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SECOND ANNUAL REPORT

OF THE

FOREST COMMISSIONER

OF THE

STATE OF MAINE

1894

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STATE OF MAINE.

To the Honorable Henry B. Cleaves, *Governor of Maine*:

The Forest Commissioner respectfully submits his second report, as required by the act of 1891, chapter 100, creating a Forest Commission.

CHARLES E. OAK,

Forest Commissioner.

REPORT.

That it is a matter of great importance to the people of the United States to have a much fuller and more intelligent knowledge of the subject of forestry, is a sentiment that seems to be very rapidly gaining ground, not only among the educators of the country but among the practical business people of this busy land.

In almost every one of the civilized countries of the old world forestry has become an established science. It is taught in their leading institutions of learning and is regarded as an essential feature of a common education. But in this country until within a very few years the forests were regarded as the enemy of civilization, and our chief study has been, how best to destroy instead of how best to preserve.

A partial awakening has occurred however, and the national government has begun a general investigation of the subject and also several of the states have established forestry departments to investigate their individual needs, but as the soil, climate, and general features of the several states are so varied, the work of other states seems to be of little assistance to us.

In several states it may be only an esthetic taste that leads many people to interest themselves in the subject—a taste that I fear is too much lacking among the majority of our Maine people, as far as forest lands are concerned, simply because beautiful wooded hills are too common to be fully appreciated; yet our practical business people should not lose sight of the importance of preserving and maintaining the attractiveness of our forest regions, for the reason that we are being greatly benefited and enriched by them, every year.

In assuming the duties of this office, however, I did not understand that it was expected I should study Maine forests with an esthetic view, but more especially with reference to deriving some practical knowledge that should be of material benefit, yet having no source from which to derive information relating to the subject of forestry as applicable to Maine, I have not been able to accomplish as much as I hoped to do in the way of actual results, to embody in a detailed report.

Before giving such details as we have been able to obtain, however, I wish to give a brief outline of the system of lumbering that has been followed in this State through the years past in order to show, in part, the basis of our reasoning.

The "Pine Tree State" as Maine is commonly called, is almost a mis-nomer at the present time, for although Maine is known as the state of magnificent forests, it is to be regretted that the pine tree has become, comparatively, a thing of the past.

Within the memory of very many of our older inhabitants, in speaking of the timber lands, only the value of the pine was taken into consideration in fixing prices, even spruce, which has since become so very valuable, being considered of so little value as to enter as a very small factor in their calculation.

No one seemed to dream that the spruce growth would ever yield such enormous revenues as they have since done—far exceeding those from pine—and stranger still, that cedar lands were formerly regarded as absolutely worthless and marked as *waste* lands on their charts and plans but have since proved to have been the most valuable, per acre, of any of the timber lands, having yielded in many instances thirty dollars and forty dollars per acre.

An old lumberman has told me that in Washington county, he could once obtain permits to cut spruce directly on the banks of good driving waters at a mere nominal price, but that it was considered almost degrading to cut anything but pine in those olden days, and as soon as the supply was exhausted in that county, he went to Aroostook in search of more. Numerous pieces of land he bought there solely for the pine growing upon them and later sold to settlers for a small pittance, having since yielded from three dollars to thirty dollars per acre in spruce and cedar. After the pine began to be somewhat scarce throughout the State the lumbermen began to cut the largest and best spruce, and these cuttings of spruce have gradually increased and pine decreased ever since.

With the increased cutting of spruce, however, the character and quality of the lumber has gradually grown poorer until the present time, so much so, that those familiar with old cuttings, express great surprise at the appearance of the brows and booms of logs along the Penobscot, Kennebec and Androscoggin, of to-day.

Possibly their recollections may be partly at fault when they tell us of the size and quality of the spruce cut of fifty years ago, yet there must be much truth in their statements.

In northern Maine, on the waters leading into the St. John river, until within ten years, the mill owners would not buy any lumber less than eleven inches in diameter at the top end, excepting at a two-thirds price when delivered at mills in St. John, and even now they try to limit the cut to from ten to twenty per cent of what they call "battens" or logs less than eleven inches at the top end, for which they pay full price. How different it is on the other waters of the State, where the day has long since gone by when they have limited the size to eleven inches or more, and where, in granting permits, the proprietors stipulate that they must cut to eight inches perhaps, and what is worse for the general welfare of the State, that on many townships thus stripped of lumber to manufacture at the lumber mills—the pulp manufacturers are permitted to go on and cut down to as small size as they fit—usually to about four inches.

These facts are not at all new to many of our citizens but perhaps the results of such cutting if much longer continued have not been considered as they should have been by the people at large and it is for this purpose of bringing the facts to the attention of the public that I attempt to show in a simple manner the bearing they may have upon the general prosperity and business interests of the State.

The first thing to consider perhaps, is the exceedingly wasteful manner in which our lumber was cut in the past—is being cut even to-day but perhaps in a lesser degree, and the effect it may have on the business interests.

The old style of cutting pine was to make what was called ton timber, or timber that after felling was hewed square with a broad axe in the woods, and then floated to where it could be manufactured in the mills or shipped to England to be whip-sawed into the desired shape.

Ton timber to be salable was required at that time to be at least sixteen inches square, and nothing but the very choicest and best lumber would pass inspection.

A small rot, or shake, would condemn a stick even after it had reached market, and the utmost care was taken by the operators to have every stick perfect. Any one can imagine what resulted from such cutting. Tree after tree was felled only to be condemned while of those from which timber was taken the larger portion was left on the ground to decay, or furnish fuel for forest fires. Millions upon millions have thus been wasted, and much of it, for only very slight imperfections.

Nor was this all. The spirit of wastefulness seemed to pervade the whole atmosphere and in order to get the pine, enormous quantities of other lumber was sacrificed in clearing the way and supplying skids or materials for bedding the trees as they fell.

