless and wasteful cutting see suggestions for lumbering in Hosmer's report.

The lumber operators as well as the owners of wild land are beginning to realize that to increase both the production and capital value of forest land the yield must be harvested more economically than it has been in the past, and that more care must be taken to preserve the young growth, to tend to keep out fires, and in general draw from the forest, while protecting it, the best returns which it is capable of giving.

# PRINCIPLES OF PRACTICAL FORESTRY.

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## Resume of forestry in the United States and in foreign countries. Act of legislature creating Bureau of Forestry in Maine.

KENNEBAGO VALLEY.

A region where timber was mainly blown down in 1883 and later, and where the few birches left standing have since died from exposure. Second growth of birches, fir and spruce has followed.

# PRINCIPLES OF PRACTICAL FORESTRY.

Forestry is a word that is becoming familiar to nearly every reader of the newspaper or the magazine, but still probably very few stop to consider its real meaning. It is a question claiming more and more the attention of scientists, sought and studied in our colleges and made a calling ranking with that of the lawyer, physician, and other of the higher professions.

There is nothing new in the forests themselves, which have existed ever since the beginning of time, but it is the treating of the same that is opening a new avenue of employment for hundreds. Neither is it to be a work wholly of a scientific nature but it is one with the practical side bristling at every point.

From Mother Earth to the mill, or we might go farther and put it from Mother Earth to that handsome piece of parlor furniture, or delicately tinted writing paper, bearing the water mark of "linen," but perhaps only a few brief days made from the forests, could be termed a branch of Forestry.

To Forestry our land owners are giving an ever increasing interest, studying the best methods of how to grow, preserve and continue the vast forests of Maine. Only a few years ago the man who advanced the idea of Forestry was the laughing stock of the old woodsman, who allowed "there would be wood enough as long as man existed." Those were the days, however, before the great vats and grinders of the ever increasing pulp mills had commenced to devour the forests to an extent that sent out a warning of alarm.

To the farmer or purchaser of land, the soil of which is adapted to the growth of spruce, it will in part be as profitable to him or his heirs as the soil that is wholly suited or particularly chosen for its cropbearing qualities. Rich indeed is the owner of soil suited to both the growth of crops and the tree.

Land that is non-agricultural, on account of being hilly or rocky, often is the best soil for the growth of spruce, and on which trees will grow to a merchantable size in from forty to fifty years. By merchantable size is meant a tree having a diameter of from twelve to fifteen inches breast high. The yield is estimated to be about 1,000 to 20,000 feet per acre.

Experience teaches us that a forest when young should be crowded to promote upward growth, as a tree that stands alone grows too much to branches and does not yield good timber.

Much care should be taken in the cutting of our forests, taking out only that which is sizeable and merchantable and leaving the smaller to grow, thereby solving the problem of preserving the forests, but still handling them to a profit. Only the average growth should be removed from a tract each year.

It has been ascertained that the average annual growth of the state forests of Saxony, (nearly all non-agricultural land) is 225 feet board measure per acre. There are 432,300 acres of such forest; therefore the total annual growth of the whole forest is 97,200,000 feet, which amount of timber can annually be cut without impairing the forests. The forest properly treated increases rather than diminishes in value.

Saxony, which takes the lead in forestry, derives a net annual revenue of $4.50 per acre from her state forests. France, from 2,100,000 acres of productive forest, derives a net annual revenue of $1.91 per acre. Prussia, from 6,000,000 acres of state forests, has a net annual revenue of $1.50 per acre. The aggregate of the state forests of Germany is 10,000,000 acres from which is derived an average annual net profit of $23,000,000. The forests of Germany support three million people.

Prof. Chas. S. Sargent of the United States government says in his report on the forest trees of North America: "The condition of the forests of Maine is interesting. They show that forest preservation is perfectly practicable in the Atlantic region at least when the importance of the forest to the community is permanent. The very existence of the State depended on the maintenance of the forest. The great forests of pine could not be restored, but the preservation of the few remnants of these forests was not impossible. The forests of Maine, once considered practically exhausted, still yield largely and continuously, and the public sentiment which has made possible their

protection is the one hopeful symptom in the whole country that a change of feeling in regard to forest property is gradually taking place. The experience of Maine shows that where climatic conditions are favorable to forest growth, the remnants of the original forest can be preserved and new forests created, as soon as the entire community finds forest protection essential to its material prosperity."

While practically a new feature, considerable progress is being made in Forestry in the United States. Legislative recognition has been given Forestry in eighteen states, but the work has been abandoned in three, leaving fifteen in which the work is being carried on at present as follows: Maine, Connecticut, Kansas, Maryland, Michigan, Minnesota, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Oregon, Pennsylvania, West Virginia and Wisconsin.

Over a quarter of a million dollars is now annually appropriated by Congress for Forestry purposes. A career for young American foresters is opening and there are several schools where scientific education and practice in Forestry can be acquired.

Positions in the United States Bureau of Forestry opened to trained foresters is that of field assistant. It carries a salary of from $720 to $1,000 a year in the beginning, with the payment of all living and travelling expenses incident to field work. Field assistants generally spend about six months in the field and the remainder of the time in the preparation of the reports in Washington.

The individual corporations and pulp concerns are taking a greater interest in forestry from year to year, realizing that in such work lies the success of their business. Such concerns as the International and Great Northern are putting in much work along the line of forestry.

A branch of forestry that is being given more attention than formerly is that of tree planting. Forest planting in Maine should be practically confined to the land that, by nature of its roughness or sterility, is unfit for agricultural purposes. Very hilly and stony lands are usually fit only for the production of timber, and should be kept constantly forested. So long as lumber was cheap and plentiful no progress could be made in such

planting, but now that it is becoming profitable to grow timber this otherwise worthless land has begun to receive attention. Many a worn out farm may be restored to fertility by growing forest trees upon it for a series of years and many Maine farms are better suited for the production of timber than for any other purpose.

In his message to Congress President Roosevelt said: "Public opinion throughout the United States has moved steadily toward a just appreciation of the value of forests, whether planted or of natural growth. The great part played by them in the creation and maintenance of the national wealth is now more fully realized than ever before. Wise forest protection does not mean the withdrawal of forest resources, whether of wood, water, or grass, from contributing their full share to the welfare of the people, but, on the contrary, gives the assurance of larger and more certain supplies. The fundamental idea of forestry is the perpetuation of forests by use. Forest protection is not an end of itself; it is a means to increase and sustain the resources of our country and the industries which depend upon them. The preservation of our forests is an imperative business necessity. We have come to see clearly that whatever destroys the forest, except to make way for agriculture, threatens our well being."

As an investment forestry is more and more playing a part in the commercial world. The capitalist of to-day is looking for a safe place in which to invest his income and the purchase of timber lands is fast becoming one of the popular investments which is considered safe and sure.

Not many years ago lumber values were such that private parties making a business of lumbering could not afford to do the expensive logging necessary to preserve the forests. To cut only trees above twelve or fifteen inches in diameter involves a considerable added expense over cleaning the ground as they go, and to clean the ground of tops and other inflammable debris is still another expense which would put a business so conducted almost out of competition with that of the ordinary sort.

Lumber is now high enough, however, so that if the lumbermen will be content with a nominally lighter annual profit they can make preservative lumbering pay and feel that whatever the sacrifice it will be more than compensated for the increase in the

Hemlock growth on banks of Long Lake, Aroostook County.

value of the capital remaining in the timber by growth and steadily growing values.

## ACT CREATING FOREST COMMISSION.

The act creating a Forest Commission was passed by the legislature in 1891 and is as follows:

### STATE OF MAINE.

CHAPTER 100.

AN ACT to create a Forest Commission and for the Protection of Forests.

SECT. 1. The state land agent is hereby made forest commissioner of the state of Maine, and in addition to the salary now received by him as land agent, he shall receive as compensation for his services as forest commissioner two hundred dollars per annum, and his actual traveling expenses incurred in the performance of his duties, an account of which shall be audited by the governor and council.

SECT. 2. It shall be the duty of the forest commissioner to make a collection and classification of statistics relating to the forests and connected interests of the state, and to institute an inquiry into the extent to which the forests of Maine are being destroyed by fires and by wasteful cutting, and to ascertain so far as he can as to the diminution of the wooded surface of the land upon the water sheds of the lakes, rivers and water powers of the state and the effect of such diminution upon the water powers and on the natural conditions of the climate. The information so gathered by him, together with his suggestions relative thereto shall be included in a report to be made by him annually to the governor on or before the first day of December.

SECT. 3. 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 select-

men 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.

SECT. 4. County commissioners of each county in which there are unorganized places shall annually appoint, when they deem it necessary, such number of fire wardens as they deem necessary not exceeding ten, for all such unorganized places in any county, whose duties and powers shall be the same with respect to such unorganized places as those of the fire wardens of towns, and they shall also have the same authority to call out citizens of the county to aid them in extinguishing fires, that town fire wardens have to call out citizens of the town. The compensation of such fire wardens shall be paid by the county, and the compensation of persons called upon by them as aforesaid, to render aid shall be the same as that provided in the case of towns and shall be paid one-half by the county and one-half by the owners of the lands on which said fires occur.

SECT. 5. Any person who shall build a camp or cooking fire in or adjoining any woods in this state, shall, before leaving such camp, totally extinguish such fire, and upon failure to do so, such person shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be punished by a fine not exceeding one hundred dollars, or by imprisonment in the county jail not exceeding one month or by both such fine and imprisonment, provided, that such fires built upon the sea beach in such situation that they cannot spread into forest wood or cultivated lands or meadows, shall not be construed as prohibited by this act.

SECT. 6. It shall be the duty of selectmen in towns within thirty days after this act shall take effect, to cause to be erected 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 towns, notice 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 dollars fine, or both as provided by law. Signed, Forest Commissioner. The forest commissioner shall furnish owners of wood lands situated within this state when called upon so to do, notices of similar tenor to be posted at the expense of said owners upon their respective lands.

SECT. 7. All persons engaged in hunting game on any of the wood lands within any town or unincorporated place in this state, shall use non-combustible wads in the loading of firearms used by them.

SECT. 8. It shall be the duty of municipal officers in towns, and county commissioners, the latter with respect to unorganized places, to 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.

SECT. 9. 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, specify the value of timber as near as may be, and 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.

SECT. 10. Every railroad company whose road passes through waste or forest lands, shall during each year cut and burn off or

remove from its right of way all grass, brush or other inflammable material, but under proper care and at times when fires are not liable to spread beyond control.

SECT. 11. All locomotives which shall be run through forest lands, shall be provided with approved and efficient arrangements for preventing the escape of fire and sparks.

SECT. 12. No railroad company shall permit its employes to deposit fire, live coals or ashes, upon their track in the immediate vicinity of wood lands or land liable to be overrun by fires, and where engineers, conductors or train men discover that fences along the right of way or wood lands adjacent to the railroads, are burning or in danger from fire, it shall be their duty to report the same at their next stopping place which shall be a telegraph station.

SECT. 13. For all damages caused to forest growth by any person employed in the construction of any railroad hereafter to be built in this state the company owning such road shall be primarily liable to the person or persons so damaged. During the construction of such roads through wood land, there shall be kept posted in conspicuous places on each line of the road ways at distances of two hundred feet, abstracts of the laws relating to forest fires. Any person employed in the construction of such railroads, who shall set or cause to be set any fire along the line of said roads, shall, before leaving the same, totally extinguish said fires, and upon failure to do so, such person shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be punished by a fine of not exceeding five hundred dollars or by imprisonment in the county jail not exceeding sixty days, or by both such fine and imprisonment. It shall be the duty of all persons having charge of men in the construction of such railroads, to see that the provisions of this section are carefully complied with, and any negligence or want of ordinary care on their part in relation to the same shall constitute a misdemeanor, and upon conviction thereof, they shall be liable to the penalties imposed by this section.

SECT. 14. Any railroad company violating the requirements of this act, shall be liable to a fine of one hundred dollars for each offense.

SECT. 15. The forest commissioner shall take such measures as the state superintendent of common schools and the president

Fish River Railroad near Winchell's Landing, showing heavy growth of spruce timber.

of the state college of agriculture and the mechanic arts may approve, for awakening an interest in behalf of forestry in the public schools, academies and colleges of the state, and of imparting some degree of elementary instruction upon this subject therein.

SECT. 16. The forest commissioner shall prepare tracts or circulars of information, giving plain and concise advice for the care of wood lands and for the preservation of forest growth. These publications shall be furnished to any citizen of the state upon application.

SECT. 17. It shall be the duty of the forest commissioner to cause, at the expense of the state, copies of this chapter and all other laws of the state relating to forest fires to be printed and freely distributed to the selectmen of all the towns of the state, whose duty is shall be to post them up in school houses, saw mills, logging camps and other places, and similar copies shall be furnished to owners of forest lands, who may apply for them, to be posted up at the expense of such owners. Any person viciously or wantonly tearing down, destroying or defacing any such notices, shall on conviction therefor, be punished by a fine of five dollars.

SECT. 18. All acts and parts of acts inconsistent with the provisions of this act, are hereby repealed, but none of the penalties proposed by this act shall be considered as substitutes for or as repealing the provisions of existing laws, making persons guilty of acts of trespass or liable for civil damages to persons injured by such acts.

[Approved March 25, 1891.]

# CONCLUSIONS AND RECOMMENDATIONS,

Including references to valuable papers contributed by practical and scientific students of forestry.

Photo taken in Nashville Plantation, showing a sound pine log overgrown by a birch, which when cut was more than 100 years old.

## CONCLUSIONS AND RECOMMENDATIONS.

Early in the present year I was able to perfect arrangements with Hon. Gifford Pinchot, the head of the Forestry Bureau of the United States, for co-operative work between the National Bureau of Forestry and the Forestry Department of this State. Mr. Pinchot agreed to send to Maine a competent force of his best men. Early in July this agreement was carried out and Ralph S. Hosmer of New Haven, Conn., accompanied by ten men, arrived in the State and began experiments at Squaw Mountain township, near Moosehead lake. This place was considered the best adapted for the work in view. For ten weeks the members of Mr. Hosmer's party labored and studied the forest conditions of the section in which they were located, in the interests of the State as well as the National government. The result of their investigations and experiments will be found in this report.

Mr. Hosmer is a field assistant attached to the Bureau of Forestry. He is a graduate of the School of Forestry, connected with Yale College, and is thoroughly practical in his work. His report will be found of more than ordinary interest, for he describes with minute detail every phase of the subject and gives his reasons for every idea advanced in a clear and lucid manner.

Prof. Munson's interesting article on the distribution of plants in forest regions explains how nature will reseed our waste lands and that, without the use of plow and axe, only a few years would elapse before the land now cleared throughout the State would again be covered with a thrifty growth of soft and hard woods.

The special article on the system of logging practiced by the Berlin Mills Company should be read carefully by every wild land owner and lumberman in the State. There is no doubt that this company is cutting its lands to better advantage than any other concern in the State, although the M. G. Shaw Lumber

Company has for a number of years worked over its lands with great care, sawing down its trees and taking therefrom all the wood of any value. The tendency, however, is rapidly growing with land owners and lumbermen that our forests are becoming of too great value to continue the wasteful cutting that has been carried on in the past, and that log cutting with a view of getting the most that is possible from our forests, will eventually be carried on with as much care and skill as is used in other lines of business of the same magnitude. Care in the economical cutting of our forests is the first principle of forestry.

What Mr. Cary says in his article of the ravages of spruce by beetles up to this time, applies only to the extreme western part of the State, but little if any damage having been done outside of the Androscoggin valley.

The beetle or saw fly which, twenty years ago, destroyed all the larch or juniper trees in New England and New York, have disappeared, and reports from the forest sections show that large quantities of this wood are again growing in all the wooded areas of the State.

In conclusion, I wish to reiterate what I have previously said that the greatest danger to our forests is from fire. With reasonable care in cutting, judging from the conservative estimates of standing timber which have been obtained, there need be no fear of our forests being destroyed through the inroads made in the timber belts by the pulp and lumber industries of the State.

In this connection, however, looking at the proposition from the point of view of a forester and one deeply interested in the preservation of our forests, I believe the laws should be so changed as to impose the payment of a license fee upon every non-resident hunter. As the law now stands sportsmen can and do come in large numbers from outside the State, taking advantage of the low rates of fare to Maine over some of the western railroads, large parties in many cases employing only one registered guide, roam the woods at will and wantonly kill all game in sight, regardless of limit.

Such practices, leaving the question of the game supply out of consideration, are dangerous to our forests. These men have no interest in the woods other than of pleasure and profit. They are in a great measure irresponsible and are promiscously lighting fires which endanger our forests, which are the greatest wealth of our State.

From statistics which have been gathered it appears that the fires which have swept over valuable timber sections of the State have occurred in October in dry seasons, and recurrences of these devastating fires may certainly be expected unless some check is placed upon the careless non-resident sportsmen.

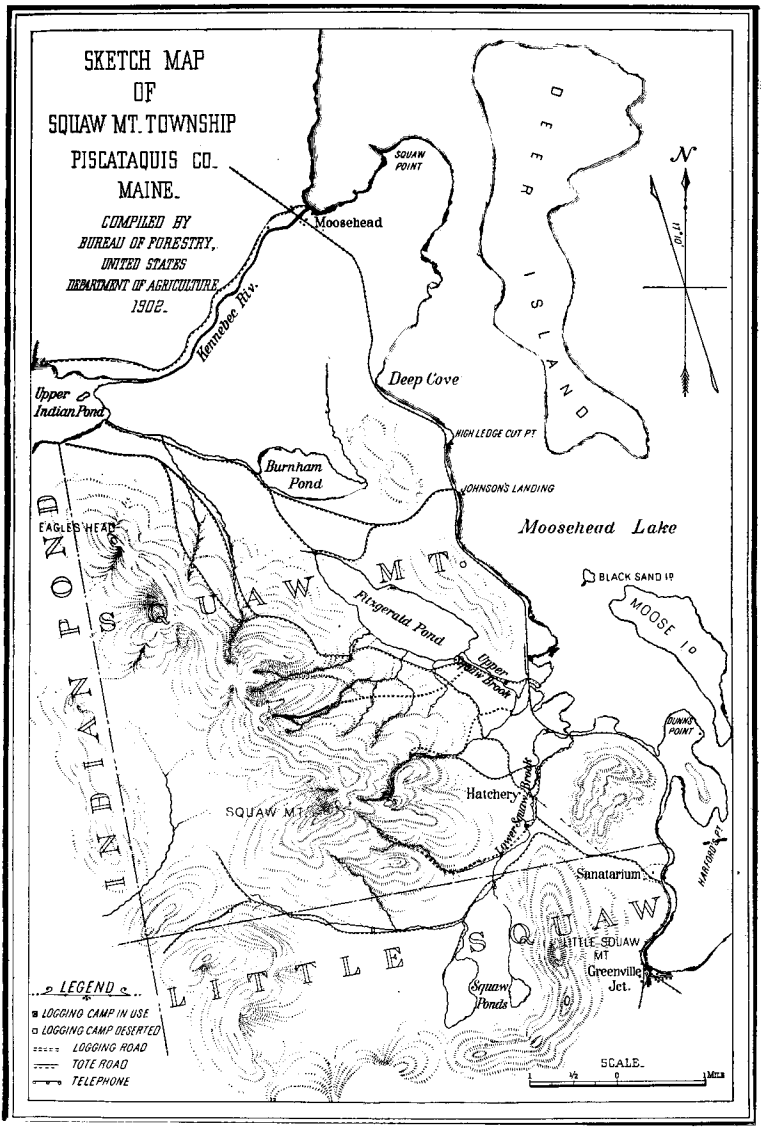
I believe every non-resident sportsman should be obliged to pay a license fee for the privilege of hunting in the State. The receipts from this source would permit the employment of more game wardens, who also act as fire wardens, to protect our extensive forests, especially in the open season, thereby greatly lessening the danger from fires. If non-residents are not to be compelled to pay a license fee of at least ten dollars, to be expended for warden service, I recommend that an appropriation be made to enable this department to employ a force of fire wardens to patrol our forests through the dry seasons.

EDGAR E. RING,

*Forest Commissioner.*

# A STUDY OF THE MAINE SPRUCE.

By Ralph S. Hosmer, M. F. (Yale), Field Assistant in the Bureau of Forestry, U. S. Department of Agriculture.


SKETCH MAP
OF
SQUAW MT. TOWNSHIP
PISCATAQUIS CO.
MAINE.
COMPILED BY
BUREAU OF FORESTRY,
UNITED STATES
DEPARTMENT OF AGRICULTURE,
1902.
Kennebec Riv.
Moosehead
SQUAW POINT
DEER ISLAND
N
11° 00'
Deep Cove
Upper Indian Pond
HIGH LEDGE CUT PT.
Burnham Pond
JOHNSON'S LANDING
Moosehead Lake
EAGLES HEAD
PISCATAQUIS
SQUAW MT.
Fitzgerald Pond
BLACK SAND I.
MOOSE I.
Upper Squaw Brook
BUNKS POINT
Hatchery
SQUAW MT.
Lower Squaw Brook
Sanatarium
HARFORD PT.
LITTLE SQUAW
LITTLE SQUAW MT
Greenville Jct.
Squaw Ponds
LEGEND
LOGGING CAMP IN USE
LOGGING CAMP DESERTED
LOGGING ROAD
TOTE ROAD
TELEPHONE
SCALE.
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0
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# A STUDY OF THE MAINE SPRUCE.

SUMMARY.

The more important conclusions reached from the study of forest conditions on cut-over land in Maine, the results of which are given in the following pages, may thus be summarized:

(1) Upon the forest land of the same general character as Squaw Mountain Township practical forestry may with advantage be introduced, particularly on lands held to supply continuously the demands of large pulp or saw-mills.

(2) To insure the best results from conservative methods it is advisable that working plans be prepared, which, taking into account the local conditions of each forest, will outline for each the form of management by which the best results may be attained.

(3) In adopting a system of conservative lumbering in which the cut is limited to a given diameter, the higher limits are generally preferable, because their use leaves the forest in better condition after lumbering than when a smaller limit is used. The diameter limit is, however, subject to modifications as the result of the character of the forest and the requirements of the owner.

(4) In carrying out the recommendations advised in the working plan the marking of the trees to be felled and the competent inspection of the lumbering are considered essential to the success of the work.

(5) In every lumbering operation care should be taken to prevent waste. It is to the advantage both of the owner of the land and of the contractor to utilize as much of the merchantable tree as possible, by felling with the saw, by cutting low stumps, and by running the logs well up into the tops. Waste should be avoided, as far as possible, by using the less valuable trees in the

building of structures necessary to the lumbering, while care should be taken that no mechantable logs are left in the woods.

(6) The hardwoods should be lumbered wherever possible, both because of their value and because of the improvement to the forest caused by their removal.

(7) Damage to young growth in lumbering impairs the capacity of the forest for the production of a second cut, and is largely avoidable without added expense.

# A STUDY OF THE SPRUCE ON CUT-OVER LAND IN MAINE.

## INTRODUCTION.

The object of this report is to set forth the results of a study of the Spruce on cut-over land in Maine, made during the summer of 1902 by the Bureau of Forestry of the United States Department of Agriculture in co-operation with the Honorable Edgar E. Ring, Land Agent and Forest Commissioner of Maine.

The work, the results of which are given in the following pages, was undertaken as the starting point in a thorough investigation of the Maine forests. It is the first attack on a very large problem, of which so far the only published studies from the point of view of the forester are those of Mr. Austin Cary, which appeared in the reports of the Forest Commissioner of Maine in 1894 and 1896.* The purpose of the first season's work was to study the life history of the Spruce, and, so far as possible, of the trees with which it occurs in mixture. It included an investigation of the rate of growth of Spruce in height and diameter, as influenced by differences in topography, aspect, and forest type, of its distribution, and of the conditions necessary to its successful reproduction. Particular attention was given to the present methods of lumbering and their effect upon the forest, and to devising modifications which are practicable and advisable in hastening the production of a second crop upon the lumbered area.

In attacking this phase of the general problem it was believed that in the limited time at the disposal of the party, the best results could be attained from a detailed study of one area. The investigation was therefore confined for the most part to one

*Second Annual Report of the Forest Commissioner of the State of Maine, Augusta. 1894, pp. 14-102.

Third Annual Report, 1896, pp. 15-203.

township, which was selected as being typical of much of the forest land in the central part of Maine. The conclusions reached are applicable to land similar in topography and of the same forest type as that studied, and are intended to assist owners of such lands in the care of their forests on the lines of conservative forest management.

The locality selected for the investigation was Squaw Mountain Township, Piscataquis County, Maine, on Moosehead Lake. Here the work was carried on during the months of July, August, and September by a party of ten men, with headquarters at the new Moosehead State Fish Hatchery, built the previous autumn, which is conveniently located on the Lower Squaw brook at the intersection of two of the main tote roads on the township.

Acknowledgments are due to Hon. Edgar E. Ring for assistance and suggestion in regard to the work; to Mr. C. C. Nichols, superintendent of the Moosehead Hatchery, for courtesies extended to the party during the season; and to Messrs. Charles D. and Will M. Shaw, of the M. G. Shaw Lumber Company of Greenville, the owners of the township, for the many favors and special privileges granted the writer, which were of material assistance to him in the work.

## THE TRACT.

### SITUATION.

Squaw Mountain township, or, as it appears on some maps, Township 2, Range 6, B. K. P., E. K. R., shown on the accompanying sketch map (Plate I) is an unorganized town lying about midway on the western border of Piscataquis County, at the outlet of Moosehead Lake. It is bounded on the east and north by Moosehead Lake and the Kennebec River, while its southern and western limits are lines approximately six miles in length and running respectively N. 84° W. and N. 6° E.

The township is crossed by the Canadian Pacific Railway, which follows the shore of Moosehead Lake from Deep Cove to Greenville Junction. Moosehead station is at the outlet of the lake. The township is easily reached by land or water from Greenville Junction, the terminus of a branch of the Bangor and Aroostook Railroad.

LAND CUT OVER THIRTY YEARS AGO.

Another group of spruce containing some large trees left at the former lumbering.

Numerous logging and tote roads render the various portions of the township easy of access. And, to add to convenience in communication, a long distance telephone connects the Moosehead Hatchery with Greenville.

TOPOGRAPHY.

Rising from the shores of Moosehead Lake, Squaw Mountain lies as a great L-shaped ridge across the center of the township, the longer arm having the general direction of north northwest to south southeast, and the shorter one, on which is the highest peak, northeast to southwest. The altitude of Squaw Mountain, as given in Hubbard's map of Northern Maine, is 3,262 feet above the sea.

For a distance of about a mile from the lake, the slope is gentle, but as one ascends the mountain it becomes steeper, until near the summit of the ridge it is in many cases nearly precipitous. Numerous spurs break the outline of the main ridge, and form large coves between them. The mountain is wooded, save where fire has cleared the main summit and the smaller peak, known as Eagle's Head, at the north end of the ridge. Although steep, the sides of the mountain have not suffered from excessive erosion, nor are there any slides, as on some of the other high mountains in the State. The northeastern part of the township, from Burnham Pond to Squaw Point, is a gently rolling flat, while a succession of low hills border the lake from Deep Cove to the Little Squaw Mountain ridge.

All the streams on the township are tributary to the Kennebec river, either through Moosehead Lake or by flowing directly into Indian Pond. There are four principal water sheds on the township: (1) The valley of the Kennebec River and the land in the vicinity of Burnham Pond, all of which drains into Upper Indian Pond; (2) Fitzgerald Pond and its tributary streams, emptying into Moosehead Lake through the Upper Squaw Brook; (3) Lower Squaw Brook, draining the Squaw ponds on Little Squaw Township and also flowing into the lake, and (4) the valley to the west of Squaw Mountain which outlets into Indian Stream and the Kennebec River. The altitude of Moosehead Lake is 1,023 feet above the sea.* Fitzgerald and Burnham Ponds are not

*The Water Power of Maine. Water Wells. Augusta, 1869, p. 93.
A recent survey (July, 1901), by the Bangor and Aroostook Railroad, gives the elevation of the lake as 1,029.7 feet above the sea.

many feet higher than the lake; but on the Lower Squaw Brook there is considerable fall from the Squaw ponds to the outlet. The shores of Moosehead Lake are for the most part formed by rock outcrops, and the forest comes to the water's edge.

### ROCK AND SOIL.

The rock on the greater part of the township is a mica schist, but near the shore of Moosehead Lake, along the Canadian Pacific Railway, there are outcrops of slate. The mineral soil varies from a sandy to a clayey loam, most of the soil of the township having a distinct admixture of clay. There are also deposits of sand and gravel of glacial origin, and, in the swamps, a considerable stratum of vegetable soil.

### BRIEF HISTORY.

Squaw Mountain Township is included in "Bingham's Kennebec Purchase." This tract was sold to William Bingham by Massachusetts, January 28, 1793, and is sometimes called the "Million Acre Purchase." Little is known of the history of the individual townships, but between 1845 and 1850 Squaw Mountain Township was acquired by the Crooker estate of Bangor, by which it was sold, soon after 1860, to Mr. M. G. Shaw, the founder of the company by which it is at present owned.

The first lumbering on the township was of White Pine. The shores of the Kennebec River and the northeastern part of the township were first cut over, and subsequently all the lower lying part of the township. The first logging operations by Mr. Shaw were in the winter of 1863-1864, when two jobbers worked for him on the township; one cutting Pine and Spruce to the west of Burnham Pond and landing it in Upper Indian Pond; the other working on the Lower Squaw Brook and hauling into Moosehead Lake. These operations continued for several winters, and, in addition to the Pine and Spruce which made the principal crop, some Tamarack, Cedar, Hemlock, and Black Ash were cut.

In 1867 and 1868 other jobbers worked on Spruce and Pine in the vicinity of Fitzgerald and Burnham Ponds. Their work was continued in subsequent years near Upper Indian Pond. In

1870-1871 a jobber named Tom Young worked on the southeast side of Squaw Mountain, in a valley which still bears his name, and which is at present again being logged for Spruce.

Up to this time only the best and largest trees were cut, none smaller than twelve to fourteen inches in diameter on the stump. For many years the rule was to cut no tree unless it would make a stick twenty-four feet long and eight inches in diameter at the small end. In practice, however, the top diameter limit was much nearer ten inches.

After 1875, there was an interval of eight years when no lumbering was done on the township, but in 1883 cutting began once more in the vicinity of Burnham pond, and continued for several years. In this case the trees were cut somewhat closer, the rule being to take any tree that would make a log thirty feet long and seven inches at the top, which means practically eleven inches on the stump. This rule holds for saw logs at the present time.

From 1886 until 1893 logging was going on in the large valley to the west of Squaw Mountain. After this came an interval of three years, when the present operations on the east and south sides of the mountain began. This work, begun in 1896, covers the land cut over thirty and forty years ago, as well as the virgin forest higher up on the slopes than the earlier lumbermen cared to go. Prior to 1896 all the logs cut on the township were saw-logs, and most of them went down the Kennebec River to the Shaws' own mill at Bath. In 1896 logs were first cut for pulp, and sawing in place of chopping was introduced. The rule in regard to pulp logs is to cut any tree which will make a stick twenty-four feet long and six inches in diameter at the top, or to a diameter of about nine inches on the stump. In the recent work care has been taken to cut low stumps and to utilize as much as possible of the felled tree.

In the nearly pure stand of Spruce on the exposed upper slopes of Squaw Mountain the recent lumbering amounted to practically clear cutting. Everything that was merchantable was taken—even closer than the above rule would indicate—while owing to the method of lumbering necessitated by the steep and rough slope many of the smaller trees were also cut. One or two limited areas were absolutely clear cut, that the merchantable logs might be rolled down the slope to the yard.

REASONS FOR SELECTION.

The selection of Squaw Mountain Township as the place where this investigation should be carried on was determined by several considerations.

Because of its varied topography, this township presents within a limited area a number of forest conditions which may be taken as representative of the principal types of forest common to central Maine. On it were areas of original forest, land cut over for Pine and Spruce saw-logs, areas cut over a second time, places where the spruce has been cut for pulp, and others where the forest had been clean cut. There are also localities where hardwoods have been lumbered, while burns and areas of windfall are likewise present.

Logging has been in progress on the township for the last six years, and is now going on, affording an excellent opportunity for stem analyses on land previously cut over, as well as in virgin stands. There was opportunity for a study of the effect of lumbering on the forest, and to see what was taking place soon after the cutting in the reproduction of Spruce and other species. The lumbering of hardwoods during the summer of 1902 made it possible to collect data for them also.

Squaw Mountain Township has been owned and lumbered for over forty years by one company. Through the courtesy of the owners, the M. G. Shaw Lumber Company, of Greenville, the definite history of the different operations was available, including the scale bills of the various jobs, so that a close idea could be got as to what definite areas had produced at the first cutting in comparison with the present stand.

From personal examination and from conversations with men interested in other forest land in the central part of Maine, the writer believes that he is justified in considering Squaw Mountain Township as typical of much of the surrounding country where similar conditions of topography and the same types of forest obtain. The work was therefore carried on with the idea of getting from it conclusions of practical value to owners of forest land so situated.

## THE FOREST.

The forest on Squaw Mountain Township is a mixed forest of conifers and broadleaf trees, of the general type common throughout northern New England and the Adirondack region of New York. The conifers predominate, and the commercially important tree is the Red Spruce (*Picea rubens* Sargent).* The trees which make up the bulk of the forest are, in the order of their abundance on the township: Spruce, Balsam, Yellow Birch, Beech, Sugar Maple, Arborvitæ, commonly known as White Cedar, Paper Birch, Hemlock, Black Ash, Aspens, commonly known as Poplars, and White Pine. With these are associated White Elm, Black Spruce, Red or Norway Pine, Tamarack, locally known as Juniper, Hornbeam, Wild Red (Bird) Cherry, Red Maple, and Mountain Ash. The underbrush is mainly Mountain or Spotted Maple, Moosewood, or Striped Maple, and Witch Hobble, and, in the swamps, Alder and Willow.

A list of all the trees and of the principal shrubs found on Squaw Mountain Township is given at the end of this report. This list includes, besides those already mentioned, the names of the scattered individuals of other species of trees which are also found on the township.

### FOREST TYPES.

In order to study the forest in detail it was found advisable to classify it according to the principal forest types. These types, four in number, are Swamp, Flat, Spruce and Hardwood Land, and Spruce Slope. Two of the types, Spruce and Hardwood Land and Spruce Slope, were subdivided into Upper and Lower, the variations within the main type depending on differences of habit rather than on a change in the composition of the forest. The chief attention was paid to the Spruce and Hardwood Land and to the Spruce Slope, and it is believed that the tabulated results are thoroughly typical. The limitations of time made it impossible to pay the same attention to the types of Swamp and Flat. For this reason no type tables are given for these types. A description of each type follows:

*Whenever the word Spruce is used alone throughout this report it refers to this tree.

SWAMP.

The Swamp occupies the low lying areas of the township, especially near the lake west of Deep Cove and in the vicinity of Fitzgerald and Burnham Ponds. It is flat, poorly drained land, on part of which standing water may be found throughout the year. The soil is a muck or peat, and the ground cover consists of sphagnum moss and low water loving herbaceous plants.

The typical trees of the swamp are the Arborvitæ, (White Cedar), Balsam, Tamarack, (Juniper), Black Ash, Red Maple, White Elm, and Black Spruce. On knolls and small ridges which rise above the general level of the swamp and are fairly well drained, grow the Red Spruce, White Pine, and scattered hardwoods. These elevations do not properly belong to the Swamp type, but are too small in area and too few in number to be treated separately.

The most important tree of the Swamp type is the Arborvitæ (White Cedar), which grows in mixture with the Balsam, making trees of good size and quality. The Spruce growing in the Swamp does not reach the height nor size that it attains on the other types of forest, but it is still an important tree in the mixture.

FLAT.

The Flat is an important type in Maine, and one which, especially on the Penobscot waters, is widely distributed. On Squaw Mountain Township it embraces the lower part of the township on ground slightly higher than the Swamp. The land to the north and east of Burnham Pond and to the northwest of Fitzgerald Pond belongs to this type. It is marked by the predominance of conifers, especially Spruce, Balsam, and White Pine. On the Flat grew the White Pine, of which in former times there was a fine stand on the township. Of the broadleaf trees found in mixture on the Flat, the Yellow Birch and the Beech are the most abundant except on old burns or cleared areas, where Paper Birches and the Aspens have come up thickly. On the points running out into the lake to the east of the railroad, are found dense stands of Spruce and Balsam, among which are the stumps of the great White Pines of the

LOWER SPRUCE AND HARDWOOD LAND.
A group of spruce of good size and quality.

original forest, or, if the point has been cleared, a thick cover of Paper Birches.

The Flat is the transition type between the Swamp and the Spruce and Hardwood Land, and in many ways resembles each of them.

### SPRUCE AND HARDWOOD LAND.

The Spruce and Hardwood Land type is the most important one on Squaw Mountain township. It is characterized by well drained land and occupies the lower slopes of the mountain, where the spruce is found in mixture with the hardwoods. It ranges in altitude from 1,100 feet to 2,000 feet. Both the Spruce and the hardwoods here reach their best development, and the forest contains the greatest number of trees in mixture.

For purposes of comparison this type was subdivided into Upper and Lower Spruce and Hardwood Land. On these sub-types the character of the forest is not essentially different, but the habit and development of the trees exhibit slight differences. In the valuation surveys the diameter of the stumps of trees cut in former lumbering operations were measured. By the use of tables showing the relations between diameter at stump height and at breast height, it was possible to show in the type tables the size and number of merchantable trees standing before the lumbering. In order to compare the original stand of Spruce with that now on the township, the average number of trees and their percentage in mixture on the type before lumbering took place, is given at the bottom of each of the type tables.

The following tables, based on the valuation surveys run in the Spruce and Hardwood Land, show for the two sub-types mentioned above, the average number of trees per acre of all species, ten inches and over in diameter breast high, their average and maximum diameters, and the percentage of each species in mixture.

TABLE No. 1.

LOWER SPRUCE AND HARD WOOD LAND.

Trees 10 inches and over in diameter, breasthigh, on 105 acres.

| Species. | Average number of trees per acre. | Percentage of each species. | Average diameter breast high—inches. | Maximum diameter breast high—inches. |
|---|---|---|---|---|
| Yellow Birch | 13.55 | 17.39 | 17.2 | 34 |
| Beech | 13.13 | 16.85 | 12.5 | 24 |
| Spruce | 11.25 | 14.44 | 13.2 | 24 |
| Sugar Maple | 9.60 | 12.32 | 14.3 | 28 |
| Hemlock | 7.06 | 9.06 | 17.4 | 33 |
| 5-year Spruce stumps | 4.49 | 5.76 | 14.5 | 26 |
| 30-year Spruce stumps | 4.27 | 5.48 | 16.4 | 30 |
| 12-year Spruce stumps | 4.06 | 5.21 | 15.4 | 32 |
| 20-year Spruce stumps | 4.00 | 5.13 | 15.7 | 26 |
| Arborvitæ | 2.14 | 2.75 | 12.9 | 23 |
| Balsam | 1.07 | 1.37 | 11.3 | 16 |
| 1-year Spruce stumps | .82 | 1.05 | 15.3 | 27 |
| 40-year Spruce stumps | .53 | .68 | 16.8 | 27 |
| 3-year Spruce stumps | .41 | .53 | 15.2 | 24 |
| Black Ash | .29 | .37 | 12.6 | 20 |
| Arborvitæ stumps | .26 | .33 | 19.6 | 31 |
| Dead Hemlock | .13 | .17 | 18.5 | 26 |
| Dead Spruce | .12 | .15 | 14.3 | 22 |
| Dead Arborvitæ | .10 | .13 | 14.8 | 19 |
| Paper Birch | .06 | .08 | 15.3 | 21 |
| Dead Beech | .05 | .07 | 15.1 | 24 |
| Dead Balsam | .04 | .05 | 14.0 | 16 |
| Dead Yellow Birch | .03 | .04 | 21.5 | 26 |
| Aspens | .01 | .01 | 15.0 | 15 |
| Dead Sugar Maple | .01 | .01 | 11.0 | 11 |
| White Pine | ..... | ..... | ..... | ..... |
| Spruce windfalls | ..... | ..... | ..... | ..... |
| Other hard woods | .44 | .57 | 12.9 | 25 |
| All species | 77.92 | 100.00 | 14.8 | ..... |
| Original Spruce stand | 29.95 | 38.43 | ..... | ..... |

TABLE No. 2.

UPPER SPRUCE AND HARD WOOD LAND.

Trees 10 inches and over in diameter, breasthigh, on 98 acres.

| Species. | Average number of trees per acre. | Percentage of each species. | Average diameter breast high—inches. | Maximum diameter breast high—inches. |
|---|---|---|---|---|
| Beech | 12.33 | 16.46 | 13.1 | 26 |
| Spruce | 12.13 | 16.19 | 13.1 | 24 |
| Yellow Birch | 11.52 | 15.38 | 17.0 | 34 |
| 5-year Spruce stumps | 9.82 | 13.11 | 14.8 | 28 |
| 30-year Spruce stumps | 7.78 | 10.39 | 17.1 | 29 |
| Sugar Maple | 7.69 | 10.26 | 15.1 | 31 |
| Hemlock | 3.94 | 5.26 | 16.7 | 31 |
| 1-year Spruce stumps | 3.80 | 5.07 | 14.3 | 24 |
| Arborvitæ | 1.30 | 1.73 | 12.9 | 27 |
| Balsam | .92 | 1.23 | 11.0 | 23 |
| Black Ash | .54 | .72 | 13.4 | 21 |
| 3-year Spruce stumps | .42 | .56 | 14.8 | 24 |
| Yellow Birch stumps | .39 | .52 | 17.2 | 24 |
| Paper Birch | .36 | .48 | 13.4 | 22 |
| Hemlock stumps | .29 | .39 | 20.2 | 27 |
| Dead Sugar Maple | .21 | .28 | 14.3 | 21 |
| 20-year Spruce stumps | .15 | .20 | 18.3 | 22 |
| Arborvitæ stumps | .12 | .16 | 11.7 | 20 |
| 40-year Spruce stumps | .09 | .12 | 16.2 | 22 |
| Aspens | .06 | .08 | 11.1 | 13 |
| Dead Spruce | .05 | .07 | 17.1 | 21 |
| Dead Beech | .05 | .07 | 13.6 | 16 |
| Dead Balsam | .02 | .03 | 13.4 | 16 |
| Dead Yellow Birch | .02 | .03 | 25.3 | 29 |
| White Pine | .02 | .03 | 42.4 | 48 |
| Dead Hemlock | .01 | .01 | 11.0 | 11 |
| Dead Arborvitæ | .01 | .01 | 13.0 | 13 |
| Spruce windfalls | ..... | ..... | ..... | ..... |
| Other hard woods | .84 | 1.12 | 12.3 | 19 |
| Other hard wood stumps | .03 | .04 | 10.0 | 10 |
| All species | 74.91 | 100.00 | 14.9 | ..... |
| Original Spruce stand | 34.24 | 45.71 | ..... | ..... |

SPRUCE SLOPE.