Having once started the spirit of wastefulness among the operators it is hard to make decided changes in the methods employed, even up to the present day, and probably never will be stopped until the people have the fact brought home to them that our forests are virtually exhausted. Reasoning from what has taken place during the last fifty years, the time when this condition shall exist is not very far distant, unless better judgment and greater intelligence is used.

In cutting spruce on the St. John river and its tributaries, where they try to limit the size to eleven inches, the usual custom is, not to measure the trees to see where they arrive at the size required but to "top" it at the place where it will scale best. Logs to saw to advantage must be straight and if a crook or sweep in the tree occurs, that is the place selected to end the log, and as a usual thing, the balance of the tree, although it may be excellent lumber, is left on the ground, for the reason that the next log is likely to be only nine or ten inches at the top and it would not pay the operator to pay full stumpage on such lumber and get only two-thirds price when it reaches the mills.

I am told that the same thing occurs, but perhaps to a less extent, on the other waters of the State, but of that I am not so conversant as with the cutting in the region first mentioned where I have frequently visited the lumber regions and have seen very large quantities of lumber left where it fell, only to be wasted. As before remarked, it is within the memory of very many of our people when the best of lumber was standing in large quantities even down to tide waters. When the people stop to think of that and the few years it has taken to create the condition as it exists to-day, perhaps they will have less faith in the idea that our forests are inexhaustible and that the growth each year makes up for the amount wasted or taken away. Year by year the woodsman goes farther and farther back in the woods—onto smaller streams and into less accessible regions, in establishing his camps for the winter's operation. The reason for this is owing to various causes, one of which being that the land owners wish to take off a crop of fully matured lumber from townships far remote, in order to prevent its going to decay, and also to allow the young growth a chance to spring up, but that reason cannot be given much longer, because I think there is not a single township in the State that has not been cut over either as a whole or in part. What other possible reasons can be given then, than that operators go to these far off townships, and pay the same stumpage that they recently paid on townships much nearer market, simply because they find plenty of lumber there, but could not find it nearer home. Again, our wild land owners *insist* that their more accessible land is being over valued and over taxed by the State authorities, and I have no doubt that in many instances this is true. They state that upon these townships once stood large crops of lumber but that having taken the crop off, the township compares with milk after skimming, of some value but the cream is gone. Many entertain the idea that even after removing all the heavy crop of valuable timber, it is only a very few years before another will grow, and thus the supply never be exhausted at our present rate of cutting, and although I at first entertained the same views, it has largely been with reference to either proving or disproving this work, that work has been done in this department during the last two seasons.

From the last State Assessor's Report I learn that the total acreage of wild lands of the State is 9,666,727 acres.

From this, for the sake of rough calculation, I deduct for the average of lakes, cleared lands, bogs, burned and waste lands enough to give the actual lumber producing acreage, of the wild land region which we call 9,000,000 acres, to which the State assessors have given a value of $18,210,894 or about two dollars per acre, which we will assume is about correct.

For a number of years past it is conceded that the total cut of the State from these wild lands has equaled at least 500,000,000 feet, upon which, the average stumpage has been about $2.50 per thousand, making the yearly income from stumpage about $1,250,000 or approximately 7 per cent of the total value of the wild lands each year.

If, then, there was no annual growth the total value of the wild lands would be exhausted in about fourteen years, and if we assume that the value of the soil after removing the lumber to be fifty cents per acre—without growth, the total value of the lumber would be gone in about eleven years.

Knowing then the rate of cutting each year, which is approximately 7 per cent of the present valuation, the necessity of knowing the percentage of growth is readily appreciated.

If we are correct in estimating the percentage of cutting, and should discover that the annual growth is only 2 per cent, we should find ourselves face to face with the alarming condition that in twenty years the lumber industry of the State would be entirely gone.

I do not wish to be understood as making the statement that the total annual growth is only 2 per cent in my judgment, yet I think it can be demonstrated to the satisfaction of any person who will take the trouble to study the matter, even in a superficial manner, that of the spruce lumber that has already reached a merchantable size, which we will assume to be twelve inches in diameter three feet from the ground, that the annual growth on such lumber cannot possibly exceed 2 per cent on the average.

As it is only the merchantable lumber that fixes the present value of lumber lands, it seems to me of the greatest importance that a close study should be made of the younger growth in order to understand more perfectly exactly what we have to depend on in the future, in the way of furnishing a constant supply of lumber.

With this idea in mind, since taking charge of this office, I have endeavored, with the limited means at my command, to obtain as much information upon the subject as possible, to embody in a detailed report.

The result of the work will be found in the report of Mr. Austin Cary whose partial services I was enabled to secure—he having been previously engaged by the National Division of Forestry to do some special work in this State.

He is a careful painstaking worker, and the large amount of special information he has furnished us I have no doubt will prove of great value.

His recommendation for future work I hope will be heeded, and if followed for a few years we shall be able to intelligently grasp the situation.

Careful attention for several years has been given to the study of how best to prevent forest fires, as every one fully realizes how disastrous to Maine as well as to individual owners, an extensive conflagration of this kind would be.

The summer travel to our State for purposes of fishing, hunting and recreation, is rapidly increasing, and as it is only by free access to the private property of the individual land owners, that the State is so greatly benefited by this travel, it seems entirely just and proper that every safeguard should be adopted to protect their individual interests as well as our own as a community.

There is great danger from the carelessness or thoughtlessness, I should say, of the tourist in forest regions, on account of forest fires, and I hope that more restrictions may be placed upon them—not such as would be burdensome and prevent their coming, for we welcome them all—but such as will cause them to more carefully observe the rights of others and use greater caution to prevent such fires.

They should be impressed with the gravity of the situation as far as possible because when they once realize the possible danger, there is every reason to believe they will be very willing to co-operate in preventing such a catastrophy.

Notices such as the forestry law requires have been carefully posted throughout the State in localities where fires were likely to occur and as far as I was able with the limited means at command every precaution taken to have the people properly warned.