Above the Spruce and Hardwood Land, on the steep slopes of the mountain, lies the Spruce Slope. The type is characterized by a dense and nearly pure stand of conifers with the Spruce predominating. On the steep and rocky slopes the soil is thin and the trees are shallow rooted, so that after an opening is made in the forest many of the remaining trees are thrown by the wind. Near the summit of the ridge the trees become too short and scrubby to be of commercial importance.

This type was also subdivided into its upper and lower portions; but it should be stated that the Upper Spruce Slope is still within the belt of merchantable timber.

The following table based on the valuation surveys run in the Spruce Slope shows the average number of trees per acre, of all species, ten inches and over in diameter breast high, their average and maximum diameters, and the percentage of each species in mixture.

TABLE No. 3.

SPRUCE SLOPE.

Trees 10 inches and over in diameter, breasthigh, on 20 acres.

| Species. | Average number of trees per acre. | Percentage of each species. | Average diameter breast high—inches. | Maximum diameter breast high—inches. |
|---|---|---|---|---|
| 5-year Spruce stumps | 25.25 | 32.41 | 15.3 | 28 |
| Spruce | 19.70 | 25.29 | 13.5 | 24 |
| 1-year Spruce stumps | 14.85 | 19.06 | 13.8 | 26 |
| Yellow Birch | 5.55 | 7.13 | 16.6 | 45 |
| 30-year spruce stumps | 2.65 | 3.40 | 17.0 | 28 |
| Paper Birch | 2.45 | 3.15 | 12.0 | 16 |
| Sugar Maple | 1.70 | 2.18 | 15.9 | 26 |
| Spruce windfalls | 1.00 | 1.28 | 14.1 | 26 |
| Beech | .95 | 1.22 | 14.2 | 22 |
| Balsam | .80 | 1.03 | 12.4 | 16 |
| Balsam stumps | .60 | .77 | 12.3 | 16 |
| Dead Spruce | .50 | .64 | 17.7 | 22 |
| Paper Birch stumps | .45 | .58 | 12.4 | 15 |
| Yellow Birch stumps | .20 | .26 | 13.7 | 17 |
| Balsam windfalls | .20 | .26 | 11.8 | 14 |
| Dead Yellow Birch | .15 | .19 | 14.6 | 20 |
| Arborvitæ | .10 | .13 | 18.7 | 21 |
| Hemlock | .10 | .13 | 14.2 | 16 |
| Dead Balsam | .05 | .06 | 10.6 | 10 |
| Hard wood windfalls | .05 | .06 | 10.0 | 10 |
| Arborvitæ stumps | .05 | .06 | 14.0 | 14 |
| Aspens | | | | |
| Other hard woods | .55 | .71 | 14.6 | 19 |
| All species | 77.90 | 100.00 | 14.5 | |
| Original Spruce stand | 63.95 | 82.08 | | |

VIRGIN FOREST.

In order to compare the stand on cut-over land with that of the original forest, and as an example of what is possible when all the conditions for growth are favorable, valuation surveys were run in the belt of virgin forest lying on the south and southeast slopes of Squaw Mountain. This belt, which is now being logged, is the last of the original forest on Squaw Mountain township. It lies in the Lower Spruce Slope type, and consists of a heavy stand of large and mature trees, of the first

SPRUCE ON SPRUCE SLOPE.

A dense stand of spruce, suitable for pulp. Subject to wind throw unless clean cut.

quality. It represents a class of forest of which very little is now left in Maine.

The following table, based on the valuation surveys run in the virgin forest, shows the number of trees per acre, of all species, ten inches and over breast high, the average and maximum diameters, and the percentage of each species in mixture.

TABLE No. 4.

VIRGIN FOREST.

Trees 10 inches and over in diameter, breasthigh, on 20 acres.

| Species. | Average number of trees per acre. | Percentage of each species. | Average diameter breast high—inches. | Maximum diameter breast high—inches. |
|---|---|---|---|---|
| Spruce | 52.60 | 65.46 | 14.7 | 27 |
| Yellow Birch | 11.50 | 14.31 | 15.0 | 29 |
| Sugar Maple | 4.60 | 5.73 | 12.9 | 21 |
| Paper Birch | 3.30 | 4.11 | 11.4 | 16 |
| Balsam | 2.15 | 2.68 | 11.1 | 14 |
| Beech | 1.45 | 1.81 | 11.8 | 16 |
| Hemlock | .55 | .68 | 16.1 | 24 |
| Arborvitæ | .50 | .62 | 13.4 | 17 |
| Black Ash | .10 | .12 | 10.0 | 10 |
| Aspens | | | | |
| Dead Spruce | | | | |
| Spruce windfalls | | | | |
| Other hard woods | 3.60 | 4.48 | 12.6 | 19 |
| All species | 80.35 | 100.00 | 14.3 | |

## THE SPRUCE.

The Spruce predominates on Squaw Mountain Township. It appears in all the types, forming a large percentage of the trees in mixture, and is the tree of greatest commercial importance. In the present study, greater attention was paid to its growth and development on the Spruce and Hardwood Land and the Spruce Slope types, because it was felt by the writer that the time of the party would be better occupied by so doing, since these types are those most widely distributed in the mountainous parts of central Maine. The Flat, more typical of the northern part of the State, could very properly be made the subject of further investigation.

REPRODUCTION.

One of the objects of this investigation was to study the reproduction of Spruce on cut-over land. Observations were made of the Spruce bearing cones and of the young seedlings on the ground in order to investigate the habit of the species in seed-bearing and in the occurrence of seed years. While the spruce bears some seed every year, only occasionally is there a season when an abundance of seed is produced. The average interval between such seed years, as they may properly be called, can only be definitely determined by continuous records kept in a given locality. There is great need of such records in this country, and much valuable work waits to be done along these lines.

Something, however, may be learned of the time between seed years from the old cones on the trees and by observations of the seedlings of common size and age. On Squaw Mountain Township there is evidence that a heavy seed year occurs at intervals of from eight to ten years. Four years ago, 1898, was probably such a year. The present season is decidedly an "off" year, few cones being found on the trees in comparison with the number produced four years ago, many of which are still hanging on the trees. The trees which have the greatest number of this year's cones are found in the Upper Spruce and Hardwood Land, on southeast exposures; and of these the trees bearing the most heavily are those growing on land which has been cut over.

The probable explanation of this fact is that the trees now standing in such situations are enjoying the advantages of the added light and space resulting from the lumbering, and are therefore tending more to the habit of the tree grown in the open. It is a recognized fact that trees growing in the open produce more seed than those in the forest, both because of the greater leaf surface with the consequent greater production of food material, and also because of the larger number of twigs on which the cones can be borne.

Careful attention was paid to determining the size at which the Spruce begins to seed. Nowhere on the township was any tree found with a diameter smaller than five inches at breast-height, on which were cones. The largest number of cones was

found on trees from ten to fourteen inches in diameter, although the capacity to bear seed is largely affected by the slope, aspect, and exposure to the wind.

Spruce seed is distributed by the wind, by birds, and by squirrels. The wind is of course the main agent of dissemination, and when the winged seed is shaken from the cones, during the late fall and winter, it is often carried considerable distances. This is especially true when it falls on an icy crust on a steep slope.

On Squaw Mountain Township the prevailing winds are from the west and northwest, which accounts in part for the local distribution of seed and the abundance of seedlings on southeast exposures.

The conditions which govern germination are moisture, warmth, and a suitable seed bed. The little seedling does not at first require much light, and seems to do well under dense forest cover as in the more open situations. At this stage, provided the seed bed is a good one, the Spruce seedling is apparently indifferent as to altitude, slope, and aspect, for on all situations are found large numbers of germinating plants.

### SEED BEDS.

The best seed bed for Spruce is the moss and duff floor found on the spruce slopes, which permit of the easy penetration of the roots and provide abundant moisture and food material. Next comes decaying wood—old logs and stumps—then leaf litter and, lastly, mineral soil. In the crevices of the moss-covered bark of old logs, especially Hemlock and White Pine, the Spruce seedlings thrive and grow. As the log rots away they send down their roots into the mineral soil and finally establish themselves firmly. Not infrequently one finds rows of small trees, the origin of which can be directly traced to old logs now completely decayed. On digging in such places bits of the old log may usually be found.

Leaf litter is not so favorable as duff or moss as a seed bed for Spruce. On it the little tree can not so easily extend its root system and firmly establish itself as upon the less compact duff. The needs of the broadleaf seedlings, on the other hand, are met by the leaf litter, so that the small Spruce upon it is often

crowded out by the faster growing Beech or Maple. Furthermore, on land where the forest floor is mainly leaf litter there are less Spruce seed trees in the forest and consequently fewer seedlings.

On the leaf litter under the broadleaf trees, the Spruce seedlings are often helped out by fragments of decaying wood. Out of a large number pulled up in such situations almost every one had bits of wood clinging to its roots, while on an equal number taken from moss on the slopes no wood was found. As the Spruce reaches its best development when growing in mixture with the hardwoods, and as it is, in such situations, excellent in quality, the seeding of spruce in just that part of the forest where it is most desirable, is dependent largely on the amount of dead wood which chances to be at hand, where the forest floor is composed mainly of leaf litter.

Spruce seedlings come up in the old logging roads and slashes unless choked out by weeds and grass. On Squaw Mountain many of the old yards and some of the roads have grown up to a tangle of raspberry bushes, making so dense a canopy that nothing else can grow. No spruce was found in any of these patches. The old roads on the lower portions of the township have grown up to grass, but in those on the slopes there is good reproduction of Balsam and Spruce. The Balsam is also found with the Spruce in the Flat and the Swamp types. On the slopes it acts as a nurse to the Spruce by forming with it a dense stand, at once making the Spruce develop a long and well formed bole and protecting it from the wind in the sapling and pole stages. The Spruce is usually able to hold its own, by its greater tolerance, and in the end outlives the Balsam. On the low land the Balsam is apt to make a dense thicket and to grow in nearly pure stands.

In the old slashes the small Spruce seedlings start under the old tops. When these at last rot down and release them, the seedlings are enabled to make up for the suppression by a vigorous growth.


SEEDLINGS ON OLD PINE STUMP.

These seedlings started from spruce seed scattered on the stump.

SEEDLINGS.

On Squaw Mountain Township the best conditions for the reproduction of Spruce were found well up on the southeast slopes on duff and moss. On the north and northwest slopes the conditions are not so favorable, and fewer seedlings occur. But on all parts of the township the Spruce is very much in evidence, and enough seedlings are everywhere present to maintain the Spruce as the most prominent tree in the forest.

Owing to its ability to bear shade the Spruce can compete with its broadleaf rivals. While the Yellow Birch and still more the Beech and Sugar Maple are also tolerant trees, the Spruce has the faculty at any age to take advantage of an opening made in the forest and to grow vigorously in the increased light and space thus made available. Even if it has been suppressed for a long time the small Spruce tree will respond to the improved conditions and proceed to grow as if it had always enjoyed them. This ability of the Spruce to grow under shade until the chance to better itself comes, enables it to maintain itself in the mixed forest of the lower slopes and in good soil; while on the poor soil of steep upper slopes it will take first place, thriving where other species can not succeed.

Out of the vast number of seedlings which germinate, comparatively few live beyond the seedling stage. Until a height of a few inches is reached they do not unduly crowd one another, but with an increase in size and height the more vigorous plants overtop and crowd out their weaker neighbors. The greatest mortality occurs in the seedling stage, or before the trees get to be three feet high, and mainly between the heights of six inches and two feet.

To determine the approximate average number of seedlings per acre, a number of plots were measured on the various types and exposures. While some larger seedlings were included, the greater number were under six inches in height.

The heaviest stand was found on the flat summits of ridges in the Spruce Slope type on the southeast side of Squaw Mountain. Here the number of seedlings to the acre was over 4,000. With a ground cover of duff and moss over a deep bed of humus, the conditions for the reproduction and growth of Spruce were here exceedingly good. On other plots in the

Spruce Slope type, representing more nearly the average conditions, the number of seedlings ranged from 900 to 3,000 per acre, the average of fifteen plots being a little over 2,000.

The factor which seems to have the most influence on the number of seedlings is the depth of the humus. This has a very direct bearing on the effect of lumbering upon the forest, for if the cutting is sufficiently heavy to destroy the cover completely and expose the humus to the action of sun and rain, there is danger not only that the existing seedlings will be killed but also that the future reproduction will be seriously hindered.

On the upper slopes, seedlings of Yellow Birch and Paper Birch are found with the Spruce and Balsam. On the lower slopes the Beech and Sugar Maple appear together with the Hemlock, and as one descends into the Spruce and Hardwood Land the number of seedlings of these species increases. In the depressions on the slope where enough moisture collects to approach somewhat the conditions of the Swamp, is found the Cedar.

In the Upper Spruce and Hardwood type the approximate number of Spruce seedlings per acre was found to be 1,600, while on the Lower Spruce and Hardwood Land ten plots gave an average of a trifle over 800.

On most of the old logging roads on the east slope of Squaw Mountain, last used five or six years ago, is a dense stand of Paper and Yellow Birch. Growing on the mineral soil of the old roads and on the old yards, these young trees stand about five feet high and make such a dense tangle that one has almost to force his way through. A stand of this character makes an efficient cover for the soil, and a few years later, when the trees get to the pole stage and thin out, the conditions for Spruce reproduction will be good, the Birch acting as a nurse to the Spruce. Already the Spruce has begun to find a foothold, notwithstanding the density of the Birch, as was shown by counts made on a number of ten-foot squares. Out of twenty which were counted, seventeen had Spruce, the average number of Spruce seedlings being fifteen, while the average number of Paper Birch seedlings was seventy-seven, and of Yellow Birch, sixty-two, with a scattering of Balsam and Bird Cherry.

The growth of the little tree in the seedling stage depends very much on the local conditions. To determine the time

required for a Spruce seedling to grow to stump height, analyses were made of seedlings in the Lower Spruce and Hardwood Land type, with the following results:

| | | | | | | |
|---|---|---|---|---|---|---|
| Height above the ground, feet, | .5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 |
| Time required for growth, years, | 15 | 22 | 27 | 31 | 34 | 38 |

These seedlings grew under practically the conditions of virgin forest, for the openings made by the removal of the few trees logged on the area, had not materially affected the forest cover.

Size alone is little indication of age, for a small sapling which has stood all its life in the shade may be older than a much larger tree standing in an open spot where it has enjoyed more favorable conditions.

Passing from the Spruce in the seedling stage to the larger trees, the relative number of trees one inch and over in diameter at breastheight may be seen in the table which appears under "Present Stand." This table, based on the valuation surveys, gives the number of standing spruce trees in each diameter class for each of the forest types on Squaw Mountain Township and in the virgin forest. It will be seen that the decrease in number is much more rapid in the lower diameter classes than in the larger ones.

## PRESENT STAND.

### VALUATION SURVEYS.

One of the most important things to know in the study of the production of a forest is the quantity of timber which constitutes the present yield. To the owner, the estimate of present merchantable yield, which his forest contains, is of direct importance in forecasting the profits of the lumbering. To the forester, an estimate of the present yield is necessary as a basis for the prediction of future crops.

In estimating standing timber it is the custom of the Bureau of Forestry to run valuation surveys by the strip method. The valuation surveys consist of lines of strip acres, one surveyor's chain (sixty-six feet) wide and ten chains (660 feet) long. These lines are run, usually on compass courses, and at regular

intervals, so as thoroughly to gridiron the forest to be estimated. On the acres so measured all trees to a given diameter are counted and calipered, the diameter being taken at breastheight, four and one-half feet from the ground. A separate tally is kept of each acre, and on it is recorded the number of trees of each species in each diameter class, usually by inch classes.

In the computations of results all the acres run in a given type are thrown together and an average acre made. This is taken as representative of the type.

To supplement the valuation surveys the heights of a large number of trees are measured in order to show the average height in relation to the diameter at breast-height.

On Squaw Mountain Township the valuation surveys were run with two objects in view: First, to obtain an average of the present stand of Spruce for the several types; and second, to get exact information as to the composition of the forest. All living trees one inch and over in diameter breasthigh were calipered, the diameter being taken to the nearest inch. Record was also made of the dead trees of each species and of the stumps of trees cut in the former lumbering operations.

The surveys run on the township, the results of which appear in this report, were distributed in the different types as follows:

| | |
|---|---|
| Lower Spruce and Hardwood Land, | 105 acres. |
| Upper Spruce and Hardwood Land, | 98 " |
| Spruce Slope, | 20 " |
| Spruce Slope, (virgin forest), | 20 " |
| Total, | 243 acres. |

The following table based on the valuation surveys shows the average number of spruce trees per acre, in each diameter class for each of the forest types and for the virgin forest:

SPRUCE SEEDLINGS UNDER MATURE TREES.

Showing the way the young spruce trees start on the Lower Spruce and Hardwood Land. The one to the left shows suppression.

TABLE NO. 5.

AVERAGE NUMBER OF SPRUCE TREES PER ACRE.

| Diameter breasthigh—Inches. | Lower Spruce and hardwood land, 105 acres. | Upper Spruce and hardwood land, 98 acres. | Spruce Slope, 20 acres. | Virgin forest, 20 acres. |
|---|---|---|---|---|
| 1 | 11.14 | 33.88 | 67.90 | 49.15 |
| 2 | 7.50 | 26.37 | 63.65 | 58.25 |
| 3 | 8.78 | 19.18 | 47.25 | 49.00 |
| 4 | 5.85 | 12.92 | 31.05 | 37.55 |
| 5 | 5.37 | 8.47 | 20.40 | 25.90 |
| 6 | 4.10 | 7.36 | 16.20 | 21.10 |
| 7 | 3.42 | 5.94 | 12.65 | 14.50 |
| 8 | 2.77 | 4.92 | 9.70 | 11.70 |
| 9 | 2.48 | 4.09 | 5.75 | 8.45 |
| 10 | 2.31 | 2.97 | 5.10 | 8.35 |
| 11 | 1.96 | 1.91 | 2.55 | 6.65 |
| 12 | 1.83 | 1.73 | 3.05 | 5.65 |
| 13 | 1.22 | 1.29 | 2.15 | 5.30 |
| 14 | 1 01 | 1.17 | 1.15 | 4.75 |
| 15 | .95 | .91 | 1.40 | 5.20 |
| 16 | .71 | .72 | 1.35 | 3.60 |
| 17 | .61 | .55 | .85 | 3.60 |
| 18 | .26 | .37 | .60 | 3.00 |
| 19 | .23 | .22 | .70 | 1.70 |
| 20 | .13 | .14 | .30 | 1.50 |
| 21 | .05 | .06 | .15 | 1.10 |
| 22 | .05 | .02 | .15 | .65 |
| 23 | .01 | | .15 | .65 |
| 24 | .02 | .02 | .05 | .40 |
| 25 | | | | .30 |
| 26 | | | | .25 |
| 27 | | | | .05 |
| Total | 62.66 | 135.20 | 294.25 | 328.20 |
| Total trees 1 inch to 4 inches in diameter, breast high. | 33.27 | 92.35 | 209.85 | 193.95 |
| Total trees 4 inch. to 9 inch. in diameter, breast high. | 18.14 | 30.72 | 64.70 | 81.65 |
| Total trees 10 inch. and over in diameter, breast high. | 11.25 | 12.13 | 19.70 | 52.60 |

VOLUME TABLES.

To determine the yield on the average acre, volume tables are prepared from the actual scale of felled trees. The tables show the number of board feet which may be obtained from trees of given diameter and height.

Knowing from the valuation surveys the number of trees per acre in each diameter class, and from the height curves the corresponding height, the yield per acre is obtained by means of the volume tables. The total yield for the whole area may be obtained by multiplying the yield on the average acre by the number of acres in the type.

The volume tables used in computing the present yield of Spruce on Squaw Mountain Township were made by scaling logs which, owing to the sudden thaw in the spring of 1902, remained on the yards during the summer. Only sound logs were included. They were scaled in board feet by the Bangor Rule, full scale being allowed and the average diameter at the top-end being taken.

The usual custom in scaling by the Bangor Rule is to allow one inch rise for logs over thirty feet long and two inches for those thirty-six feet and over. As is generally known by those who use the Bangor Rule, this method of scaling undervalues the contents of the logs, especially the smaller ones, and some agreement is often made between the operator and the jobber to secure a fairer valuation. This may be by allowing a greater rise, by increasing the final total scale by a given percentage, or by an arrangement as to price. Another way, and the fairest way of scaling by the Bangor Rule, is to scale the tree as several short logs; e. g., a forty-foot stick as two fourteens and a twelve, the actual top diameters being measured by calipers. This method of scaling by short lengths is not in general use, but is that employed in making the following volume tables, in which a true value was particularly desired as they are designed for use in computing the contents of stands which are to be cut, at least in part, for pulp.

The trees on Squaw Mountain Township were felled with the saw, low stumps were cut, and the logs were run well up into the tops, many having top diameters of less than six inches. The logs measured contained about as much as it is profitable to handle under the present market conditions.

Two volume tables were made, one from logs cut on the Spruce and Hardwood Land, the other from those from the Spruce Slope. These appear in Table Number 6.

TABLE No. 6.

VOLUME OF SPRUCE.

| Diameter, breasthigh—Inches. | Spruce and Hard Wood Land. | | Spruce Slope. | |
|---|---|---|---|---|
| | Volume—Board feet. | Basis—Trees. | Volume—Board feet. | Basis—Trees. |
| 6 | 18 | 2 | 20 | ..... |
| 7 | 26 | 7 | 25 | 8 |
| 8 | 37 | 11 | 32 | 29 |
| 9 | 49 | 35 | 40 | 18 |
| 10 | 63 | 41 | 51 | 35 |
| 11 | 78 | 45 | 63 | 22 |
| 12 | 95 | 56 | 76 | 17 |
| 13 | 113 | 43 | 91 | 15 |
| 14 | 132 | 32 | 103 | 19 |
| 15 | 154 | 33 | 127 | 11 |
| 16 | 178 | 30 | 148 | 10 |
| 17 | 206 | 16 | 170 | 10 |
| 18 | 234 | 17 | 194 | 9 |
| 19 | 264 | 12 | 219 | 7 |
| 20 | 295 | 8 | 244 | 6 |
| 21 | 326 | 1 | 270 | 2 |
| 22 | 370 | 4 | 298 | 2 |
| 23 | 393 | 2 | 325 | ..... |
| 24 | 425 | 2 | 353 | ..... |
| Total | ..... | 397 | ..... | 220 |

## GROWTH.

### HEIGHT.

The following table gives the height on a basis of diameter breast-high which the spruce reaches on the different types in the township. The figures are based on data obtained from the measurement of standing trees by a Faustmann Hypsometer.

TABLE No. 7.

HEIGHT OF SPRUCE.

| Diameter, breasthigh—Inches. | Swamp, 187 trees—height, feet. | Flat, 94 trees—height, feet. | Spruce and Hardwood Land, 350 trees—height, feet. | Spruce Slope, 485 trees—height, feet. |
|---|---|---|---|---|
| 2 | 15 | 17 | 19 | 14 |
| 3 | 22 | 25 | 27 | 21 |
| 4 | 27 | 33 | 34 | 28 |
| 5 | 36 | 40 | 40 | 33 |
| 6 | 42 | 47 | 44 | 37 |
| 7 | 47 | 51 | 48 | 41 |
| 8 | 52 | 55 | 52 | 44 |
| 9 | 54 | 59 | 55 | 48 |
| 10 | 56 | 63 | 58 | 52 |
| 11 | 58 | 65 | 60 | 55 |
| 12 | 59 | 67 | 62 | 58 |
| 13 | 60 | 68 | 64 | 60 |
| 14 | 60 | 69 | 66 | 63 |
| 15 | 60 | 70 | 68 | 65 |
| 16 | 61 | 70 | 70 | 67 |
| 17 | 61 | 70 | 72 | 68 |
| 18 | 61 | 71 | 74 | 70 |
| 19 | 62 | 71 | 75 | 71 |
| 20 | 62 | 71 | 76 | 72 |

DIAMETER.

The main purpose in the study of the growth of Spruce on Squaw Mountain Township was to obtain figures for an estimate of growth in the future. In studying the question, advantage was taken of the logging operations which have been in progress on the township for the last six years and analyses of recently cut stumps were made to ascertain the rate of growth in diameter on the stump, on the Lower Spruce and Hardwood Land and the Spruce Slope types. The measurements taken were as follows:

Height of the stump;

Diameter outside bark;

Diameter inside bark;

Width of each ten years' growth along the average radius, for five decades.

Table No. 8 is based on the measurements covering the last twenty years and shows what the average growth in diameter of Spruce on Squaw Mountain Township has been during that time. Twenty years was selected because it was believed to

SPRUCE REPRODUCTION IN VIRGIN FOREST.

A dense stand of seedlings in an opening made by the fall of one or two large trees.

be the fairest period to use on this township, the reasons for the choice being: (1) that twenty years is a sufficiently long time to eliminate purely accidental variation in growth; (2) because during the last twenty years enough lumbering had gone on in the forest on Squaw Mountain Township to render the conditions of growth similar to those obtaining on cut-over land.

It should, however, be distinctly understood that in the former lumbering only the larger trees were removed, the land in most cases being merely "deviled over" for the very best timber. The changes in the natural conditions as a result of the openings made by the lumbering were consequently not as marked as they would be after the more severe methods of logging, in use at present. The effect of this will be discussed under the head of increased growth.

Table No. 8 besides giving the average annual growth in diameter also shows the number of years required for a tree of given size to grow one inch in diameter. It will be seen from a study of the table that the rate of growth is slower in the Spruce Slope type than it is in the Spruce and Hardwood Land, and that up to a certain point the larger trees increase more rapidly than the smaller ones. This increase in growth culminates when the tree is about fifteen inches in diameter breasthigh, and the rate then falls off.

TABLE No. 8.

RATE OF DIAMETER GROWTH OF SPRUCE.

Based on the last 20 years.

| Diameter breasthigh—inches. | Lower Spruce and Hardwood Land, 564 trees. | | Upper Spruce and Hardwood Land, 379 trees. | | Lower Spruce Slope, 144 trees. | | Upper Spruce Slope, 87 trees. | | Average of all types, 1,174 trees. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Annual growth—inches. | Time required to grow 1 inch—years. | Annual growth—inches. | Time required to grow 1 inch—years. | Annual growth—inches. | Time required to grow 1 inch—years. | Annual growth—inches. | Time required to grow 1 inch—years. | Annual growth—inches. | Time required to grow 1 inch—years. |
| 5 | .036 | 25 | .054 | 19 | .015 | 67 | .026 | 38 | .033 | 30 |
| 6 | .048 | 21 | .063 | 16 | .022 | 45 | .030 | 33 | .042 | 29 |
| 7 | .063 | 16 | .071 | 14 | .032 | 31 | .034 | 29 | .050 | 23 |
| 8 | .080 | 13 | .078 | 13 | .046 | 22 | .038 | 26 | .061 | 19 |
| 9 | .098 | 10 | .085 | 12 | .067 | 13 | .041 | 24 | .073 | 15 |
| 10 | .114 | 9 | .091 | 11 | .093 | 11 | .044 | 23 | .086 | 14 |
| 11 | .126 | 8 | .096 | 10 | .113 | 9 | .047 | 21 | .096 | 12 |
| 12 | .136 | 7 | .102 | 10 | .124 | 8 | .049 | 20 | .103 | 11 |
| 13 | .142 | 7 | .109 | 9 | .127 | 8 | .052 | 19 | .108 | 11 |
| 14 | .146 | 7 | .112 | 9 | .126 | 8 | .055 | 18 | .110 | 11 |
| 15 | .148 | 7 | .112 | 9 | .122 | 8 | .058 | 17 | .110 | 10 |
| 16 | .150 | 7 | .109 | 9 | .116 | 9 | .060 | 17 | .109 | 11 |
| 17 | .148 | 7 | .106 | 9 | .110 | 9 | .062 | 16 | .107 | 10 |
| 18 | .146 | 7 | .106 | 9 | .103 | 10 | .062 | 16 | .107 | 11 |
| 19 | .142 | 7 | .106 | 9 | .096 | 10 | .062 | 16 | .102 | 11 |
| 20 | .138 | 7 | .106 | 9 | .091 | 11 | .060 | 17 | .099 | 11 |
| Average | .116 | 11 | .094 | 11 | .088 | 16 | .049 | 22 | .087 | 15 |

The following table made from the table of growth for the Lower Spruce and Hardwood Land (Column 2, Table No. 8), shows the growth in diameter to be expected in trees six to thirteen inches in diameter breasthigh, for periods ranging by decades from ten to fifty years. Its use will be discussed under Future Yield.

TABLE No. 9.

GROWTH IN DIAMETER OF SPRUCE.

Lower Spruce and Hardwood Land.

| Present diameter breasthigh—inches. | Diameter breast-high after 10 years—inches. | Diameter breast-high after 20 years—inches. | Diameter breast-high after 30 years—inches. | Diameter breast-high after 40 years—inches. | Diameter breast-high after 50 years—inches. |
|---|---|---|---|---|---|
| 6 | 6.5 | 7.0 | 7.6 | 8.4 | 9.2 |
| 7 | 7.6 | 8.4 | 9.2 | 10.2 | 11.4 |
| 8 | 8.8 | 9.8 | 10.9 | 12.2 | 13.5 |
| 9 | 10.0 | 11.1 | 12.4 | 13.7 | 15.2 |
| 10 | 11.1 | 12.4 | 13.8 | 15.2 | 16.7 |
| 11 | 12.4 | 13.6 | 15.1 | 16.6 | 18.0 |
| 12 | 13.4 | 14.8 | 16.3 | 17.8 | 19.2 |
| 13 | 14.4 | 15.9 | 17.4 | 18.9 | 20.3 |

INCREASED GROWTH AFTER LUMBERING.

When the large trees in a forest are removed by logging or windfall, openings are made in the forest cover through which additional light is admitted to the smaller trees. These trees, taking advantage of greater light and growing space, begin to grow faster, and a distinct gain in the rate of increase follows. This is particularly true of a species, which, like the Spruce, has the faculty of growing well even after a long period of suppression. A comparison of the growth in different decades in those trees which stood on land cut over twenty and thirty years ago showed, in some trees, a marked increase in growth after lumbering.

On the Lower Spruce and Hardwood Land seventy-nine trees out of a total of 564, or fourteen per cent, showed increased growth. The data from these trees were retabulated and the growth computed for the last ten and the last twenty years, the average rate of growth in diameter being respectively .241 and

.242 inch per annum; in each case a period of four years being required in which to grow one inch.

Although the number of trees which showed increased growth was not sufficient to justify more extended computations, this matter has a very practical bearing. Under the present methods of lumbering many more trees are removed than was the case twenty years ago, and consequently a larger proportion of the small trees left standing must be benefited by the increased light and space. These trees should grow faster than they are now growing, and, if cut twenty years from now, a much larger percentage of them should show increased growth.

It is often argued that the trees of the other species will also take advantage of the openings in the forest made by lumbering and crowd out the Spruce. While it is perfectly true that the small spruce will not be the only trees to profit by the improved conditions, our knowledge of this species does not justify the conclusion that, with diameter limit ten, twelve, or fourteen inches at breastheight, those Spruce trees with a diameter of five inches and over at breastheight, now standing in the forest, will be suppressed. On the contrary it is believed that they will not only hold their own but will grow faster. In order, however, to be thoroughly conservative, all the tables of future yield, to be discussed later, have been based on the growth for the last twenty years; and any increase due to lumbering has been disregarded.

## FUTURE YIELD.

To estimate the future yield of a forest it is necessary to know the number of trees in the smaller diameter classes in the forest, and their rate of growth.

The manner of obtaining the rate of growth has already been discussed, and tables (Nos. 8 and 9) have been given by which the diameter of the small tree may be computed for given times in the future. The average number of small trees per acre in each of the diameter classes is obtained from the valuation surveys. The number of Spruce trees per acre on the various types on Squaw Mountain Township is given in Table No. 5, which appears under "Present Stand."

Knowing, then, the number of trees per acre in each diameter class, and from Table No. 9 what the diameter of that class will

be in a given number of years, the yield at that time may be calculated in the same way as is the present yield. The results so obtained will of course be only approximate, but with conservative tables of growth, this approximation is sufficiently accurate to be of practical value.

### DIAMETER LIMITS.

In computing the future yield it is usual to adopt a diameter limit to which the present cut shall be made and calculate the time necessary before an amount equal to the present yield or a given portion may again be cut from the same area. The most common diameter limits for the Spruce are ten, twelve, or fourteen inches, diameter breasthigh. This means a diameter on a stump cut two feet above the ground of eleven, thirteen, or sixteen inches.

The future yield for the Lower Spruce and Hardwood Land on Squaw Mountain Township is given in Table No. 10. This table is applicable approximately to similar land elsewhere under the same conditions. In preparing it the present yield was made to include the amounts cut during the last six years, in order to present conditions for which a system of cutting under forest management would be advisable. It is obviously impossible to attempt to introduce such a system of forestry on land from which everything of merchantable size has been removed. The following tables are therefore based on the stand as it was before the present lumbering operations began.

Taking the Lower Spruce and Hardwood Land as an example, Table No. 10 shows that if a ten-inch limit were adopted, and all the Spruce trees ten inches and over in diameter breasthigh in this type on Squaw Mountain Township were cut, the average present yield per acre would be 2,169 board feet. If twelve inches were the limit, 1,821 board feet could be obtained, while if only the trees fourteen inches and over were logged, 1,307 board feet would be the present yield. With these amounts as the present yield and with the number of small trees now growing on this type in the township, an equal amount of spruce timber could again be cut in seventy-five years, if ten inches were made the limit to-day; in forty-nine years if it were twelve inches; and in twenty-six years if fourteen inches were chosen.

The table also shows for each of the three limits the amounts which could be obtained at the end of ten-year periods for five decades.

TABLE No. 10.

ESTIMATE OF FUTURE YIELD PER ACRE OF SPRUCE.

Lower Spruce and Hardwood Land.

Based on amount standing before recent lumbering.

| Cutting limit: diameter breasthigh—inches. | Average present yield per acre—board feet. | Average yield per acre obtainable at the end of 10-year periods, in board feet. | | | | | Interval required between equal cuts—years. |
|---|---|---|---|---|---|---|---|
| | | 10 | 20 | 30 | 40 | 50 | |
| 10 | 2169 | 167 | 384 | 472 | 834 | 1049 | 75 |
| 12 | 1821 | 230 | 560 | 959 | 1238 | 1868 | 49 |
| 14 | 1307 | 354 | 834 | 1672 | 2488 | 3271 | 26 |

Table No. 11 shows the same estimate expressed in percentage of the present yield; the values as before being given in ten-year periods.

TABLE No. 11.

FUTURE YIELDS OF SPRUCE EXPRESSED IN PERCENTAGES OF PRESENT STAND.

| Cutting limit: diameter breasthigh—inches. | Average present yield per acre—board feet. | Average yield per acre obtainable at the end of 10-year periods, in percentages of the present yield—per cent. | | | | | Interval required between equal cuts—years. |
|---|---|---|---|---|---|---|---|
| | | 10 | 20 | 30 | 40 | 50 | |
| 10 | 2169 | 7.69 | 11.70 | 21.80 | 38.44 | 48.36 | 75 |
| 12 | 1821 | 12.64 | 30 75 | 42.11 | 67.43 | 102.51 | 49 |
| 14 | 1307 | 27.08 | 63.81 | 127.92 | 190.36 | 250.34 | 26 |

The adoption of a limit depends on a number of considerations. In the first place the present yield per acre must be sufficient to yield a fair profit upon lumbering. The smaller the diameter limit, the larger will be the present cut and if a definite amount is to be logged the smaller the area cut over. On the other hand, with the smaller the diameter limit more time must elapse before an equal cut can again be obtained from the same area.

PAPER BIRCH SEEDLINGS.

On a logging road used two years ago. The first trees to take advantage of the new conditions.

The larger diameter limits are better for the forest than the smaller ones because the density and composition of the forest is less disturbed, because the damage from lumbering is lessened, and because a larger number of trees is left to shed seed.

The decision as to which diameter limit is best must be made for the individual case, but when the returns from lumbering under two diameter limits are nearly equal the higher limit is usually preferable.

It should be understood that the adoption of a diameter limit does not necessarily mean that every tree is cut according to a fixed and rigid rule. The diameter limit serves, rather, as a guide to the man who marks the trees to be felled, who may, under certain conditions, without infringement of its purpose, take some trees below the limit and leave standing for seed trees or other purposes others above it. It is an average figure from which the yield may be computed, but is subject to local modifications at the discretion of the forester. In practice the trees cut below the diameter limit will about balance in amount of timber those left uncut above the limit.

On the Lower Spruce and Hardwood Land on Squaw Mountain Township the limit which in the long run would be the most profitable is fourteen inches. This can be seen in Table No. 10. The rotation with a twelve-inch limit is forty-nine years and at the end of fifty years, with this limit, 1,868 board feet could be cut. If fourteen inches—with a rotation of twenty-six years—were chosen as the present limit the yield at the end of fifty years would amount to 3,271 board feet; or, if a crop equal to the present yield had been cut at the end of the first rotation, (twenty-six years), by waiting two years longer another, (second), crop of the same amount, (1,307 board feet), could be obtained. In other words about twice as much can be got in the long run by using the larger limit.

It is of course not necessary to delay the next lumbering until an equal amount can again be cut—nor is this always to be recommended. The tables show what can be got at various times in the future when, even if the crop is smaller than it is today, the higher prices which will probably obtain then, for Spruce, would make lumbering profitable.

It should be remembered that these estimates are based on cut-over land and that, therefore, the present yield is not as great as it would be in original forest.

### PRACTICAL BEARING.

The practical import of this discussion of future yield is that by such calculations a system of management can be devised whereby a forest tract can be made to yield constant returns at given intervals. The time has come when such systems may profitably be introduced, especially in the case of the large pulp-mills. The amount of power required and the expensive machinery of the plant demand that the mill be located on some large water-power, and that the location be a permanent one. A saw-mill can be moved when the timber supply is exhausted; but with the pulp-mill the case is different. It follows that the supply of the raw material must be constant. This means that large tracts of forest land must be owned or controlled by the company operating the mill and, further, that a system of management must be followed to secure continued crops. This in a word is forestry.

### WORKING PLANS.

As conditions of stand and growth are seldom uniform over large areas no general directions can be laid down for forest management. The problem can be satisfactorily solved only by the preparation in each case of a forest working plan which will take into account all the local conditions and modify the management accordingly. It is such plans that the Bureau of Forestry is making in co-operation with private owners in various parts of the United States as illustrations of what may be done in forest management.

A working plan of the kind above indicated is of course tentative, not permanent. Both forest and market conditions are subject to change, and it is not now possible to forecast the future to such an extent as to permit the prescription of an inflexible system. With the increase in value of species which are not at present merchantable, more intensive methods of management than are now possible or advisable can be introduced, by which the percentage in mixture of the desired species, in this case the Spruce, may be maintained and increased. It is


SPRUCE ON UPPER SPRUCE SLOPE.
A dense stand of spruce suitable for pulp.

sufficient for the present that there are enough small trees left in good condition to make the next crop.

In some situations which are exposed to wind, it is advisable to adopt a system of clean cutting rather than to lumber to a definite diameter limit. On steep slopes where the Spruce stands nearly pure and is shallow rooted, the removal of the large trees will almost invariably be followed by the blowing down of a large percentage of those left uncut. Similar conditions often obtain on flat land where the soil is scanty and the root system of the trees shallow. In such places the wind often sweeps down over considerable areas, throwing all the standing trees.

In the case of State lands and large private preserves it is often advisable to maintain the forest on the mountains as a "protection forest," keeping it intact to preserve the soil from erosion or better to protect the forest floor of an important drainage basin. Or the beauty of the standing forest may be preferred to the money returns obtainable from its manufacture into lumber. These considerations do not affect the ordinary private owner. He is interested in the forest primarily as a source of lumber, and naturally and properly wishes to cut and use the timber trees on his lands.

On land where it is practically impossible to prevent fire after lumbering, it is useless to attempt to introduce forestry—which has to do essentially with the future crop. The only policy on such lands is to cut everything that is merchantable without expectation of return. This fact, however, does not greatly diminish the area in Maine to which forestry is applicable as a sound business measure, for there are very few cases indeed when the protection of the forest from fire is not practicable at a reasonable expense.

The best preventive of fire is an enlightened public sentiment which will see that simple regulations are enforced and that the necessary precautions are taken. Fortunately for Maine, there is a good public sentiment in regard to forest fires, so that it mainly rests with the operators to see that the greatest care is taken to prevent fire from starting after lumbering.

Lumbering greatly increases the danger, but if proper precautions are taken, particularly in dry seasons, it will be reduced to the minimum.

## THE HARDWOODS.

The broadleaf trees, the value of which is rapidly increasing, enter largely into the forest mixture in Central Maine. From the point of view of the best interests of the forest the large and mature trees of these species should be removed. But in practice the lumbering of the hardwoods can only be advised when the market conditions are such as to make the operation a financial success.

While the present investigation was primarily concerned with the Spruce, attention was also paid to the broadleaf trees and data for them were collected. The study included the determination of the height of the more important hardwoods on Squaw Mountain Township; the results of the hypsometer measurements made on the Lower Spruce and Hardwood Land type are given in the following table, which gives the height on a basis of the diameter breasthigh for the Yellow Birch, Sugar Maple, Beech, Black Ash, Paper Birch, and Aspen.

TABLE NO. 12.