Whether it has been owing to these notices in part that we have so fortunately escaped extensive conflagration since the enactment of the law I do not presume to say, but even with the large increase of tourists and hunters I am pleased to be able to report no heavy fires and the number of smaller ones, less than in former years and confined to smaller areas.

The danger exists, however, especially in the vicinity of railroad lines passing through forest lands, and in my judgment it will only be by seeing that the law is carefully observed that we shall be able to escape for any length of time a disastrous fire.

The railroad companies as a rule, show but little disposition to observe the spirit of the law—yet for their individual interests some care is shown in order to avoid their own liability.

Aside from the Maine Central, no railroad company of the State, over which I have traveled, have their right of way properly cleared of inflammable materials, but we have assurance that considerable work of this kind will be done another season.

From a partial investigation of the effect of a heavy forest fire it is learned that, in some localities, it will take at least three hundred years to even prepare a new soil suitable to grow another forest upon, and even where the soil is not destroyed the length of time required to produce a forest like the original is much greater than is commonly supposed.

The previous report from this department reviewed the disastrous effects of such fires to some extent and cited some pertinent facts but if volumes were written upon the subject, they could hardly picture all the evils following in the wake of an extensive forest fire in our State.

In closing I will quote from the report of Mr. Packard, "that the protection of our forests from fires is the first, great and important duty of the State towards our wild lands."

At the same time the suggestion to be found in Mr. Cary's article in this report should be carefully followed.

At present it is all a matter of guess work among the lumber land owners, the parties directly interested, as to the best methods of maintaining our forest resources and at the same time derive reasonable revenues from them, and it will only be by careful investigation and study of the subject that we shall be able to prevent a possibie disastrous condition in our State.

Hon. CHARLES E. OAK, *State Land Agent and Forest Commissioner:*

SIR: In transmitting to you the results of field and office study carried out in some special directions, I wish briefly to refer to some general considerations regarding the forests of the State, and to suggest lines of further work.

The importance of her forests to the State of Maine I need not dwell upon. Forest products have been our largest export. Trees cover the greater portion of the surface of the State, and their cutting, manufacture and sale occupy a large proportion of our people. Moreover, great natural characteristics of the State render it probable that this will continue to be so. The geology of the State providing only in limited regions a soil agriculturally productive, combined with our moist climate which causes rapid growth and ensures that all neglected land shall be quickly covered with trees,—these facts seem to render it certain that the most profitable use for a large portion of our territory will permanently be the growing of timber.

In any such community as ours, large areas of woodland must remain, even in the best settled districts. Such areas in the aggregate have great productive power, and their situation renders them of the greatest value and use. Leaving them out of account, however, we might roughly designate areas which seem destined to be unmixed and perpetual forest. Of the great natural divisions of the State, the fertile Aroostook region is probably best defined. Embracing the northern angle of the State, and the district east of the East Branch Penobscot, the rocks underlying the country provide such a fertile soil as renders it certain that unless in the future there shall be nothing in agriculture, this is destined to be a farming country. The coast region of the State as well, carrying the impetus of earliest settlement, possessed of established transportation and a number also of natural advantages, we can safely count on as devoted mainly to commercial and manufacturing interests.

Of great bodies of territory, however, it seems that an entirely different future is to be predicted. Washington county, for instance, north of the coast line, and the great plateau country centering on Moosehead lake and containing the head waters of all four of the great rivers of the State, possess little to attract any but the tourist and lumberman. Rough land, with seldom either a deep or fertile soil, far, too, from present centers of population, these tracts seem to be destined permanently to the production of timber. As Scandinavia is to Europe, the source of its oldest and finest timber, so, it appears, will the rough lands of Maine and New Hampshire, and the mountain ridges of the Appalachian system to the south, be to the eastern United States.

Taking for granted these predictions, and the continued importance of the lumber business in Maine, what is the State's interest in the matter? It lies, broadly speaking, in the directions of economy and the steadiness and permanence of business. It demands that our resources shall be used to best advantage. It demands that our standing timber be not wasted or exhausted, that growth be utilized to best advantage, that the future producing power of our forests be not destroyed. That this is the interest and right of the community should be distinctly recognized, but on the other hand it is seldom antagonistic to the interest of any class. The State's interest does not require that timber should be cut at a loss, nor does it demand that growth should be left for the future that is worth more to-day. The interests of the State and of individuals are generally identical, and whatever in the way of forest study the State might attempt would result first in benefit to her farmers and the owners of her timber-lands and mills.

The lines of workwhich I would suggest as proper and profitable for the forest commission of this State are guided by these principles. The first essential to economical and intelligent use of our resources is thorough knowledge of them. By this I mean not the hap-hazard guess of some one acquainted with a minute fraction as to how much timber there is in the country and how long it is going to last. I mean a thorough survey of mature and growing timber with reference not only to immediate demands, but to the development of the future. Income and outgo through growth, cut and waste should be studied with similar thoroughness, and the relation of all these facts ascertained to the resources and business conditions of the rest of the country. In a word, full and accurate statistics as to our forests and lumber business, based sufficiently on direct observation, is the first thing wanted in this direction.

The utility of such knowledge as might thus be gained, will not, I take it, be disputed. If we are overcutting our resources, we shall then know it, and moreover in showing that a more saving policy will pay, a remedy will be supplied. In other words the future of business can be predicted, and our resources handled with a view to their productiveness in the long run. Much particular information of value would also be gained. The amount and value of yearly growth, the question of when and how close to cut, and numerous related ones are matters of concern to lumbermen on which opinions and practice widely vary. Such studies as I have indicated would settle these questions. They would supply to the lumberman those facts in the case which he could not otherwise obtain, enabling him satisfactorily to solve his own particular problems.