HEIGHT OF BROADLEAF TREES.

| Diameter, breasthigh—inches. | Yellow Birch, 492 trees—height, feet. | Sugar Maple, 179 trees—height, feet. | Beech, 276 trees—height, feet. | Black Ash, 89 trees—height, feet. | Paper Birch, 341 trees—height, feet. | Aspen, 323 trees—height, feet. |
|---|---|---|---|---|---|---|
| 2 | 25 | 24 | 21 | 18 | 23 | 23 |
| 3 | 33 | 32 | 29 | 26 | 31 | 31 |
| 4 | 39 | 38 | 36 | 32 | 38 | 38 |
| 5 | 44 | 44 | 42 | 38 | 44 | 43 |
| 6 | 48 | 48 | 48 | 43 | 49 | 48 |
| 7 | 51 | 52 | 52 | 47 | 53 | 52 |
| 8 | 54 | 56 | 55 | 51 | 56 | 55 |
| 9 | 56 | 59 | 58 | 53 | 59 | 57 |
| 10 | 57 | 61 | 61 | 55 | 62 | 59 |
| 11 | 59 | 63 | 63 | 57 | 64 | 61 |
| 12 | 60 | 65 | 65 | 58 | 66 | 62 |
| 13 | 62 | 66 | 66 | 60 | 67 | 63 |
| 14 | 63 | 68 | 67 | 61 | 68 | 64 |
| 15 | 64 | 70 | 69 | 63 | 68 | 65 |
| 16 | 65 | 71 | 70 | 64 | 69 | 65 |
| 17 | 67 | 72 | 70 | 65 | 70 | 66 |
| 18 | 68 | 73 | 71 | 66 | 71 | 66 |
| 19 | 69 | 74 | 72 | 67 | 71 | 66 |
| 20 | 71 | 75 | 73 | 68 | 72 | 66 |
| 21 | 72 | 76 | ..... | ..... | ..... | ..... |
| 22 | 73 | 77 | ..... | ..... | ..... | ..... |
| 23 | 74 | 78 | ..... | ..... | ..... | ..... |
| 24 | 75 | 79 | ..... | ..... | ..... | ..... |

BEECH CUT FOR VENEER.

Diameter on the stump 16 inches, 14 inches at top, two logs 12 and 14 feet.

## HARDWOOD LUMBERING.

Lumbering of the hardwoods has been undertaken on Squaw Mountain Township at various times, the local conditions making possible operations which would not have paid on land similar in character but less accessible. Twelve years ago an interesting experiment was tried by the M. G. Shaw Lumber Company of driving hardwood logs from Squaw Mountain Township down the Kennebec River to their mill at Bath. The trees were felled in the summer and allowed to remain on the ground with the tops on until autumn, before being cut into logs. The logs were then hauled to a special yard on the bank of the river and were rolled into the water just in time to go down with the rear of the drive. Some of the logs were peeled and various methods of painting and plugging the ends were tried but the percentage of logs which arrived at the mill was too small to make the operation a success and after two years it was given up.

Whatever may be possible on a short drive, this experiment shows that it is not feasible to drive Yellow Birch and Sugar Maple for as long a distance as from the outlet of Moosehead Lake to Bath, or about 150 miles.

The hardwoods cut on Squaw Mountain Township during recent years have, for the most part, been shipped by rail or water to the veneer mill at Greenville, owned by the Greenville Manufacturing Company. The establishment of this mill has created a local market for hardwoods, and various operations have been undertaken on land adjoining Moosehead Lake to supply the demand; most of the logs being transported across the lake on a steam scow, which last summer, made regular trips, at intervals of a few days, to the several hardwood operations on the lake, loading at the yards on the shore on which were landed the logs cut on the land near by.

During the summer of 1902 lumbering of Yellow Birch, Beech, and a few Sugar Maple was in progress on Squaw Mountain Township. The logging was carried on upon the low ridge between Fitzgerald Pond and Moosehead Lake south of Johnson's Landing and extended back from the lake for about half a mile, to the top of the hill.

VOLUME TABLES.

Advantage was taken of the lumbering mentioned above and full stem analyses were made of Yellow Birch and of Beech. The study included the determination of the volume of the felled tree and of its rate of growth. From these data volume tables have been constructed for the Yellow Birch and the Beech which show the number of board feet of merchantable lumber to be obtained from trees of these species. The logs were cut from ten to sixteen feet in length and were scaled by the Bangor Rule. These tables are, so far as the writer is aware, the only volume tables for the Maine hardwoods that have been published. They are given as Table No. 13.

TABLE No. 13.

VOLUME OF YELLOW BIRCH AND BEECH.

| Diameter breasthigh—inches. | YELLOW BIRCH. | | BEECH. | |
|---|---|---|---|---|
| | Volume—board feet. | Basis—trees. | Volume—board feet. | Basis—trees. |
| 10 | 33 | 1 | 57 | 1 |
| 11 | 62 | 2 | 76 | 9 |
| 12 | 92 | 9 | 95 | 22 |
| 13 | 121 | 10 | 114 | 28 |
| 14 | 147 | 19 | 134 | 25 |
| 15 | 172 | 16 | 156 | 14 |
| 16 | 197 | 16 | 180 | 7 |
| 17 | 225 | 22 | 287 | 7 |
| 18 | 260 | 17 | 235 | 3 |
| 19 | 303 | 15 | 264 | ..... |
| 20 | 347 | 14 | 296 | ..... |
| 21 | 385 | 10 | ..... | ..... |
| 22 | 413 | 1 | ..... | ..... |
| 23 | 533 | 3 | ..... | ..... |
| 24 | 461 | 2 | ..... | ..... |
| Total | ..... | 157 | ..... | 116 |

Besides the use of the logs for veneer the tops of the trees were also utilized for cordwood, which found a ready market in Greenville. It is a distinct advantage when such a market exists or can be made, for not only is material sold which would otherwise be wasted but the large tops are removed from the forest, leaving the small trees unhindered and lessening the danger from fire.

CORDWOOD FROM YELLOW BIRCH TOPS

Wherever a market can be made the hardwood tops should be utilized as cordwood.

GROWTH IN DIAMETER.

From the measurements of growth made on the trees analyzed, the average annual growth in diameter was computed, together with the number of years required to grow one inch. These figures may be modified by a more extended study but are here given as an indication of the growth of these species. They are based on measurements of the growth of the last fifty years and represent the conditions in a forest slightly opened by the lumbering of the softwoods.

TABLE No. 14.

RATE OF DIAMETER GROWTH OF YELLOW BIRCH AND BEECH.

Based on last 50 years.

| Diameter breasthigh—inches. | YELLOW BIRCH, 68 trees. | | BEECH, 93 trees. | |
|---|---|---|---|---|
| | Annual growth—inches. | Time required to grow one inch—years. | Annual growth—inches. | Time required to grow one inch—years. |
| 5 | .032 | 31 | .067 | 15 |
| 6 | .038 | 27 | .076 | 13 |
| 7 | .044 | 23 | .084 | 12 |
| 8 | .050 | 20 | .091 | 11 |
| 9 | .055 | 18 | .097 | 10 |
| 10 | .060 | 17 | .101 | 10 |
| 11 | .064 | 16 | .104 | 10 |
| 12 | .068 | 15 | .106 | 9 |
| 13 | .072 | 14 | .107 | 9 |
| 14 | .076 | 13 | .108 | 9 |
| 15 | .079 | 13 | .108 | 9 |
| 16 | .081 | 12 | .107 | 9 |
| 17 | .083 | 12 | .107 | 9 |
| 18 | .084 | 12 | .107 | 9 |
| 19 | .084 | 12 | .106 | 9 |
| 20 | .083 | 12 | .106 | 9 |

## SUGGESTIONS FOR LUMBERING.

Both the forester and the lumberman are interested in getting as much as possible from the felled tree and in preventing the unnecessary waste which, unfortunately, so often accompanies the average logging job. In lumbering a forest conservatively, certain modifications of ordinary methods are usually advisable to insure a more nearly complete utilization of the crop, and at the same time to protect and increase in value the part of the stand remaining after lumbering.

### SAWING VS. CHOPPING.

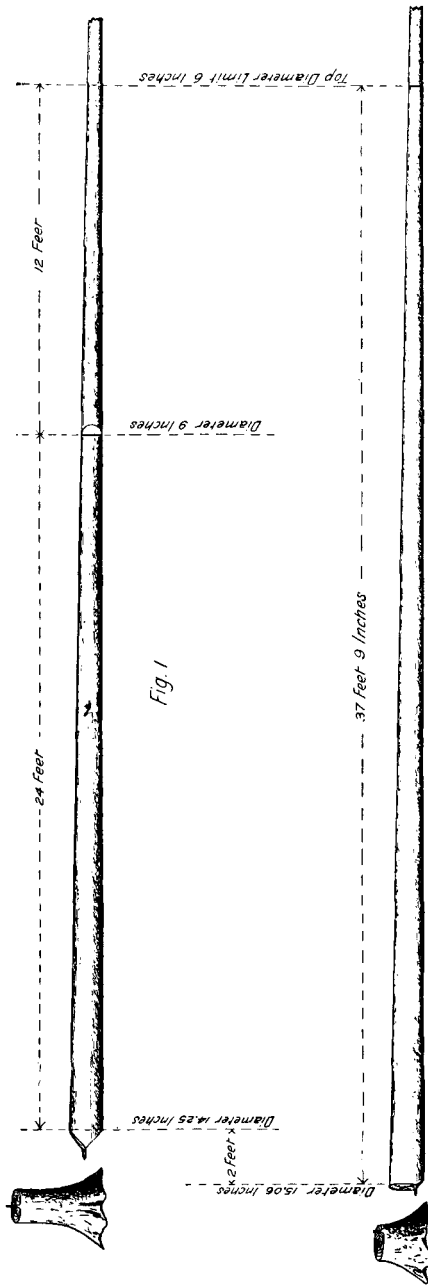
One of the most common causes of waste in lumbering is the custom of felling the tree by chopping. It does not require a knowledge of lumbering methods to see that the kerf made by the saw is much smaller than that made by the axe. It may safely be said that a loss in length of approximately one-half the diameter of the log will be caused in each cut by the use of the axe, while the saw kerf is only a fraction of an inch. In felling trees with the saw therefore there is a considerable saving in length in the best part of the log, where the timber is of the largest diameter and ordinarily the most sound.

### HIGH STUMPS.

Another frequent cause of waste is the high stump. Here again, timber in the best part of the tree is needlessly left in the woods which if carefully utilized would add alike to the profit of the owner and the scale bill of the jobber. In the majority of cases the tree can be cut at or a little above the top of the swelling of the roots, and a saving made of from twelve to twenty-four inches.

### DIAMETER AT THE TOP END.

A further saving would follow by running the log as far up into the top as possible. This part of the log, while not as good as the butt, is still valuable, especially for pulp, and with the present price of spruce altogether too valuable to waste. Owing to the Bangor Rule and the methods of scaling which are in use, the jobber often finds it to his advantage to top the log at eight




COMPARATIVE LOSS IN LUMBERING.

Contrasting sawing and chopping, low and high stumps, and small and large top diameters.

or nine inches rather than to take it to six. This results in a waste, on the average tree, of twelve feet, amounting by the Bangor Rule to ten board feet. A good share of the unfairness in the scale could be prevented by scaling the tree as a number of short logs, as is at present done by some lumber companies in the State, or by allowing greater rise than is now usual. It is strongly recommended that owners of forest land make it one of the conditions in their contracts with jobbers that the logs be run well into the tops and that some agreement as to scale, fair to both parties, be adopted. The exact diameter depends on whether the logs are to be used as saw logs or for pulp, and on the local conditions; but with the present price of spruce it is poor business policy to leave merchantable timber in the woods.

In the accompanying figures (on opposite page) are shown two trees, drawn to scale and having the dimensions of the average Spruce tree on Squaw Mountain Township of those ten inches and over in diameter breasthigh. One is cut in the ordinary way, the other according to the recommendations just made. In the first case (fig. 1) the tree is felled with the axe, has a three foot stump, and is topped at nine inches, diameter outside bark. In the latter (fig. 2), the tree is felled with the saw, the stump is cut one foot, eight inches above the ground and close to the swelling of the roots, and the log is run up to six inches outside the bark in the top. For exact comparison the actual scale in cubic feet is given for both trees. In the first case, the merchantable part of the tree contains 18.60 cubic feet; in the second, 27.17 cubic feet; an actual gain of 8.57 cubic feet. In practice in Maine, one cubic foot is considered equivalent to ten feet board measure. Assuming this to be correct there is a gain of 85.7 board feet by cutting under the improved method. On a tract where, as on the lower Spruce and hardwood land on Squaw Mountain Township, there are 11.25 trees per acre ten inches and over in diameter breasthigh, with an average size corresponding to that in the figure, this would mean a gain of 964 board feet per acre. This would amount, with a stumpage value of $3.00 per 1,000 feet B. M., to $2.89 for every acre cut over.

Referring again to the methods of scaling, if the tree cut with the saw (fig. 2) were scaled full length by the Bangor Rule, allowing a rise of two inches, it would give seventy-four feet board measure. If scaled as three short logs—two of twelve

feet, one of fourteen, with top diameters, inside the bark, of eleven, nine, and five inches, respectively—it would give 114 feet board measure.

### OTHER FORMS OF WASTE.

There are other ways in which waste can be prevented in logging Spruce. Skidways and yards should be built of species other than Spruce wherever possible, and if Spruce is used for skid logs they should be marked for removal and taken out after the logs are hauled from the yard. The use of Spruce in camps, hovels, bridges, and corduroy, and as skids in roads should as far as possible be avoided. Less valuable timber is almost always available, and is suitable for the same purposes. Care should be exercised in felling not to do unnecessary injury to the young growth, particularly when other species are lumbered with or after the Spruce, and small trees are bent over should be released.

The roads should be laid out with care, and as few built as necessary to get out the logs. Too many roads not only destroy more timber but add greatly to the cost of maintenance in time of heavy snow. The careful operator will see to it that logs are not left in the woods and that lodged trees are pulled down and the logs hauled out.

The observance of these suggestions will result in the much better condition of the forest after lumbering and will insure both a larger present and future cut.

### MARKING AND INSPECTION.

If practical forestry is to be applied, it is advisable to mark the trees to be cut. In this way only can a definite limit be adhered to and proper provision made for preserving trees, for seed or other reasons. In marking trees for removal it is the custom of the Bureau of Forestry to stamp the letters "U. S." on a blaze on the stump. The work is done by a special crew with stamping hammers, at a cost of about fifteen cents per acre. All the trees that are marked are to be felled, and only those, the stamped blaze on the stump furnishing a check on the fellings. The marking and the subsequent work should be done under inspection and according to the terms of a contract embodying recommendations similar to those made above.

WASTE IN LUMBERING. HIGH STUMPS.

High stumps on which 12-20 inches in length might have been saved. The one to the right is a White Pine.

Owing to the conservatism of the ordinary lumberman and to the novelty of conservative forest management it is believed that in order to prove effective an attempt to improve the method of lumbering should be made under the charge of an inspector. The inspector should be a man experienced in lumbering, should appreciate the purpose of practical forestry, and should be a competent scaler. The saving in material will amply pay for the cost of such supervision and a better condition of the forest after lumbering will be assured.

## A LIST OF THE TREES FOUND ON SQUAW MOUNTAIN TOWNSHIP, MAINE, WITH SOME IMPORTANT SHRUBS.

### CONIFEROUS SPECIES.

| Common Name. | Scientific Nome. |
|---|---|
| White Pine | *Pinus strobus* Linn. |
| Red (Norway) Pine | *Pinus resinosa* Ait. |
| Tamarack | *Larix laricina* (Du Roi.) Koch. |
| Black Spruce | *Picea mariana* (Mill.) B. S. P. |
| Red Spruce | *Picea rubens* Sargent. |
| White Spruce | *Picea canadensis* (Mill.) B. S. P. |
| Hemlock | *Tsuga canadensis* (Linn.) Carr. |
| Balsam | *Abies balsamea* (Linn.) Mill. |
| Arborvitæ (White Cedar) | *Thuja occidentalis* Linn. |

### BROADLEAF SPECIES.

| | |
|---|---|
| Black Willow | *Salix nigra* Marsh. |
| Glaucous Willow | *Salix discolor* Muhl. |
| Aspen | *Populus tremuloides* Michx. |
| Largetooth Aspen | *Populus grandidentata* Michx. |
| Balm of Gilead | *Populus balsamifera* Linn. |
| Paper Birch | *Betula papyrifera* Marsh. |
| Yellow Birch | *Betula lutea* Michx. f. |
| Hornbeam | *Ostrya virginiana* (Mill.) Koch. |
| Beech | *Fagus atropunicea* (Marsh.) Sudworth. |
| White Elm | *Ulmus americana* Linn. |

| Common Name. | Scientific Name. |
|---|---|
| Mountain Ash | *Pyrus americana* (Marsh.) D. C. |
| Elderleaf Mountain Ash | *Pyrus sambucifolia* Cham. & Schl. |
| Wild Red (Bird) Cherry | *Prunus pennsylvanica* Linn. f. |
| Sugar (Hard) Maple | *Acer saccharum* Marsh. |
| Silver Maple | *Acer saccharinum* Linn. |
| Red Maple | *Acre rubrum* Linn. |
| Black Ash | *Fraxinus nigra* Marsh. |
| White Ash | *Fraxinus americana* Linn. |

SHRUBS.

| | |
|---|---|
| Ground Hemlock | *Taxus minor* (Michx.) Britton. |
| Shining Willow | *Salix lucida* Muhl. |
| Beaked Hazelnut | *Corylus rostrata* Ait. |
| Green (Mountain) Alder | *Alnus alnobetula* (Ehrh.) K. Koch. |
| Speckled (Hoary) Alder | *Alnus incana* (Linn.) Willd. |
| Wild Gooseberry | *Ribes cynosbati* Linn. |
| Fetid Currant | *Ribes prostratum* L'Her. |
| Witch Hazel | *Hamamelis virginiana* Linn. |
| Wild Red Raspberry | *Rubus strigosus* Michx. |
| Serviceberry (Shad-bush) | *Amelanchier canadensis* (Linn.) Medic. |
| Mountain (Spotted) Maple | *Acer. spicatum* Lam. |
| Striped Maple | *Acer pennsylvanicum* Linn. |
| Red-osier Dogwood | *Cornus stolonifera* Michx. |
| Sheep Laurel | *Kalmia angustifolia* Linn. |
| Black (Highbush) Huckleberry | *Gaylussacia resinosa* (Ait.) Torr & Gray. |
| Canada Blueberry | *Vaccinium canadense* Richards. |
| Low Blueberry | *Vaccinium vacillans* Kalm. |
| Redberried Elder | *Sambucus pubens* Michx. |
| Witch Hobble | *Viburnum alnifolium* Marsh. |
| Withe-rod | *Viburnum cassinoides* Linn. |
| Arrow Wood | *Viburnum dentatum* Linn. |

# DISTRIBUTION OF PLANTS IN FOREST REGIONS.

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By W. M. Munson, M. S., Professor of Horticulture at University of Maine, Orono.

WASTE IN LUMBERING. LARGE TOPS.

The underneath top had a diameter of 13 inches where cut and of 9 inches at the point where the man is standing.

# DISTRIBUTION OF PLANTS IN FOREST REGIONS.

W. M. MUNSON, University of Maine.

It is a matter of common observation that a given species of plant is usually distributed over a somewhat extended area, and that under similar conditions of environment certain species apparently come in spontaneously. For instance, in travelling in any direction through Maine, and westward to the Mississippi valley, the common white pine is almost constantly found. The beech, the oak and the poplar are hardly less common. These and hundreds of other species which are distributed over wide areas and widely separated districts, indicate either that there must have been separate creations of the same species in different places, or else that all of the individuals of a given species must have descended from a single original parent form, and have been distributed over the areas where now found.

The idea of spontaneous generation—that a certain "germinal principle" exists in the ground and that under proper conditions a growth of pines or oaks or beeches, etc., will appear—has long since been generally discarded. But, even at the present day, there are many intelligent people who believe in special creation or the "multiple origin" of species. Even Agassiz believed that "each species originated where it now occurs, probably in as great a number of individuals and occupying the same areas as at present." Dr. Gray, on the other hand, held what seems the more rational view, that all individuals of a given species are descended from a common parent and have become widely distributed, as we now find them, by modes which nature has obviously established for that purpose. Or, as he says: "Why should we suppose the Creator to do that supernaturally which would be *naturally* effected by the very means he had set in operation."

The white pine, for instance, may readily be conceived to have come from one original parent and to have been disseminated by

natural means. The scales of the ripened cone open, allowing the seeds to escape. Each seed is provided with a wing which, acting as a sail or parachute, retards its fall and allows it to be borne, often for great distances, by the wind. The cones, too, do not all ripen at the same time, so that seeds, falling at intervals, may be borne in different directions and scattered over a wide area, even in a single season. If now some of these seeds fall in favorable places they will germinate and in time produce crops of seed, and so continue the distribution in geometrical ratio, practically without limit. Obstacles of various kinds, as the sea or a mountain range or climatic conditions, may however intervene and thus the actual area of this or any other species may be definitely limited.

Referring to most of our well-known plants, whether of forest, field or garden, we find that nature has established many and varied modes for securing their dissemination. In most cases, too, these modes are obviously sufficient to account for the distribution of the species in question. In some instances, however, the mode of distribution is not known, or the source from which seed could have been derived is not evident, and the question of origin is a perplexing one. To assign more than one starting point—in other words a multiple origin—is a natural and easy explanation; but it suggests difficulties as great as those it overcomes. For instance, there are immense areas in South America and in Africa that have almost identical conditions of soil and climate but not one single plant in common. If nature has created some species in similar but widely separated districts, why not others? Again, it cannot be said that the plants found on a given area are positively the ones best adapted to the soil and other conditions there present; for on every hand we see foreign weeds usurping the places of our native and cultivated plants; for example the field daisy—"whiteweed"—and the Canada thistle. Inasmuch, therefore, as nature has established efficient means for the distribution of plants, it is reasonable to suppose that these means are employed in accomplishing the desired end.

SOME MODES OF DISTRIBUTION.

Without treating the question exhaustively, there are three principal divisions of the subject: *first,* the provisions of the plant itself; *second,* natural forces outside of the plant; and *third,* modifying influences or limitations. The first division would naturally include structural modifications of the fruit and of the seed, physiological characters such as texture of seed coats, conditions of vitality, etc., and various methods of propagation. The second division would include a discussion of the agencies of the wind, rivers, birds, animals and man. The third would include a discussion of isotherms and the conditions affecting climate, etc.

*Modifications of Fruits:* The most obvious modification of the fruit consists of a wing which aids the wind in carrying the fruit, often for considerable distances. Fruits of the elm, birch, ash, and maple are familiar examples. In case of the basswood there is a wing-like bract on the stem which bears the fruit.

The composite family,—asters, goldenrod, dandelion, thistle, etc.,—while not of immediate interest to the forester, is, nevertheless, of importance in affording a quick cover to ground that has been burned over and serving as shade and mulch. The fruits of this family are provided with an appendage or fringe of hairs—pappus—which is very efficient as a means of flight. It is not an uncommon thing in the autumn to see hundreds or even thousands of fruits of thistles, dandelions, etc., sailing along high in the air and carried for distances of many miles.

The fleshy fruits of certain species, while, so far as is known, of no importance in the economy of the plant itself, are most efficient means of dispersal. The fleshy fruits consumed by birds and other animals are eaten for the flesh and not for the seeds which, in most instances, are uninjured by the process of digestion. These seeds, being dropped in the excrement, often at great distances from the place where eaten, are in condition to grow and again form new centers of distribution. Almost every natural order contains some species with fleshy fruits. I need only mention a few of the most common, such as apple, hawthorn, plum, cherry, blueberry, red cedar, ground hemlock, etc. Over fifty species of the rose family alone,—not including the roses—in the territory east of the Mississippi, have fleshy fruits.

Nuts and nut-like fruits, taken in connection with the habits of the animals which eat them, are important means of distributing many species. Beechnuts, walnuts, chestnuts, acorns, and many others at once suggest themselves. The squirrels and other animals which feed upon these nuts deposit them in various out of the way places, hiding them with leaves and rubbish. By the death of the animal hiding them, or for various reasons, some of these nuts may remain where deposited and thus establish new plants at considerable distance from the parents.

*Modifications of Seeds:* The seeds of many plants, as distinguished from fruits, are furnished with wings or other special means of dissemination. The pines, spruces, hemlock and arbor-vitæ (white cedar) are particularly good examples of trees with winged seeds. The catalpa an important tree in Ohio and the middle west, is another familiar instance. Many seeds, as in case of the milk-weeds, are furnished with long light hairs (coma) which serve to carry the seeds for long distances. All of the willows and poplars are furnished with a soft silky down, which serves the same purpose.

*Physiological Characters:* In many seeds the coats are of such a character as to resist the injurious effects of water so that they may be borne for great distances by ocean currents or by rivers. Darwin, many years ago, tried some very interesting experiments on seeds immersed in sea water. He found that out of eighty-seven seeds sixty-four germinated after an immersion of twenty-eight days, and a few after one hundred and thirty-seven days. Reflecting that branches with fruits attached, are sometimes washed by rivers down to the sea and afterwards cast ashore and dried, he thought they might then be blown by the wind into the sea where they could float and thus be transported by the currents. By repeating his experiments with this thought in view, he found that branches of hazel nut floated ninety days and asparagus eighty-five days, and the seeds afterwards germinated. The average results of the experiments showed that the seeds of fourteen per cent of the plants of any couptry might float twenty-eight days without loss of vitality.*

It is probable that in many cases seeds retain their vitality for a long time—a fact which would have a most important bearing upon the final results of dissemination. For instance, the seeds

*Origin of Species, 158.


CUT OVER LAND.

A group of stumps cut low with the saw.

of a given species, as of pine or spruce, may during a good "seed year" be scattered over a wide area where conditions are unfavorable to germination; but in time these conditions may so change as to become favorable to germination and, if the seeds have retained their vitality, they will now spring up and produce a crop of plants. If, in the mean time, the seed tree has been destroyed, the source of the young seedlings is an apparent mystery. There is no doubt that some seeds will germinate at a relatively great age, but no tables of longevity are reliable as so much depends upon the conditions surrounding the seed while dormant. Seeds which are buried in a damp soil, being excluded from air and warmth, are in the best possible condition for preservation, and it is not improbable that plants which spring up when a forest is cleared away are, many of them, from seeds which had been sown years before.

The prodigality of nature in the production of seeds of every kind is also an element which should not be overlooked. Very few of the whole number of seeds produced in any given area ever grow into plants. A single tobacco plant may produce about 40,000 seeds, and an average sized elm produces upwards of half a million.

*Exceptional Methods of Propagation:* While seeding is the most common means of perpetuating and extending the range of a given species, other modes of propagation are often employed and are of no small importance, especially in re-foresting an area after destructive fires. The method of propagation peculiar to many plants is inseparable from their distribution. The black willow, for instance, is a familiar example of a tree which spreads rapidly by the rooting of twigs broken from established trees by the wind; the native plums increase rapidly by means of suckers; some of the viburnums and dogwoods by layers or stolons; the oaks and chestnuts by sprouts from the stumps of injured trees; the blueberry by underground stems similar to those of witch grass, the strawberry by runners; and so on indefinitely.

## AGENTS OF DISTRIBUTION.

I have already suggested, in a general way, some of the agencies concerned in plant distribution and more particularly the wind, water birds and other animals. It may be well to consider more in detail, though briefly, some of the more important of these agents.

*The Winds:* The action of the wind in distributing those light seeds or fruits furnished with wings or pappus needs only to be mentioned. But the power of the wind is much greater than this; a tornado may tear branches, or even transport trees bodily and carry them for many miles. Birds are driven, often for hundreds of miles, by heavy winds and may thus transport seeds which had been eaten to an entirely new locality. When the wind blows continuously in one direction for several days in succession, floating seeds and fruits are often carried to far distant shores, there to establish new centers of distribution.

*The Waters:* The efficiency of brooks and rivers as agents of dissemination is a matter of common observation. Freshets, carrying branches of trees, fruits and seeds which are stranded at various points along the shore, may be observed every year, and the similarity of the vegetation along the shore is an obvious result. As already intimated, these seeds, fruits, etc., may be carried out to sea and, by means of ocean currents, transported to far distant lands.

*Birds:* The importance of birds as active disseminators of seeds is often overlooked. As before suggested, the seeds of many fleshy fruits pass uninjured through the digestive tract of birds and may be distributed over very wide areas. In fact, according to Lyell,* English farmers feed turkeys with the fruits of the common hawthorn and then sow the seeds which are excreted and thus gain a year in the growth of plants—the process of germination being hastened by this treatment. In many cases, too, fleshy fruits are carried some distance by birds and the flesh consumed, while the seed is dropped.

The mistletoe is entirely dependent on birds for distribution and it is said that there are now growing around the Coliseum at Rome 261 species which were planted there by birds.† The common poke weed (Phytolacca) which was originally carried from America to Bordeaux, France, to be used in coloring wine, has been scattered by birds throughout France.‡ Nevertheless this is one of the species which believers in "spontaneous generation" have often cited in support of their theory, since it so frequently appears, especially in the central states, very soon after fire has destroyed all traces of vegetation. The destruc-

* Principles of Geology, 395.
† Prentiss, Distribution of Plants, 10.
‡ Ibid.

tion of birds by their numerous enemies has an important bearing upon the point in question. A bird with fresh seeds in its crop, which it had eaten, perhaps a hundred miles away, is pursued by its enemies and killed. The seeds, if they happen to fall in a congenial place, are ready to spring up and grow. It is estimated that the number of birds of any species which die every year, equals the number by which that species, on the average, is permanently represented. So it is probable that the method just mentioned may be an important factor in the dissemination of plants. Wading birds, ducks, etc., are undoubtedly important factors in scattering such seeds as abound in wet places. The mud in which they delight to walk is charged with seeds of all kinds and, adhering to the feet and plumage of the birds, is often carried for long distances. Darwin, having observed some mud on the foot of a woodcock, examined it and found the seed of a Juncus which germinated. From a ball of earth taken from the leg of a partridge, at another time, he raised no less than eighty plants. Many other cases might be cited to show the importance of birds as factors in seed distribution.

*Other Animals:* One has only to recall the many kinds of seeds and fruits seen adhering to the tails and other long-haired portions of the bodies of domestic animals to readily admit the importance of animals as plant distributors. The wild animals, which range over large areas, are, without doubt, of great importance in this way. As suggested by Lyell, a deer, when chased by dogs or other enemies, will dash through thickets, swim rivers and lakes, carrying with him seeds and even thorny branches which again are brushed off in other thickets. If caught and devoured, many of the seeds which he had swallowed just before the chase may be left upon the ground and in due time spring up and grow. Cattle, sheep and horses are often seen carrying seed-bearing branches especially of grasses and plants provided with hooks and awns, while many of the seeds dropped in the excrement are uninjured and ready to germinate under favorable conditions. The work of squirrels and other animals in distributing nuts has already been mentioned.

*Man:* The agency of man in modifying the distribution of plants, both consciously and unconsciously, is of inestimable importance. The work which he purposely does in this direction

is indeed greatly exceeded by that which he unconsciously or unwillingly does. Sportsmen and lumbermen are invariably followed by the advent of new plants. The plantain and the pigweed are unerring guides to the invasion of man, and they almost invariably accompany him in his migrations. The campfire started by the hunter may result in a destructive forest fire, denuding many square miles of territory and giving opportunity for a wholly new vegetable covering; or it may simply make a slight opening which shall enable a few plants to obtain a foothold. Whether the result of accident, lawlessness, or of systematic burning for the encouragement of certain plants—as in blueberry culture—fire is one of the most important controlling factors in the vegetation of a country; and with the exception of fires started from lightning strokes, man is entirely responsible for the operation of this factor. The enumeration of the ways in which man distributes plants, and of the kinds of plants which he carries, might be continued almost indefinitely, but the suggestion is sufficient.

MODIFYING INFLUENCES OR LIMITATIONS.

*Time:* "In estimating the activity of any causes, we must not consider whether they act slowly in relation to our observation, but in reference to the duration of species in general."* In considering the subject in hand, therefore, it is well to remember that the modes of distribution suggested need not necessarily have acted frequently in order to produce the results now seen. The various modes of distribution may operate only once in a century, and still be effective in producing the results observed. Furthermore, as already suggested, a plant when once established in a new and favorable position at once becomes a new center of distribution by the most ordinary means.

*Environment; the Struggle for Existence:* The earth is filled with plants and there is sharp competition for every inch of its surface,—competition for food, for moisture and for light. "To range widely," says Darwin, "implies not only the power of wide dispersal, but also the more important one of being victorious over previous occupants." Or, as Bailey observes, "the greater the population of any area, the less chance have other plants to gain a foothold."

* Lyell, Principles of Geology.

KENNEBAGO VALLEY.

Spruce timber from which the largest has been cut out, leaving at this point a good growing stand.

Nature abhors bare ground, and if any good soil is without a plant cover there is always some obvious reason for it. Plants of different form and habit may, however, grow together in a sort of plant society, as a result of what Darwin has called *divergence of character,* and thereby a given area may support more plants than would be possible if only one kind were growing upon it. In almost any forest, for instance, may be seen the tall timber trees, a lower "second growth," usually of different species, the low "underbrush" and finally, still lower, shade-enduring ferns and annual herbs and "scrubby" perennials. The plant that is first established, however, appropriates the food to itself and new comers find difficulty in getting a start. Last spring, under a row of Norway maples, I observed hundreds of young seedlings struggling with the grass on the lawn and with the bare gravel of the adjacent drive in a vain attempt to extend the number of maple trees on the university campus. By the first of September, however, not half a dozen of these seedlings could be found, and before another spring these, too, will have succumbed and the same process will be repeated. Conditions of soil, climate and exposure have a very decided limiting effect. The shade-loving plant that flourishes in the dense forest perishes as surely when exposed to the scorching sun and biting winds of the plains as do other plants removed to unwonted shade,—a fact to which is due in a large measure, the "succession of forests" about which so much is said. Climate also is a most potent force in modifying or limiting the distribution of plants. The same climate which favors the growth of our majestic elms, and oaks and white pines, is destructive to the equally choice mahogany, live oaks and long-leaved pines of the South. And even a slight difference of climate, or an unfavorable season, may affect the destiny of a given species in a new locality.

### THE SUCCESSION OF FORESTS.

When a forest is cleared away, whether by the lumberman's operations or by fire, it is succeeded by another, made up principally or entirely of species differing from the first. This fact is a matter of common observation and speculation. Its explanation is sometimes obvious, often difficult. It has been suggested that certain kinds of trees exhaust the soil of certain

elements and that other trees requiring different conditions follow; that, analogous to the rotation of crops practiced by the farmer, and for similar reasons, there is a natural rotation of forests. On investigation, however, it will be found that in some instances, at least, forests of the same sorts have thrived on the same areas for more than a thousand years in succession,—as in case of some of the beech and spruce forests of Germany. In accounting for this it should be borne in mind that the leaves and the dead limbs and trunks, by returning to the soil a large portion of the material used in growth, maintain to a large extent its fertility. Furthermore, the amount of potash, phosphoric acid and other valuable elements of plant food contained in a crop of grain is five to ten times larger than that contained in a crop of hard or soft wood; while the continual mulch and shade of the foliage keeps the soil in the best possible mechanical condition. So the theory of soil exhaustion will not hold.

How then is it possible for deciduous trees and shrubs to come in where before there was apparently little but a "black growth" of pine, spruce, hemlock, etc.? In the first place in nearly every evergreen forest there will be found scattered trees of various deciduous species, notably poplar, maple, ash, beech and others most commonly carried to considerable distances by wind, birds or other animals. These are usually unnoticed by the casual observer, and very often they are insignificant, stunted specimens which barely survive in the struggle for existence; though they may in reality be five to twenty-five or even fifty years old. If, now, a slight opening is made in the forest, as by a camp-fire on slight clearing, the sunlight is admitted, the slender sapling becomes a sturdy tree and produces offspring which repeat the same story.

Again, there are two things absolutely essential to the life of every plant, *viz.*, moisture and light. Moisture to render soluble the plant food and make it available for use; and light to utilize the food supplied and build up plant tissues. The proportion of these two requisites varies with different kinds of plants; but for each species there is a minimum and a maximum limit to the amount of light (and the attendant heat) and moisture required. Beyond these limits, in either direction, the plant suffers. Some plants have a narrow range, others a wide one.

For instance, the black ash, the cypress and some others will thrive though constantly standing with "wet feet," but would perish if placed on a high rocky ridge. The black spruce and the low blueberry, on the other hand, are found alike on low swampy areas and on sand hills or rocky ledges. As to light, trees are classed as light-loving and shade-enduring species. The two classes grade into each other almost imperceptibly; but in general terms the light requirements of a species may be told by the character of its own shade. The oaks, birches and poplars for instance, have light, "open" heads and require much light; maples are much more dense and will endure greater shade; while beeches and hemlocks are typical shade-enduring species. If now, the seeds of some light-loving species should fall in a beech wood, or in a hemlock or spruce forest, it would stand very little chance of growth, while the young beeches and hemlocks and spruces would thrive. But if for any reason the protective shade is removed, the intruders stand a better chance of surviving than do the offspring of the original growth. On the other hand, if seeds of beech or maple, spruce or hemlock are distributed over a tract covered with oaks or birches or poplars, the shade of the established species is sufficient to favor rapid growth of the intruders. The latter soon develop into mature trees, the tops casting the usual dense shade. In time they produce seeds which also grow into trees. Now the seeds of the oaks and birches which fall in the shade of their own parents may grow and produce other trees, but those seeds which fall under the dense shade of the invading plants either fail to sprout or soon perish. After many years the older trees, which were the original occupants, perish by accident or from age, the new growth of beeches etc. are in the majority, with a constantly increasing percentage. Eventually, it may be centuries after the first invasion, the light, graceful birches and the sturdy oaks will alike have given place to the beeches and other shade-enduring plants. Of course the light conditions are not the only factors in this warfare of species. Conditions of soil and moisture and exposure are usually exceedingly complex, and might be such, over certain parts of the tract, that the invaders could obtain no foothold; in which case the original forest would persist. The fact, however, that in any region a given species is never found except in some special locality, as a swamp or a dry sand hill, does not prove that it

will not flourish elsewhere. Indeed the species may really much prefer other localities from which it has been excluded by its competitors.

Another potent factor in the succession of forests is the characteristic of sprouting from the base, possessed by some trees, such as oak, chestnut, maple, willow, poplar, cherry, etc. Professor Beal lays particular stress on this feature in the succession of forests in Michigan. In describing a typical virgin pine forest in central Michigan he says:* "Let us look for young deciduous trees. Here are a few very slender oaks of two or three species, some that are eighteen feet high and less than one inch and a half in diameter near the ground; yes, and there is now and then one which has died to the ground, apparently smothered for want of light, but a few spindling sprouts are coming up showing that life still holds out. On digging a few of these slender oaks, we find some of them come from clumped roots or 'grubs' of various sizes, showing that the present growth is the first, second, third or fourth sprout which has apparently come in succession from the same foundation; some of these old sprouts are now represented only by dead stumps, some of which are charred near the ground. By counting the rings of growth in the last sprout, or if small, the bud rings, we may tell very accurately how long since a fire killed the former sprout. Below the denser growth of large trees we shall be able to find scattering oaks of various ages. On my last visit I brought home two white oaks and one red oak which still had the remains of the seedling acorns attached by the stems of the cotyledons. One of these was five years old. There are others, some four inches high, crooked little things, not the eighth of an inch in diameter, bearing only two or three small leaves. The marks of bud rings show that they may be four to ten years old. On examining some near the ground, we shall find a part of them are the first, second or third sprouts from a small clumped root or grub. It is not difficult to find white oaks under eighteen inches high that are twenty or more years old, and then, this may be the second, third or fourth sprout that has followed in succession. So it is not improbable that, in some cases seen, the parent root or grub was sixty to one hundred years old and the whole now not an inch in diameter

* Rep. Mich. Forestry Com. 1888, 26.

LAND CUT OVER THIRTY YEARS AGO.
This land is again being lumbered for Spruce.

anywhere above the ground. Then what shall we say of the age of some grubs which weigh thirty to fifty pounds each? Slender little red maples are rather common in this forest. There are plenty not over a foot high and an eighth of an inch or less in diameter, that are without question twenty to twenty-eight years old, and in some cases this is not the first growth but (as with the oaks) the second, third or fourth of small size, in succession from the same root."

In like manner grubs and stunted specimens of many other species were found which were ready to spring up immediately, as soon as the proper conditions of light and moisture were provided. The young pines, hemlocks and spruces, however, are lacking in this ability to perpetuate themselves by means of sprouts.

Conditions not unlike those above mentioned prevail in all of the forest region of the eastern part of the country, and a knowledge of this fact helps to explain the rapidity with which a burned territory is reforested. Thrifty young growth does not spring up directly as a result of spontaneous generation, nor yet as the result of a providential distribution of seeds. The trees that produced the seeds may have perished long ago, and yet the stunted, slow-growing seedlings may have survived as indicated.

## SUMMARY.

The distribution of plants is the resultant of many forces more or less conflicting. Plants are so modified as to adapt them to dissemination; there are many natural and artificial agents which aid in the distribution, among the most important being, winds, waters, birds, and other animals, and man. Opposed to these agents are natural conditions of soil, climate and habit of plant, together with the inevitable natural struggle for existence. But thousands of seeds are produced and distributed to every one that can possibly grow, and the result is that the whole earth, where vegetation can possibly exist, is covered with vegetable life.

There is a natural succession of forests due to changed natural conditions and to the incessant warfare between species. This succession may be rapid, as when a given area is swept by fire and soon recovered by vegetation of an entirely different

character; or it may be the result of centuries of gradual encroachment. The agents which are used in distributing plants, together with the light-loving and shade-enduring characters of certain species, the habit of repeatedly sprouting from the root or stump, and the fact that many seeds remain dormant for long periods are the most important factors in forest succession.

# MANAGEMENT OF PULP WOOD FORESTS.

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System of Forestry practiced by
Berlin Mills Company, by
Austin Cary, A. M.,
Forester.

A TYPICAL MAINE LUMBER CAMP.