Then too, provided with such information as I have spoken of, a state commission could assist greatly in the establishment of new enterprises. Take for instance the hard woods of the state, a great resource yet practically untouched. A central office acquainted with our supplies of hard wood, acquainted too with the business conditions of the whole country, should be able to help greatly in getting new kinds of business established. Knowledge of this kind, to be worth while, must not be second hand. It must be obtained direct from the forests. Here, hand in hand with statistical work should go inquiry into the nature and habits of our timber trees. The conditions under which they grow and their rate of growth, their habits of reproduction, the diseases and enemies which attack them, these are all matters fundamental to thorough knowledge of our forests and to their most economical use. These should be objects in any study of our forests, objects which should be held steadily in mind, and which constant observation should promote. Such fuudamental knowledge, while it has frequently no direct commercial value, is essential to other investigation; it clears the whole range of the subject, and in the end will be found to justify its cost.

I have spoken so far only of extensive projects which it would take years to complete and which only an established and fairly equipped commission could carry out. There is, however, one line of work which seems to be needed at once, and which is likely to result early in great gain to the state. That is an all-round study of pine. The great forests of the state now yield but little lumber of this kind, and moreover, little is growing. The western sources of supply too are by all accounts nearly exhausted so that for some qualities of the lumber we have already gone to Europe. All indications point to the coming scarcity of this wood in the United States, and while to some extent other woods may replace it, there is every promise that prices for the best grades will be greatly advanced.

Now no argument is needed to show that Maine climate and soils are adapted to the production of the finest pine. Once the staple of our market, pine grows now faster than any other of our timbers. We have indeed considerable supplies of it, for while owing to the nature of the tree it does not reproduce freely in the forest, owing to the same facts in its constitution it does spring up freely on burnt and abandoned lands. All through the settled parts of the State, but more particularly in the southwestern portion, are groves of pine, not of large size as a rule, but in the aggregate of great extent and capable if well managed of producing great values. These groves too as a rule are in the hands of small owners who could give to them with little or no cost the little care that would be of advantage.

In view of all these facts a study of pine seems particularly opportune. Such a study should ascertain first the production of the tree on different soils and under different conditions—work by the way already largely performed by the Forestry Division of the national government. It should deal with the effects of pruning and thinning, studying the treatment of trees for a lumber crop of greatest quantity and best quality. It should be on the watch to find out when, where and by what methods planting will pay.

Such a study would enable a man to go onto a piece of pine-covered land and estimate its growth as closely as its stand. It could be told to what age the trees should be allowed to grow, and what policy in all respects should be pursued towards them to get the most profit from the land.

The financial interest concerned here is no trifling one. Lands that are now frequently waste would as a result of this work be put to good use, and a valuable crop be reaped where now are gained but trifling returns. Such a study would be of special value to the farmers of the state, to whom the points of it would be largely conveyed in the process of their gathering. To them a possible yearly income of several dollars per acre is involved, to be derived too from lands not fit for cultivation.

Maine is fortunately situated as regards her forests. In the dry western country the problems in the connection would be quite different. Ground once cut over would not cover itself again; and this would result not merely in money loss, but in disastrous effects on the climate and water supply. Restraint of cutting, the guarding of existing forest areas and acquisition of new ones, would be the essential problems. Not so in Maine. Ground cut over or abandoned is generally soon covered again with trees, and the effects of clearing upon climate and drainage while no doubt real are not with us crying evils. The main business of a state forest commission is to co-operate with the farmers and lumbermen. Its aim should be to secure economies in cutting and manufacture, and when possible to increase production. Its office should be a bank of information on all matters relating to forests and the lumber business. By drawing upon it new enterprises would be assisted. From its knowledge of our supplies and consequent forecast of the future, business could be conducted, and our resources utilized, with a view to their productiveness in the long run.

AUSTIN CARY.

BANGOR, October 30, 1894.

ON THE GROWTH OF SPRUCE.

Written by AUSTIN CARY.

For two years past much of the writer's working time has been spent in the woods, employed in some way in the study of trees; and now the question confronts me—what can be brought out of that experience of real benefit to the State?

This article is not the only answer given to that question, but this with regard to a branch of the subject will best illustrate the attitude to the whole. Knowledge of the production of forest land, the rate of growth of trees, is a central part of forestry. It is a subject amenable to scientific inquiry; while far more than rain-fall, water supply and other stock subjects of most forestry agitators it is of concern to this particular time and place. The question of timber supply and the future value of forest products rests upon it. In fixing the true and permanent value of land, rate of growth must be one element in the calculation; while to the lumberman himself who wishes to make the most out of his property, the question whether to cut now or to wait ten or twenty or thirty years largely resolves itself into the question of how much larger trees he will find if he defer his cutting. How much will a tree grow in ten years? What yield will a section or a township maintain, in quantity or in rate per cent? Are the resources of our state being unwisely encroached upon? Questions of this kind are seeking an answer with more and more urgency. In addressing myself to the subject I have not only to add somewhat to the common stock of information but to illustrate and prove the value of methods for future investigation.

It will be well to review briefly current knowledge on this matter. A general impression prevails that our forests are being cut much faster than they grow Many facts and judgments support this view but the uncertainty of its tenure in the public mind is shown by the reports that every now and then gain currency bearing to an entirely opposite effect. Those who have watched the public prints will remember how every few months some lumberman, who is said to be particularly well posted on matters up river, and qualified to judge of the future, comes out with the statement that there need be no fear of exhaustion. Great supplies still remain, while growth is nearly or quite equal to the cut. Even those who are expected to furnish us bottom facts on these matters are often silent or as ray. A year and a half ago Mr. Gannett of the United States Geological Survey, putting together the ascertained acreage of woodlands in this country with the recorded production of German forests, reckoned the annual growth of the country over at more than the annual cut; upon which the chief of the Forestry Bureau of the government immediately protested, stating that the annual growth per acre is set at least ten times too high, while in his judgment the country under present conditions cannot much longer supply its demands.

The census of 1880 inquired with great thoroughness into the forest resources of the country. The splendid volume on forest trees by Prof. Sargent, the stand of spruce timber in the State of Maine is estimated at five billion feet, while the cut for the census year was put at 301 millions. At that rate, the forests of the State would last sixteen and one-half years, fourteen and one-half of which are already gone. These are official figures, and they show the vast margin of uncertainty there is in our knowledge of the whole subject. The stand of timber even cannot be closely guessed at. How much less is known of the intricate subject of growth!

Returning to current terms and popular estimates we find in our own State at least one rule that is well defined and has wide currency. The rule that spruce land may be cut over once in about twen y years and yield a profitable crop each time is one that is the result of long experience. Let us examine it further to see what it actually tells as to the production of timber. In the first place then it tells nothing as to the age of the trees cut. Those which furnish the second crop are not grown up anew since the first cutting. They have simply increased in size sufficiently since that to come above the standard of cut. Then that standard of cut has quite likely been changed. When spruce was first cut with the pine, only the largest and perfect trees were taken. Smaller and smaller trees have since then become valuable and stumpage permits have been regulated accordingly. Another limitation also holds. In cutting over a section of land not all the trees are reached. The operator runs his roads through the thickest and largest timber, and leaves untouched large areas between. On the next cutting these areas form the center of his work. The trees left there are now much the largest on the whole tract, while some of the smaller growth has now come into the usable class. Areas therefore which were earlier untouched furnish the bulk of the second cutting. So much for the current rule. Admitting that as a rule it has its use, it is yet true that in different mouths it means different things, while as to the absolute production of ground it tells very little.

To strike at once into the heart of our subject it may be said that to ascertain the growth of a large region of which full and exact records are not in existence, three steps are necessary. First we should understand the growth of the individual ten. Second, sample areas that represent the different conditions prevailing in the region may be studied. Third, the data of soil, topography and standing growth for the whole tract should be collected, and attaching to each kind of land the production ascertained to be characteristic of it, the production of the whole tract may be arrived at. This sounds perhaps like an impossible scheme. It is' however, all possible of execution—in a proximate way I believe without great outlay—while a material beginning is already made. Such work as has been done in this State has been done under the Forestry Division of the U. S. Department of Agriculture. It furnishes pretty full data on the growth of individual trees, while an idea is furnished of what will be the result of the second branch of inquiry.

The facts have been gathered at first hands. All of last winter and a portion of the previous one were passed by the writer among the lumber camps in different parts of the State. Stations were taken from Houlton near the New Brunswick line through to the Moosehead and Chamberlain country. Then several weeks were spent in the White Mountain region of New Hampshire. Trees in all kinds of situations were studied,—swamp sites where spruce and cedar were the principal growth—ridges and slopes covered with mixed growths,—steep mountain sides where the spruce stood clean, seamed by the winds, short-limbed and thick-foliaged from exposure.

The plan of measurement pursued has been used for some years by the agents of the Forestry Division. It was described in the report of the first forest commissioner of this State, in the paper contributed by Mr. Hobbs, and it is also illustrated in the appendix to this paper. The trees were calipered every four feet, their length of crown and total height measured, their age determined, and, by measures and counts at the sections, the rate of growth in diameter and height. The manifold inferences to be derived from these figures, embracing the type and growth of forest trees, and the influence upon them of conditions of every kind, belong to those who paid for the work. I am at liberty, however, to bring out some facts which relate to the matter in hand.

Trees as they stand in the woods are very different from such as are seen on open ground, the central facts in the list being the development and relations of the crown. The early life of a forest tree is passed under the shade of its larger neighbors and its growth is, therefore, slow. I have cut trees not over four or five feet high that were over fifty years old, while on the other hand some that grew up in openings might be larger at ten or twelve years. The former, however, would doubtless be much more nearly typical of the young spruce in our great forests. This is seen plainly in the record of youth left in the adult trees. It is shown elsewhere that the average age of spruce logs as they come down the drives of this State is nearly 200 years. This figure is obtained by count of the rings in the butt of many hundred logs, and the same examination has shown, that of the total number of rings, perhaps a half, the inner hundred, say on the average, are generally closely packed. Frequently these central rings are counted with difficulty, even with a lens. At 100 years of age the average diameter of a forest grown spruce might not be far from six inches, while its total capacity would be four or five cubic feet. Somewhere about that time, however, a tree that is ever to do much begins to shoot ahead. Its trunk raises the crown up among those of its larger neighbors; perhaps some of its competitors grow old and fall or are cut. The crown, at any rate, responds to accessions of light and air. Led by its leaves it expands and thickens, while the trunk so slowly formed begins to put on diameter quickly. The tree now is becoming dominant among its neighbors. Its growth at this period might be an inch of diameter in from six to ten years.

The period of severe competition is now passed. As elsewhere in the world wealth produces wealth. The crown grows larger in surface, and the foliage in consequence elaborates more food for the tree. The trunk not only grows larger, but barring accident, is clearer and proportionately more valuable; and if in later years the annual ring grows thinner, by reason of the greater surface over which it is spread the volume of the yearly growth up to the period *of old age grows steadily greater.*

A great number of interesting and valuable facts might be brought out here as to the habits of tree growth, but for the present purpose they would be only distracting. I shall merely ask and answer the question—how much does a tree add to its bulk in a year? The answer may be found more fully elsewhere with a detailed account of how the figures have been obtained. As a practical and usable figure it may be said that a large and healthy spruce tree in the forest may add to its stem half a cubic foot of wood a year. The larger it is the more wood it will grow up to the period of decline, while young trees even though the ring of wood may be much thicker than in the larger tree, grow comparatively but a trifling amount. Ordinary sized trees in our culled-over forests, such as are, say 10 to 14 inches in diameter, breast high, might grow from a quarter to a half of a cubic foot a year. The test of the matter is the crown. If that is large, thick and free, growth may be expected whatever the size of the trunk. The crown indeed, its condition and the access it has to light, are the chief factors in the growth of a tree. The supply of moisture comes next, too much or too little being alike injurious. Of the mineral constituents of the soil trees require but little; and it is seldom that a spruce tree when there is enough for foothold, will not find also a supply of mineral food.

Leaving the individual tree for the present, I pass on to other branches of the inquiry.