# MANAGEMENT OF PULP WOOD FORESTS.

The following is an extract from an article "The Management of Pulpwood Forests" in the Journal of the Canadian Forestry Association for 1902:

As for conservative cutting of spruce woods, I will say first and most emphatically that we find it a difficult and risky process, one that is likely to bring more loss than gain unless done with great care and considerable skill. It may be different in other countries, but that is the case here. Our timber is typically large and tall; much of it stands in exposed situations, on ridges and mountains; much is on extremely rocky land. The winds are continually damaging our native uncut stands and the thinning of woods in all such places as above is either entirely impracticable or must be done with the greatest caution to ensure that what is left standing will not blow down.

As said already the danger from wind might be much less in another country. In this very region indeed considerable light cutting was done in decades past without incurring great proportional loss. That, however, was different work from what is required now. Not more than a third or half of the timber was taken then and that in bunches, the biggest and best, leaving the thin strips and the rough and steep places entirely untouched. At the present time business conditions are far different. A stick of spruce or fir scaling only twenty feet B. M. is merchantable, and has stumpage value if it is not too far away from other stuff. We are logging a good deal of rough, difficult land with oftentimes a long and costly road built into it, so that a heavy cut may be necessary to pay the bills. At any rate owners through this region expect that on any land logged over three-fourths of the stand shall be taken, and to take three-fourths of the merchantable timber from most of our lands, leaving the

balance at the same time in such shape that it can be depended on to stand and grow is, as I have indicated above, a very hazardous undertaking.

My experience in the actual handling of spruce lands covers four years. According to my observation a logging boss trained to hard cutting when told that we wish to cut conservatively is pretty sure to leave what he does leave not in the shape of small growth so much as in strips of scattering timber and odd corners on rough and difficult ground. This makes the logging show up cheaper, but it may be on the other hand that what is left standing is the very stuff that most needs cutting of any on the land. In other words as a first result instead of thinning or conservative cutting we are apt to get simply slack cutting.

When this has been corrected and the man gets a better notion of what we are about, his next move is to leave the small growth uniformly all over the land. This may do in some countries, but it means loss here. Tall and slender trees left too open, anything less than a full stand on divides and knolls, tall timber shoally rooted on rocky land, these items together may amount to a good deal in a logging job and all of them are such that sooner or later they are sure to blow down. With us the day of reckoning came in December, 1900. Two gales came that month before the ground had frozen, one of them after a soaking rain. The loss suffered was not in cut-over lands alone, but of course it was more remarked and regretted there. Some of the down stuff we have picked up since at added expense. Some of it is so scattered that it is impossible to get it.

Something of that however was to be expected. We have not been discouraged, but have simply inferred that we must be more careful and exercise closer control of the work. We learned something ourselves by experience and in the course of time we came to have a better understanding with the men. For the last two years I think we have been doing fairly well. Considerable merchantable stuff has been left to grow and for the most part I feel pretty confident about it. The key to success is variation of the cutting according to the stand and the lay of the land. The critical matter, the thing which must be continually thought about, is the safety of what is left from wind. Mixed growth, growth that is to say in which hard woods

compose half or thereabouts of the total stand, can generally be thinned with safety and comparative ease. Elsewhere great care has to be exercised, and there is a great deal in picking strips and bunches to be left entire. This we frequently do with areas of smaller-sized thrifty growth if there is no dead, failing or down stuff in them. Lastly we do not hesitate, when we think that is the proper thing to do, to cut clean.

There is one side issue that perhaps should be elucidated here, and that is the form of contract under which work of this nature is secured from contractors. The Berlin Mills Co. owns several hundred horses and does its own logging largely, but a portion of its work is done by jobbers cutting by the thousand, and strange as it may seem these men do their work as well and are fully as amenable to control as the company's own men. They have always cut quite as economically as the others—in respect to stumps, tops, picking up windfalls, dead timber, etc.—and I think we are securing from them now quite as good work in this other line.

The clause in our contracts which covers this feature of the business is as follows:—"Spruce and fir timber shall be cut to the size of twelve inches on the stump, but this rule may be varied by the Berlin Mills Co. with a view to leaving the land in good growing condition." This form of contract is not recommended as a solution of all difficulties and a guarantee of success. It does not replace supervision, but distinctly implies it. Then men might understand its terms differently and get at loggerheads with one another before they had been at work a month. But this form of contract does allow latitude and adaptation to the country, and in two of our concerns the past winter it has worked very well. The men in charge are active, capable men who were anxious, too, to do the work as well as they could. I have endeavored to be reasonable myself, and we had worked together before so we understood one another. I have spent a couple of days in each concern every three or four weeks, examining all the work done, and looking over the timber ahead to see how it should be handled. In this way we have come through the winter so far with very little friction, and the work I feel is being done substantially according to the company's interest, as near probably as it would be done by any of its own men.

One favorable condition I should not fail to mention here is the long established reputation of the company for fair dealing, and the certainty the contractors have in consequence that they will not be subjected to any underhanded tricks. As to the volume of cutting that one man can look after in the fashion outlined above, I will say that seven camps have been under my oversight the past winter scattered over a round trip by tote road of 150 miles. The aggregate cut is about eighteen millions. Even if a man has no care of supplies, that is enough to have under his control.

It is well further to state the motive for conservative cutting as we practice it. We have not settled down to the European idea of sustained yield, of running a business of a certain volume forever from a given tract of land. Whatever has been said, I do not believe that any business concern in the United States, knowing what it means, has settled on that. The reason is that we have large tracts of timber that badly need cutting, and the sooner we can get over them, saving the dead and declining stuff and putting them in shape to grow, the better it will be. This is the chief motive and, balanced by considerations of cost and practicability, is the key to our operations along this line. Of course, expected growth is a consideration as far as it is not offset by windfall. Then we believe that in the future better stumpage can be had on the smaller classes of timber. But certain of its tracts the Berlin Mills Company cuts as closely as anyone can cut, and if ever in the future the question comes up whether to shrink the volume of manufacture or to maintain it for a time longer by cutting the lands down to the lowest practicable point, that will be a new question to decide. Speaking for myself and as a forester, I feel like felicitating you Canadians on having retained so much of the timber land of Canada under government control.

HAULING FROM THE YARDS OF A KENNEBEC LUMBER CAMP.

## CONTROL OF LOGGING JOBS AND WASTE.

Below is a copy of the inspector's report as used by the Berlin Mills Co.:

### REPORT OF INSPECTION.

Camp of ..... Township.....
Date .....
Date of last inspection.....
Force .....
How employed .....
.....
Banked and or yarded to date .....
Number of crews cutting.....
Stumps (if unsatisfactory specify number and crew).....
.....
.....
Tops (if unsatisfactory specify number and crew).....
.....
.....
Length of logs.....
.....
Are they carefully butted and trimmed?.....
.....
Dead and down timber.....
.....
Fir .....
.....
Are any logs, poles or lodges left?.....
.....
Remarks .....
.....
.....
Plan of cutting (marking, size-limit, clean cutting, etc.).....
.....
How adhered to?.....
.....
By whom are roads located?.....
Is soft wood cut for skids and bedding?.....
Is care exercised to protect small growth?.....
Remarks .....
.....
.....
Are all logs marked and stamped?.....
Two-sledding .....
.....
.....

Landings .....
.....
.....
Signed .....

This inspection report represents the most effective control which we have been able to exert on our logging bosses and contractors. The work of each camp is inspected once every three weeks, and the past winter all the roads cut by the crew in the interval were gone over by the inspector, looking carefully after each item of waste. By this means foremen have been stimulated to look more carefully after this work than ever before, and in respect to economy at least, loss of stuff left in the woods, greatly improved results have been obtained.

The following extract from my report for the logging season of 1901-02 will show what we consider has been accomplished, and contains figures for the waste involved in logging, which should be of considerable interest.

Previous to that, however, there is one matter which should be briefly touched on—that is marking the timber to be cut. That system has not gotten into successful operation with us yet. Enough has been done to find out the difficulties and also the cost, which runs between two and five cents per M. But owing to several causes, one of which is the dislike of the foremen to innovation and particularly an innovation which limits their entire freedom, results commensurate to the outlay of labor have not yet been obtained. Indeed in Androscoggin timber sections with the logging methods prevailing, and particularly in view of the liability of thinned stands to blow down, the writer is not satisfied that marking according to the system now practiced in the Adirondacks, is the best method of control.

In the first place it is hard to lay out work in advance so that it will come handy. Again a man cannot tell how a stand will look after the work is done, and trees that he may wish to leave standing, that so far as he can tell in advance may be safely left, he might if he could see them after the work is done, think ought to be cut to save them from wind destruction. In fact if the man on the ground, the logging boss, fully understands what is wanted, if he as an active man and has not so much else to do but that he can spend most of his time among his choppers, he is in a far better position to regulate the work than

Dense spruce growth on very rocky land in the Kennebago Valley. Such growth as is here shown cannot be safely and profitably thinned.

any other man can be. Still marking is the only way to lay out work exactly as it is to be done, and one way or another the writer believes it a method worthy of final adoption wherever conservative cutting is practical.

Below is a summary of the waste discovered in the work of six camps which were under the inspection of the writer during the winter of 1901-02. In explanation it will be necessary to append the following: By poles are meant small sticks scaling twenty feet or less B. M. and down to about seven inches on the stump. Under down and uprooting trees is put everything of that description seen on the ground cut over. In some cases these trees lay so hard that no man would go after them; in others they may have been easy to get. The two classes cannot be distinguished here. The waste in stumps and tops is a matter of judgment in which the inspector might be a good deal off as no very extended studies or computations were made in the matter. Where a man kept his work as close to orders as could with reason be expected, no charge is made against him. Stumps were to be cut down to the swell of the roots and shovelled out if the snow was deep enough to require it. It was meant that no tops should be cut larger than six inches, and by far the most were much less. The term "sure to blow down" as applied to stuff left by the loggers explains itself. In most of the operations it was not meant to strip the land, but to leave the smaller timber to grow, where it could be safely done. Whether it will be safe, is of course, a matter of judgment. In inspecting I meant to be conservative, noting only what any experienced man, if he gave his mind to it, would feel sure was doomed to fall. I expect there will be more loss by wind in the future than is here included. Of course it is understood that I do not claim to have seen all the waste that occurred. Some of it was covered up by brush and tops so that no man could get it all.

This table shows the merchantable timber left to waste by six Berlin Mills Co.'s camps under close inspection:

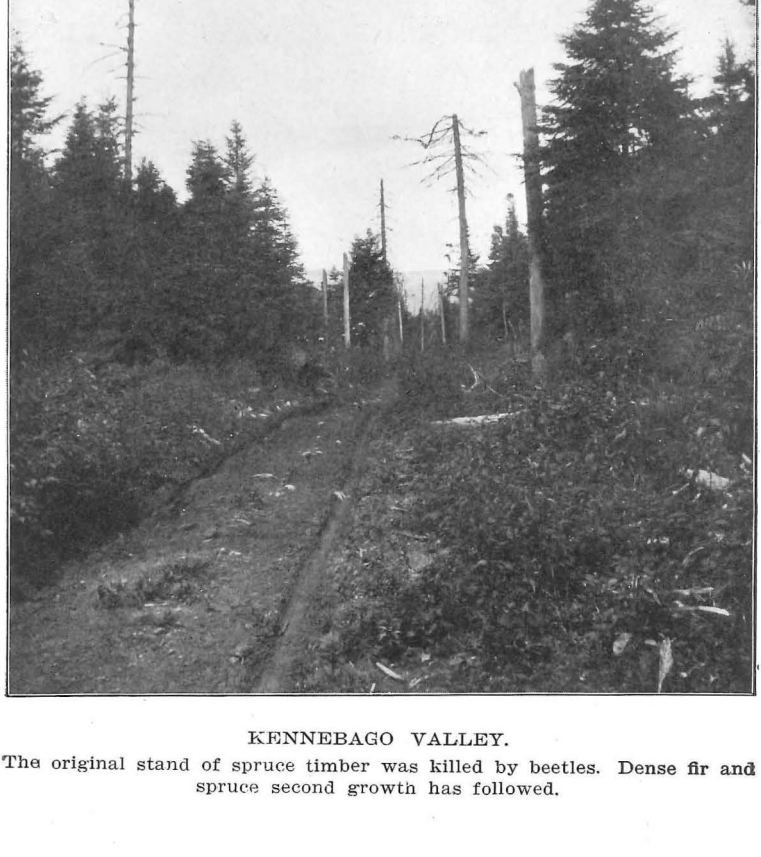
| | Camp No. 1. | Camp No. 2. | Camp No. 3. | Camp No. 4. | Camp No. 5. | Camp No. 6. |
|---|---|---|---|---|---|---|
| Total lumber cut .. | 2,000,000 ft. | 2,400,000 ft. | 3,400,000 ft. | 3,400,000 ft. | 2,500,000 ft. | 1,900,000 ft. |
| Waste in stumps and tops..... | ..... | 11,600 ft. | 35,000 ft. | 1,400 ft. | 30,500 ft. | 3,000 ft. |
| Logs and trees cut and left..... | 1,000 ft. | 2,300 ft. | 5,400 ft. | 1,900 ft. | 2,200 ft. | 100 ft. |
| Poles ... ..... | 100 ft. | 1,400 ft. | 6,000 ft. | 2,000 ft. | 5,500 ft. | 300 ft. |
| Lodged trees ..... | ..... ... | 200 ft. | 6,000 ft. | 1,100 ft. | 2,000 ft. | 1,200 ft. |
| Standing dry timber..... ... | 500 ft. | 6,500 ft. | 3,500 ft. | 1,000 ft. | 4,200 ft. | 3,000 ft. |
| Down and uprooting trees .... ... | 6,300 ft. | 10,500 ft. | 27,000 ft. | 10,600 ft. | 10,300 ft. | 4,600 ft. |
| Sure to blow down | 4,200 ft. | 7,500 ft. | 17,100 ft. | 4,000 ft. | 6,000 ft. | 2,800 ft. |
| Total ..... | 12,100 ft. | 40,000 ft. | 100,000 ft. | 22,000 ft. | 61,000 ft. | 15,000 ft. |
| Percentage of cut.. | .6 of 1% | 1.7 of cut | 3% of cut | .65 of 1% | 2.3% of cut | .8 of 1% |

Total waste in 15,600,000 feet cut, 250 M or 1.47 per cent. That can and will be improved upon, but still there are logging concerns in the State which waste twenty times as much in proportion.

## INSECT DAMAGE TO SPRUCE TIMBER.

That insects were killing spruce timber in the forests of New England was first learned by the writer in the summer of 1897 while on an extended exploration in northern Vermont and New Hampshire. The trouble as first encountered was not severe—that is to say not much timber was dead in any one place—but in the course of the season it was found that in the aggregate a large amount had been killed and that the beetles were at work over a very large territory. It was also ascertained that in previous years great damage had been suffered in the same general region.

It will be worth while to recount a few of the cases of depredation known to have occurred in our spruce woods. Old lumbermen tell of a great loss of spruce timber in northern Vermont and New Hampshire, extending into neighboring lands in Canada, which occurred some thirty years ago. The drives of the Connecticut are said to have been made up for some years thereafter largely of dead timber. The same region



KENNEBAGO VALLEY.

The original stand of spruce timber was killed by beetles. Dense fir and spruce second growth has followed.

suffered again between 1885 and 1890, when on some considerable areas the greater part of the spruce died. Here again timely cutting served to save a portion of the dead timber.

In Maine several cases of very thoroughgoing destruction have been known. Beginning about 1885 a township on the Androscoggin, which at the time was called the best spruce tract on the river, had a large part of its value destroyed in the course of three or four years. No attempt was made to save the dead timber. It stood there till it rotted down and the ground is now covered with dense thickets of fir and other young growth. On the Allagash river in northern Maine there are several adjacent townships which about 1883 were greatly damaged. In some places ninety per cent of the spruce is said to have been killed—in fact, all the grown timber. In this last case the cause of the destruction is known, for specimens of bark beetles collected at the time resemble at least, if they are not identical with, those with which we now have to deal. In connection with the other cases there is, so far as I have ascertained, no similar record. We can only judge of the cause from the effects and the circumstances.

## THE BEETLE AND ITS HABITS.

The beetle now at work in our forests has been studied by Prof. Hopkins, the highest authority on timber insects, who names it *Dendroctomes piceaperda.** It does its damage to trees by boring in the cambium and soft inner bark. The adult beetle is about as big as an apple seed, some individuals being black, others bronze in color. The beetles when moving would appear sometimes at least to swarm after the manner of bees, for a tree that is infested at all almost always has them in great numbers; indeed in one case a colony was found just beginning its attack, hundreds upon one tree, on the outside of the bark just boring their way in.

The form of their burrows is quite characteristic. They first bore a round hole through the bark to the surface of the wood, then cut a burrow four to seven inches long up and down the

*It has been determined, however, by comparison with the original specimens now in the British museum collections that the spruce destroying beetle is quite distinct, and I have applied to it the name *Dendroctonus piceaperda*, meaning spruce destroyer.—A. D. Hopkins in Bulletin 28, Deptartment of Agriculture.

tree, in which the sexes mate and in the edges of which the eggs are laid. A portion of the borings meanwhile are thrown out of the burrow, and pitchy as they are often form a tube, which marks the infested tree. The larvæ when hatched bore out laterally in the soft tissue between the solid wood and the bark, eating out a channel which increases in dimensions as the insect grows. Finally the grub pupates and after reaching the adult form bores its way to freedom to attack another tree. As near as we know now in northern New Hampshire and the Rangeley region, the first eggs are laid in the middle of June and beetles from these eggs begin to appear the last of September. Late broods may come to the winter season in the larval form, and they live through the winter in that form in large numbers. Migration from tree to tree probably ceases by the first of September.

### DECAY OF THE DEAD TIMBER.

Ordinarily, as noted above, great numbers of beetles attack a tree together and, when the colonies of larvæ are well grown, their work completely girdles it. The leaves then drop off, leaving the tree conspicuous by its red appearance. Year by year after that the twigs and limbs drop off and the trunk also shows quick depreciation. Ordinarily the sapwood shows discoloration and softening the same season as the attack. The heart wood is much slower to follow and in fact often remains perfectly sound for several years after the death of the tree. Wood boring insects assist decay in the process of destruction. On the other hand woodpeckers often considerably postpone it by loosening the bark so that water does not stand under it. Experiments are now in progress to ascertain exactly the rate of deterioration of the dead timber.

### WHERE TROUBLE MAY BE LOOKED FOR.

One of the most important matters of inquiry in the connection, practically speaking, is the choice of the insects in the way of trees and stands for attack. On this point the following may be said: The beetle with us is working on apparently healthy, though large and old, timber. It attacks both black and white spruce, but so far as noted no other species. Its choice is the very largest and finest timber, not necessarily the thickest.

Stands of smaller sized spruce, cut-over lands, and trees below ten or twelve inches in breast diameter are usually exempt. The flight of the beetle swarms is apparently short as a rule and the destruction they work proceeds from centres and in bunches. Thus a valley or section that they attack may be largely destroyed while a region a few miles away is nearly free from their depredation. What the conditions are that enable the insects in any locality to multiply into destructive numbers has not been made out with certainty yet, but there are agencies known that serve to keep this in check. Other insects and disease are both believed to figure in this work, but the woodpeckers appear to be their great enemy. In some regions it would seem that they destroy half or more of the beetles and so serve to mitigate, or even perhaps to head off entirely an epidemic of destruction. The destructive insect appears to be always present in our woods in small numbers.

### LIKELIHOOD OF WHOLESALE DESTRUCTION.

For the detail of observations, and Prof. Hopkins' conclusions and recommendations in regard to this matter, readers are referred to the bulletin named at the beginning of this paper. Another pamphlet of great interest in the connection is Bulletin 56 of the West Virginia Experiment Station, containing the results of Prof. Hopkins' study of insect depredations on the spruce and pine forests of his state for the last twenty years. That work, dealing as it does not only with the cause of the trouble but with secondary problems also and suggesting means of alleviation as well, is a distinct mark of progress in such things in this country. It suggests what a well trained man might be worth in each great lumbering state, who was watching the woods and in touch with its lumber interests.