In all careful explorations of timber the acre is the basis of estimate. The stand of sample acres is closely taken – unless indeed the explorer have such skill as to be able to arrive with one step at final results—and the yield of the whole tract estimated in comparison. Figures on growth therefore would be best put in terms of acres, and that has, in this work, been done. In this case as before, the field notes on which I base my calculations were collected in the employ of the national forestry division. Recording as they do not merely the dimensions and quality of the merchantable timber, but a count of every tree large or small on the tract chosen, with a description of each species and size in trunk, crown and general development, these figures tell vastly more than the things we are now after.

To illustrate by one case the mode of field work. On the third day of January last with my companion, I brought up at Davis' camp on Spencer Bay town, just east of Moosehead lake. Starting at once for the chopping crews, they were found at work on rolling land, covered well with spruce and a variety of other woods. The ground was covered with moss and leaves, and the soil while stony was fine, plentiful and moist, furnishing apparently all the conditions for rapid growth.

Our first business was with single trees. Spreading our work among different crews, and keeping always close to the choppers, typical trees were picked as they were felled, their surroundings noted in detail, and measures taken upon each of them as earlier described. Two days work and about twenty-five trees yielding a fair representation of the site, we put on our snow shoes and stepped out of the choppings for our sample acre. A square of 209 feet was measured off and divided into convenient strips. Then, one man with calipers and the other with blanks and pencil, we set to work to score every tree, to describe them all individually or by classes, and to estimate the length and top diameter of all merchantable logs. No attempt was made to find an average acre. For the purpose of the time one which was well covered, and represented rather the highest development of the country, was preferred.

While the country had been cut through some sixteen years before, the particular piece of ground pitched on had evidently escaped the ax. There were on the acre twelve trees above eighteen inches in diameter, twenty-three between fourteen and eighteen inches, and thirty-six more between ten and fourteen. So far from market, smaller trees than that could hardly be said to have a money value. With an eye to the future history of the land, however, it is well worth notice that there were 136 trees between that size and about three inches, while over 700 still smaller spruce were counted. Some large yellow birch, and numerous white birch, beech, maple and small fir were present, but it was distinctively a spruce acre. The amount of spruce lumber on this acre was something like seven or eight thousand feet, and the cubic contents of trees over ten inches, including the whole stem but not the branches, about 2050 cubic feet.

The method of finding the annual growth of single trees is elsewhere described. Obtaining that value for each of the trees measured on the site, the results are arranged for different sizes of trees and the resulting values taken over to the trees on the acre and applied to them by number. The details of the whole process may be seen elsewhere, permitting everyone to judge of its accuracy. Here it will be sufficient merely to summarize results. All discounts being made, it is judged that about twenty-four cubic feet is added to the stem wood of the merchantable trees yearly, reckoning from the ground up to about six inches diameter. Among the smaller trees there is great variation and not enough were measured to determine their average growth with any degree of accuracy. Perhaps a lump amount of ten or twelve cubic feet would not be far out, making the total production of spruce on this acre thirty-six cubic feet. As to the correctness of this last sum I profess no confidence. On the other, however, much reliance can be placed. Having performed or revised every step of the process outdoors and in, I feel great confidence that for the annual addition to the merchantable spruce lumber on this acre the sum of twenty-four cubic feet is not far out of the way. The annual growth on the spruce is 1.3 per cent. of the stand and supposing the other species to add to their volumn at the same rate, the total growth upon the acre would amount to fifty-nine and one-half cubic feet.

For two other pieces of ground similar figures have been worked out. One was located on the south slope of Little Squaw mountain to the southwest of Moosehead on very rough, steep land with little soil. On the acre stood fifty one trees over ten inches through, containing about 1,800 cubic feet of wood which would saw out perhaps 6,000 feet of boards. For the reason that the individual trees that furnish the amount of growth were taken on better ground than the acre I have less confidence in the accuracy of the result. It is given for what it is worth. Reckoned as before, the annual growth of the merchantable spruce is nineteen and one-half cubic feet annually.

The greater part of February and March last I spent in the White Mountains and in the region of Berlin and Kilkenny in northern New Hampshire. The spruce of the latter named region excelled by far for size and quality any I had ever seen in central and eastern Maine. On the eastern slope of Mt. Adams, in the Presidential range, most work was done. An acre was staked out there about 3,000 feet above sea level and 1,000 below timber line, while some thirty trees in the same locality were measured Here there was more wood on the acre, while as might be expected of so high and exposed a situation the percentage of growth falls somewhat short of that ascertained to be characteristic of the better sites earlier dealt with. Carrying out the same reasoning, and making the same deductions as before, the final result, giving the replacement annually of merchantable timber, is twenty cubic feet. These results it should be said are in exact terms. Cubic feet here are not cubic feet on any artificial scale rule. They are net volume in standard measure. For each cubic foot of the growth about six board feet should be allowed to ascertain its money value.

The ratio of growth to stand in this last case was 1.05 per cent. The total yearly growth upon the acre was estimated at about forty cubic feet

In this connection another idea may be developed which has wide application. What becomes of the growth of land that remains uncut, growth which is the product of air and water combined with a little material from the soil. The answer may be seen in the score of trees. On the first acre mentioned eight trees of the largest size were standing, dead and in all stages of decay. At least ten years' growth is so represented. And this fact is thoroughly illustrative. In a country that is left uncut, the annual growth is offset by the death of old trees, and is absolutely lost to human use. Hence we see the unwisdom of those who indiscriminately declaim against cutting. Wasteful cutting, or cutting that prevents the reforestation of the ground with desirable species, certainly is a deplorable evil. But on the other hand growth should not go to waste, and so the sooner every piece of virgin land is cut over and the growth instead of rotting in the air or on the ground begins to store up for human use, the sooner, financially considered, will it be for the country. Furthermore the growth of a section is materially increased when the old trees are cut out, providing young trees are left to take their places. Dead trees and those which have passed the period of vigorous life not merely produce little or nothing themselves, but in a very real sense they cumber the ground Could these be taken out, could young trees occupy their places and the whole surface of the ground be covered with productive foliage, then it is reasonable to expect that our figures of twenty or twenty-four cubic feet might be materially increased.

Such is a sample of the line of work by which the sustained yield of our spruce forests might be determined. Our nearer and second growth areas of pine, poplar, birch, etc., some of which are among our most valuable timberlands, might be studied by the more direct method of observed yield. For forests treated as are our great spruce tracts however, such methods will not apply. Indirect methods have to be invented. What other in outline should they be than these—study of the production of the individual tree—study of sample areas having homogeneous and representative conditions—study in respect to topography, soil and stand of the whole region and a summary of its growth?

It is possible that the results here arrived at may seem to practical men of small or remote value. Admitting that for immediate use that may be the case, it is yet contended that slow, fundamental work, work which combines mathematics and biology in the effort to establish fundamental principles and relations, has in it the promise of the largest results. It will, perhaps, be well, however, to take up and answer as well as may be some of the questions asked by practical men. Those questions are all akin, all turn on the amount of growth, the value of young trees, the proper time to cut. Quite frequently the question takes this form. Will the growth of timber land pay six per cent? Time and again I have been confronted with that question and its first answer has generally been in the shape of several more. Per cent on what? On the value of timber land at current rates? On the value of the land stripped? On the value of the standing timber? Or on what?

Referring both for definite information and a basis for judgment as to other conditions than those represented, to the results already worked out, I might still repeat here the advice given to the owners of a township of nearly virgin spruce on the west line of the State, who had begun to strip it of all salable timber. Having been on similar land in the same region, land which sixteen years before had been culled over, and at the time of my visit was being cut through the second time, I was able to give the information that young trees if left, trees now say from six to ten inches in breast diameter, would probably grow, if no accident befell them, on the average an inch in eight years. These facts were given for what they were worth, and it is worthy of note that they confirmed the judgment of one partner that such trees were worth more to grow than to cut, and perhaps have by this time changed the cutting policy of the concern.

There is one business man in the State who has studied this matter of growth to good purpose, and established a policy of management as a result. He is Hon. Turner Buswell of Skowhegan, manager of the lands of the estate of Ex-Governor Coburn. By count on 500 logs Mr. Buswell determined that the average rate of growth in diameter of spruce is about an inch in ten years.* Now

*For fuller notes on this study see p. 33, of this report.

his standard of cut for saw logs is eight inches at twenty feet, while from most of the lands under his control sticks six inches in diameter are salable at a profit for pulp. His question was whether to cut those small trees or to allow them to grow into logs, and he answered it in this way. Taking to the scale rule the dimensions of the two sticks, a six inch and an eight inch log of the same length, he finds the increase of scale is 117 per cent of the smaller stick an amount which comes much below the increase of money at compound interest for twenty years. Thus Mr. Buswell arrives at the rule that when camps and crews are on the ground every stick that can be handled at a profit shall be cut.

Mr. Buswell's facts are all right and so far as I see there is only one objection to his application. That objection is that the rate of diameter growth was determined on logs ten or twelve inches or larger in top diameter while they are applied to trees of much smaller size on which the growth in a country whose larger trees have been cut would be considerably greater. This Mr. Buswell admits, balancing that gain. however, with the loss from blow-downs which in such growth in the course of twenty years might be considerable If it be agreed however that Mr. Buswell's rule is immediately and practically sound, there are yet limitations to its application which ought to be stated. In the first place it does not take into account the State's interest in the matter—leaves out of sight the effect of severe cutting on the future volume of business as well as on the reforesting of the land. Then the rule may prove to be short sighted in taking no account of any future rise in prices, which might readily, growth out of account, be enough to reverse it. Nor does the rule say that it is good policy to mow down a piece of growing timber as soon as any of it is fit to cut. Young growth just coming into the merchantable class may be increasing in value at a very rapid rate. To put in roads then culling out the largest trees, and killing many more that were nicely growing, is a great waste and loss,—loss to the lumberman himself who might have made so much more out of his property.

Then if pine were the timber concerned, conclusions would have to be greatly altered. So rapid is the growth of that wood, and so great its improvement in quality brought about by age and proper conditions that growth is a much larger factor in the account. Lastly, cost of transportation is such a large element in every such calculation that conclusions are different for every case. The most that the state can do for the individual owner is to provide him with the bottom facts in the case, facts which he could not get at himself and which can then be applied to his particular circumstances.

The results earlier worked out in this paper need similar qualification, both to prevent any mistaken inferences being drawn, and to forestall their use for any partisan purpose. While the absolute results arrived at may be relied on as at least an approximation to the truth, no mistake should arise as to the meaning of the percentages. These old-growth acres have as great a stand upon them as they ever would have, which makes the percentage of growth to stand low. Now it is possible that younger trees having a fraction of the bulk of the old growth might still cover the ground quite as completely, and produce just as large an amount of wood. At any rate smaller trees standing in the proper and natural number would grow yearly a much greater percentage of their bulk. The percentage of the growth to stand or value is a widely varying matter. In land just cut the growth absolutely and relatively would certainly be low. If plenty of young growth of desirable species is left, the trees in time adapt themselves to their new conditions and the production is raised to the normal amount. This at first bears a high percentage to the stand. But as the growth accumulates, or is added to the stand, the per cent of growth to stand steadily shrinks. There is a time therefore dependent on current rates for money and other factors when it is most profitable to cut.

There is danger of a still further confusion. The actual growth per acre must not be confounded with the change from the non-salable to the salable class. Suppose again a piece of land to be stripped of all merchantable lumber and yet retain a liberal stock of young and desirable trees. In a few years these would begin to come into the merchantable class a few at a time. Two or three per year might equal the absolute growth on an acre, even a well covered acre. Soon while these larger trees continued adding to their bulk, the number of still smaller ones passing the merchantable limit might render the annual addition to the salable timber many times greater than the annual growth. Frequently in ordinary talk this and not the other is what men mean by growth. The increase of salable lumber on a tract may be a far different thing from the actual growth on that tract. By this means values may very rapidly enhance. Consideration of this matter may dictate a sparing policy, when the actual growth seems insignificant.