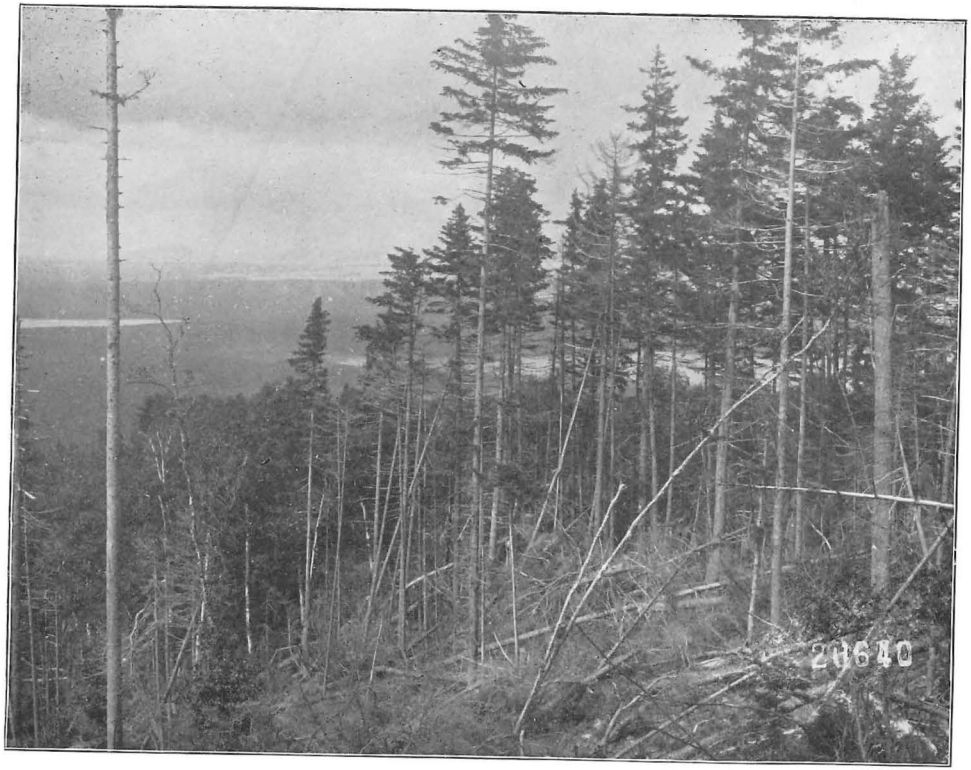
When the loss we are suffering in Maine was first discovered, when the cause of it was identified and found to be one capable of further extensive destruction, when alongside the freshness of the work of the beetles it was found by a season's cruising that they were distributed throughout the Androscoggin drainage and at work further east than Moosehead lake in central Maine, the suggestion at once arose that we might have in this insect a serious threat to the welfare of our spruce forests,

forests of vast importance to the business interests of the New England states. The idea was very stimulative of effort. The matter was watched as closely as it could be watched by one not an entomologist and many other duties to perform. Other men were put on their guard and the regulation of cutting, so as to offset the damage done, or likely to be done, suggested to those with whom the writer had influence. Finally the best equipped entomologist in the country was brought on the ground to study the matter and to suggest lines of continued observation.

The damage that has been wrought in western Maine and northern New Hampshire in the last ten years is very considerable, amounting in the opinion of the writer to a stumpage value of a good many hundred thousand dollars. On the Androscoggin the regions of greatest destruction are in the Magalloway, Cupsuptic and Kennebago valleys, while the region about the Rangeley lakes has been comparatively free. As to the likelihood of an overwhelming swarm of beetles with consequent destruction of large proportions, such as befell our hackmatack some years ago, neither Prof. Hopkins nor the writer are inclined to feel alarmed. The reasons for this are, first, the slowness on the average with which the work of destruction has progressed; and second, the check which the insects in some localities appear already to have received. There are indeed some localities within the area of their distribution where as much as a quarter or half the timber has been killed by the beetles, and where they are now multiplying very rapidly. In other localities the insect has apparently been holding its own, doing some, but not great, damage each year. Other regions again there are where with ample field for it and but a small amount as yet killed, the work of destruction appears to have nearly or quite ceased. It appears therefore that in these sections the natural enemies of the beetle are too much for it, thinning down its numbers so that it can do no harm.

### DEAD TIMBER SHOULD BE CUT.

Neither, if men will see to it, need there be any comparatively great loss. Extensive lumbering is being carried on through the region in which the insect is known to exist. The bodies of uncut timber are nearly all accessible. Cutting can be turned




A GROUP OF SPRUCE ON SPRUCE SLOPE.

In this case a large enough group was left uncut to insure protection from wind.

in the direction of the damaged or endangered localities, and cutting serves not merely to save the dead timber to use, but also to carry out of the woods so much of the source of infestation. The bunchy way in which the dead timber stands is strongly in our favor. Evidently the normal flight of the beetles is short, for the dead trees, as a rule, stand in groups; those killed one, two or three years ago together with the insect colony working, perhaps, in green timber close beside them. This trouble, indeed, may also be regarded, in one way, as a benefit to our forests. So far as it may determine a policy of thinning rather than stripping the land, it will exert a favorable action on the reproduction of spruce which will never be entirely lost.

It will be well in conclusion to summarize for the benefit of lumbermen who may have to deal with it the marks by which the work of this insect can be recognized and the measures which can be put in operation to combat it.

SIGNS OF INSECT WORK.

*(a)* Paleness in the leaves of a spruce may be due to an attack of this insect, and newly killed trees for a time present a red appearance, that contrasts strongly when seen from a distance with the surrounding foliage.

*(b)* Fine borings of wood and bark on and about a living spruce tree are an almost certain indication of the presence of this insect, and examination will show round holes bored into the bark, and the burrows connected with them. Oftentimes the borings form a pitchy bunch or tube about the opening of the burrow which is very conspicuous.

*(c)* When woodpeckers are seen at work on a green spruce tree, it is certain that it is infested with some insect and generally it will prove to be this destructive species.

*(d)* There is a small round fungus of the size of a large pea or a small cherry that grows profusely on trees killed by this insect, coming out of the holes made in the bark. This, however, does not appear until the season after the death of the tree.

*(e)* The form of the galleries made by the beetles to lay their eggs in are very characteristic. They are usually about six inches long and a quarter of an inch wide with a crook at the upper end, and frequently forked there. This gallery is

readily distinguished from the work of any other insect and as its form is marked on the surface of the wood the work of this insect may be distinguished many years after it occurred.

PRACTICAL REMEDIES.

*(a)* The best way to stop the depredation of this beetle is to cut the dead and infested timber. This should be done carefully, both to save all the dead stuff which may be used, and to make sure that all the infested trees, which may be the source of further destruction, are gotten out of the woods and into the water. Careful cutting of this kind would pretty thoroughly clean out a forest. Probably no beetles would be left in the tops, and very few in the stumps if cut reasonably low, and there is little or no doubt as to such as went with the lumber that the driving would kill them. It stands timber owners in hand then to watch their lands and as far as other circumstances will allow to turn their logging crews into such valleys and sections as most need logging. If a country is losing ground rapidly it will perhaps pay to build a road to it and improve a stream sooner than may have been designed, rather than to lose so much in stumpage. One or two valleys are known to the writer where he is confident it would pay to put a camp and cull out the dead and infested bunches at once, with such other timber as would best go with it to make up a logging operation; but of that he has never been able to convince any other person.

*(b)* Where insect work has not got so much of a start and where the situation is such that cutting is not practicable, infested trees might be cut down in the fall any time after the first of September and the bark stripped off and left to lie on the ground. The winter weather would surely kill the beetles. This doubtless looks to lumbermen like an expensive operation and it has only been tried by us experimentally, but anyone who has personally watched the spread of these insects through a country and knows the wholesale destruction which they have sometimes wrought will be satisfied that in some circumstances the expenditure of a thousand dollars in preventive work of this kind might be the best kind of an investment.

*(c)* Lastly, experiments are now in operation under the direction of Prof. Hopkins to test the effectiveness of girding trap trees to attract the insects together for ready destruction.

WASTE IN LUMBERING. HIGH STUMPS.

Two high stumps cut with axe, each of which could have been cut 12 inches lower. In the background a spruce log left in the woods.

In Europe this method has proved very effective with destructive insects. Whether it will prove effective here depends on the habits of our particular beetle and has not yet been settled.

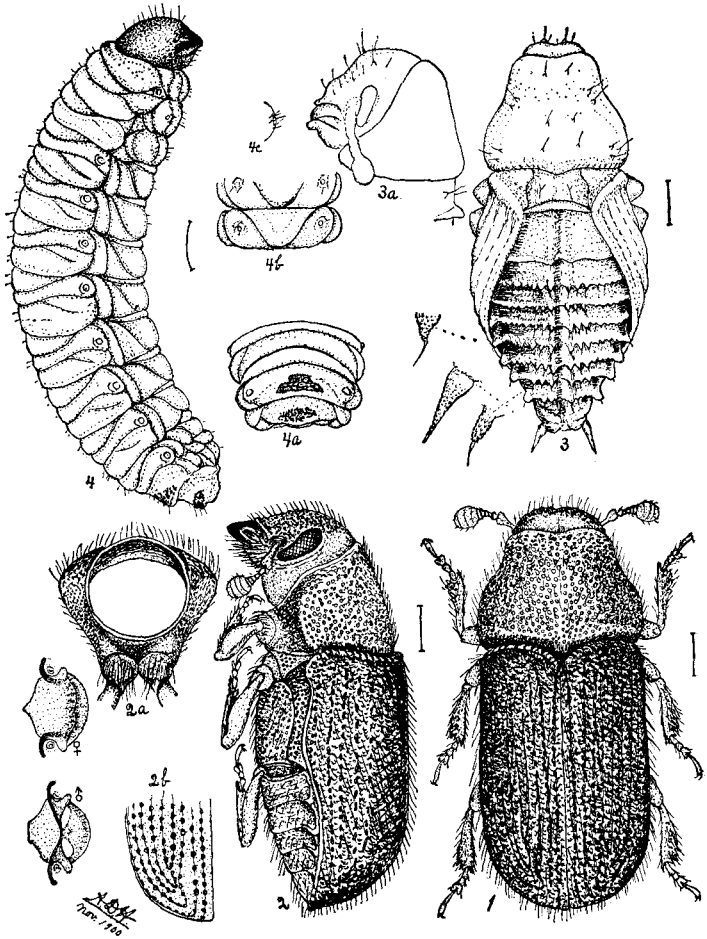
NOTE—December, 1902. We have recently let a contract to cut several hundred thousand feet of dead and infested timber near Parmachenee lake, perhaps the first work of just that kind to be done in the United States. Details of the matter may be read in "Forestry and Irrigation" for December.

## PLATE I.

*Dendroctonus piceaperda* Hopk. n. sp.

1. Adult, dorsal view.
2. Adult, lateral view: *a*, Prothorax, anterior view; *b*, tip of elytron, showing arrangements of striæ, and interspaces; ♀, last abdominal segment of female, dorsal view; ♂, last abdominal segment of male.
3. Pupa: *a*, Profile of head and prothorax.
4. Larva: *a*, Dorsal plates on last abdominal segment; *b*, foot scars (?) on ventral surface of thoracic segments; *c*, profile of ventral thoracic lobe showing foot scar (?).

PLATE I




*Dendroctonus piceaperda*—Hopkins.

From Hopkins in Bulletin No. 28—New Series—U. S. Dept. Agriculture.

## PLATE II.

Galleries of *Dendroctonus piceaperda* in Spruce—size reduced about one-fourth.

The large vertical galleries in the center of the figure are those of the parent beetles. Size and shape are characteristic, especially the curve and the frequent bifurcation at the upper end. These marks remain frequently many years after the tree is dead and by them destruction by these insects can be recognized. The small larval galleries branch out from the parent galleries, turn up and down, and in this case have completely severed the bark from the tree.

Adult and larval galleries of *Dendroctonuh piceaperda* in Spruce.
From Hopkins in Bulletin No. 28—New Series—U. S. Dept. Agriculture.

## PLATE III.

Galleries of the spruce Tetropium—natural size.

These galleries are made by a bark-living grub in dead or failing, not thrifty, trees. The irregular course of the galleries distinguishes them from those of the spruce-destroying beetle.

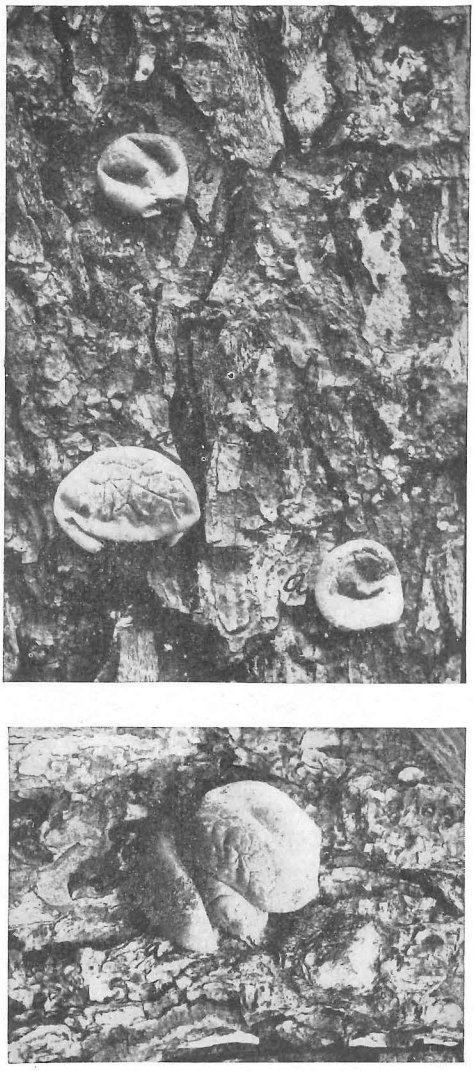
Galleries of *Tetropium cinnamopterum* on Spruce.

From Hopkins in Bulletin No. 28—New Series—U. S. Dept. Agriculture.

## PLATE IV.

A fungus *Polyporus volvatus* growing out of spruce bark.

The external portion or fruit of this fungus grows out through the holes in the bark made by the destructive beetle and others. Its mycelium or vegetative portion at the same time penetrates the wood and promotes decay. This fungus appears on trees the year after their death.



A fungus, *Polyporus volvatus*, on spruce bark.

From Hopkins in Bulletin No. 28—New Series—U. S. Dept. Agriculture.

## TOPOGRAPHICAL AND TIMBER MAPS.

The following is reprinted from the Journal of the Association of Engineering Societies for August, 1899:

I wish to present one more topic, a topic of an engineering nature. Men of your training do not have to be told that topography determines very largely the course of all woods work. Neither do you require to have explained the usefulness of a topographical map. Every lumberman is a topographer in a sense. Clear knowledge of topography is essential to the man who, from a central point, directs the conduct of a large business. So far in the lumber business each man has learned his own topography by cruising, and has carried it in his head. The limitations of this system are evident. Such knowledge is inaccurate in the first place. Then it is likely to be forgotten, and it cannot be conveyed to another man. The loss is particularly evident when one manager drops out of a business and his successor has to acquire his knowledge of locality all over again.

In the autumn of 1896 I had the good fortune to be sent by the Hollingsworth & Whitney Co., of Waterville, Maine, to make what I suppose is the first genuine topographical survey ever made of a New England timber township. The results, in the shape of a contour map and a model, proved so much of a satisfaction to the company and its superintendent that other concerns were led to desire the same thing. Thus I have been employed to survey in all about 125,000 acres. I think, furthermore, that in the economy of the spruce forests of New England topographical mapping has come to stay. A brief description of the methods employed in this work, developed as they have been in the work itself, with the aid of such hints and helps as could be got from outside, may be of interest to members of the Society.

The basis of the height work is leveling. If possible, connection is made with points known from railroad levels or otherwise, giving thus elevation above sea; then a line of levels is run over roads, or whatever else may be the best route to run on, to the ponds and other suitable marks well distributed through the township to be surveyed. From the points so determined by level I work off with aneroids, returning for correction as often

as may be to some accurately known point. Two aneroids are usually carried; a thermometer is read with them as often as necessary, and changes of pressure due to the weather are recorded meanwhile by a barograph run by an eight-day clock located at the main camp.

The low accuracy of aneroid measurement is well known, but when carefully used with the aid of the accessories noted above, the aneroid suffices entirely for the purpose. A timber land manager does not require to know, for instance, exactly how high a given mountain is. The approximate relation of things is what he wants. The areas of valleys, the positions of streams and divides, the shape and steepness of the land, the grade of future roads,—these are essential points. Then the passes and their neighborhood often require especial looking over, because it is sometimes very desirable to haul timber from one drainage to another, if that can be done without too much uphill work. In getting at all these points a hand level has frequent use, in addition to the aneroid, or, better still, an Abney clinometer.

In these surveys the land has ordinarily been blocked up ahead of me into mile squares. It is a great advantage if, when the lines were run, marks were left every quarter-mile. Then one can locate himself quite accurately on a line by pacing and without going very far. These marks serve also as the starting point in examining the interior of a lot. For instance, after having traversed the lines of a lot, noted the crossing of brooks and divides, taken the height of essential points and noted or sketched whatever topography could be seen, I might start from the middle of one side to run a line across the lot. In doing this I often use a staff compass with 3-inch needle and folding sights, but perhaps more frequently a common pocket compass with needle less than two inches long held in the hand. Indeed, direction can sometimes be held more closely with the latter instrument. For instance, a man climbing over the *debris* left by cutting or shoving his way, head down, through dense thickets of young fir loses direction in the course of a few rods. Now if he has a compass in hand he will stop and look at it. He will do so less often if he has to set a staff, level his instrument and wait for the needle to come to a stand.

Meanwhile distance is kept by counting steps. Six or seven years ago, when I first tried to keep run of distance in this way,

Topographical model of Township No. 3, R. 5, Franklin County, Maine, showing in addition to the waters, relief bogs, roads, trails, section lines, etc.

in retracing old woods lines, I found I required about 2,400 steps to the mile. Later on, either because with practice I became longer gaited or because, without knowing it or meaning to, I discounted more, the number required became less. I found at one time that I was using 2,200, and finally I got down to 2,000 to the mile. There I expect and desire to stay, because at that rate notes plot so readily. In field sketches and in final maps I have so far used a scale of four inches to the mile. On that scale, at 2,000 steps to the mile, 100 steps are two-tenths of an inch, and a half-inch square, or a piece of ground 250 steps on a side constitutes ten acres.*

By one who has practiced it, measurement by pacing can be made, even in rough land and bad walking, much more accurately than would be supposed. One travels along, looking at the country, keeping his count in some back corner of his mind. Every hundred passed is marked down or scored by breaking an elbow in a tough twig carried in the teeth or hand. When a brook is passed or a change in the land occurs note is taken, the barometer read and the count begins again. Steps taken to get round obstacles are not counted, and on strong slopes discount is made. On very steep ground, indeed, steps taken are not a guide to distance, and judgment has to be resorted to in order to fill in the count. As first remarked, however, long practice enables a man to reach greater accuracy than would be supposed. Thus I am seldom out over 100 steps from the 2,000 in crossing a lot. The count tells me when a line is approached, and enables me to pick it up with certainty, though it may be blind. Then I go right or left till I hit a quarter-post, and so ascertain the variation from the true compass course. By this means locations are made with considerable accuracy along the whole line.

What has been said makes it evident that a pedometer in just this kind of work can have but little use. It answers very well in smooth going, but its readings are no guide to distance on rough land. In my work it has been used merely as a matter of interest to estimate the number of miles travelled in a day or on a whole job. It is, in fact, a good deal of satisfaction after cruising a rough township, perhaps half-covered with brush

* Much help has been received on this and other points from the methods of the U. S. Geol. Survey in Michigan and Wisconsin, as communicated by Prof. W. S. Bayley, of Waterville, Maine.

heaps and blow-downs, to figure up and tell the company just how far I have been.

On simple ground running once across a lot serves, with a traverse of its boundaries, to give topography sufficient for the purpose. Elsewhere there are roads and streams to locate and divides that should be carefully put in. Here compass and pacing are still used, tying in to the lines as often as may be. Travel in parallel straight lines, however, has advantages if it is sufficient for the immediate purpose in hand. It is more accurate, in the first place. Secondly, if, as will no doubt be usual, the timber land topographer also understands timber, and is expected to report on its character and amount, systematic travel of this kind insures his seeing a fair sample of all the land. Timber estimates in the past have been notoriously inaccurate and misleading in their results, and one great cause of this has been that the men who made them did not see all the land. Of the accessible parts, perhaps of the good parts, they saw too much. They did not fairly balance the whole or correctly allow for the waste land. One man of my acquaintance, realizing that fact, says that in looking over land for purchase he makes it a practice to go first where no timber is to be found. Better than that is some systematic arrangement that causes one to see a sample of every part, and travel in straight lines evenly spaced will do it.

So far our maps have been constructed on the scale of four inches to the mile, and 50-foot contours in the rough land with which we have to deal serve to represent the topography. In addition, as a result of the examination, timber maps are constructed showing the character of the growth and the amount of merchantable timber judged to be standing on the land. On these sheets the progress of the cutting can be drawn in succeeding years. These timber maps are of transparent tracing cloth, so that they can be laid over the topography and the two seen in relation. Lastly, since contour maps are not easily read by most woodsmen, topographical models are constructed out of cardboard or veneer. These are perfectly comprehended by any person. With their aid a contract can be let or plans of work talked over in the office with the same clearness as to main features as if men were on the land.

The survey and mapping of a township six miles square has ordinarily cost me about two months' work, two weeks in the office and six in the field. A township can be gone over conveniently from about four camps. If there are places on the land to live in, the topographer can, if he sees fit, do much of the work alone, and will require the help at most of but one other man.

NOTE—1902. This system of mapping seems to be more appreciated by those who have had it carried out on their lands, and it is still believed by the writer to be better adapted to the timberland business of this section, as regards methods of work, presentation of results, and limits of expense which owners are willing to incur than any other system yet put in operation. It is believed, however, that there are some townships with extensive systems of new logging roads whose topography could be got more cheaply by means chiefly of stadia work. It seems certain to the writer that many timber land owners are now in a position to appreciate the value of good maps if it were presented to them, and that men well equipped to do work of this nature could build up a considerable business.


ABSOLUTELY CLEAN CUTTING.

On this slope everything was cut that the merchantable logs might be rolled down to the road.

# INDEX.

Logging a steep mountain side at an elevation of 3,000 feet in the Kennebago Valley. Expense of logging and liability to wind compels a concern to cut cleanly on such sites, yet in ordinary logging considerable small stuff is left and spruce reseeding generally follows freely.