Before leaving this subject of tree growth I wish to say something of the value of the slow methods and exact terms of science. The processes which I have described look perhaps elaborate and expensive. On the other hand it should be said that they are exact, or if they depart from exactness the liability to error is closely known. Further, a little of such work goes a long way. By comparison and estimate a small amount of accurate knowledge will form the basis of large results which can be relied on as approximately correct. Similarly as to terms. Men want to know things in board feet, in current values, in percentages. But were it attempted to do the basal reckoning in such terms, the results would be only temporarily and locally useful. Prices vary with the lapse of time. Material at one time not worth handling comes later to have distinct value A thousand feet of lumber means one thing on the Androscoggin, another on the Kennebec, still a third on the Penobscot. Yet results that are exactly worked, and couched in exact terms, can be applied to any locality and at any time.

If it is asked why no more practical and sweeping results are arrived at in this paper, I will answer that there is not yet sufficient basis for working them out. When I say that it looks something like the truth that a good spruce town should grow in the absolute sense a million feet of lumber in a year, that statement should be coupled with another to the effect that such figures and similar ones that might be made for the production of the State are little more than a guess. For those wide inductions the time is not yet ripe. More work must be done, and the basis of judgment greatly enlarged, before any one can talk about those matters with sufficient assurance to make it worth while. But when the fundamental work is done, when well considered plans have been carried through to a successful conclusion, then results will be in hand whose value it will be hard to estimate. Wholesale figures will show something about the future of business that can be depended on. Practical rules will be solidly based and widely applicable. Empirical statements may serve a temporary and restricted use, but they are liable to mislead. Rules derived from thorough fundamental knowledge will hold anywhere and for all time. Such rules are not fetiches, but are intelligently held. Their limitations are known, and they can be modified to suit circumstances.

The study of the forests of the State should be thoroughly scientific No other kind of study is worth spending money on.

AGE OF SPRUCE.

The first field work performed for the State in the interest of forestry was a determination of the age and size of spruce logs. This seemed worth while on its own account, and it is further probable that whenever in the future it shall be attempted to estimate closely the forest resources and growth of the State the results of this work will have a very important use.

In all, 1050 spruce logs were examined for this purpose, taken on drives and mill yards. The length and end diameters of each log were measured, and the rings of the butt counted to ascertain the age. About two-thirds of the logs were grown in the western part of the State on the drainage of the Androscoggin. The remainder were partly from the Kennebec, partly from the Aroostook branches of the Penobscot. A small proportion of the logs measured were cut for pulp, which renders the selection all the more representative.

The tables which embody the results of the work need, it would seem, very little explanation. The trees were first divided into age classes, and the dimensions of the logs in each class averaged. Then the same logs were divided according to butt diameters and the average age ascertained for trees of each size. The most usable result of the work is the grand average of these facts for the whole 1,050 logs. The averaged dimensions of the logs represent a tree containing about twenty-three cubic feet, or say 120 board feet, and this was grown on the average in 192 years. Adding to the log two cubic feet for stump and seven more for the top, adding also to the age twenty more years for the height growth of the stump—then dividing contents by age gives the figure fifteen cubic feet. That is to say, a spruce tree on the average and throughout its life until cut, maintains a growth of one cubic foot in six and two-thirds years. In adult life the growth per tree would be considerably greater. In young seedlings it would for many years be less. The percentage of growth to stand cannot be immediately derived from these figures.

AGE AND DIMENSIONS OF 1,050 SPRUCE TREES.

(a) AVERAGED IN CLASSES ACCORDING TO AGE.

Class.	Number of trees.	Per cent of total number.	Average age.	Average butt diameter.	Average length.	Average top diameter.
				In.	Ft.	In.
Under 125 years	52	4.9	114.5	11.5	26.4	8.0
125—150..........	120	11.4	138.7	12.1	28.5	8.5
150—175..........	210	20.0	162.6	12.9	29.9	8.6
175—200..........	218	20.8	182.6	13.5	30.3	8.9
200—225..........	210	20.0	210.8	15.0	31.3	9.9
225—250....	125	11.9	235.5	15.9	32.2	10.0
250—275..........	72	6.9	260.3	16.0	32.9	10.3
275—300..........	29	2.8	285.6	17.5	34.4	11.5
Over 300	14	1.3	311.6	18.5	37.1	12.0
Average of all..	1050	......	192.0	14.1	30.6	9.2

A log of the above dimensions contains 23 cubic feet, or about 120 board feet.

(b) ACCORDING TO BUTT DIAMETER.

	Number of trees.	Per cent of total number.	Average age.
Under 10 in.	42	4.0	162.0
10—11	97	9.2	170.1
11—12........	123	11.7	171.7
12—13........	158	15.1	174.0
13—14........	162	15.3	189.1
14—15........	117	11.2	185.4
15—16........	94	9.0	197.7
16—17...	76	7.3	214.0
17—18........	62	5.9	217.1
18—19.... ...	43	4.1	228.7
19—20........	19	1.8	230.1
Over 20	57	5.4	244.8
	1050		

A 13½ inch tree, of course, is not as a rule older than a 14½ inch tree. The irregularity shown in the series would doubtless be corrected if a larger number of trees was taken.

Average of 50 pine logs: Age, 102.8; butt diameter, 16.1; length, 30.3; top diameter, 11. A log of these dimensions contains 30 cubic feet, or about 175 board feet.

In regard to the age and size of pine far less satisfactory information is at hand. Fifty trees from all conditions and of all sizes form a very small basis for generalization. The figures will tell something however A considerably larger log than the spruce is only 103 years of age, while the average yearly growth maintained is two and one half times that of spruce. This relation of the two species is doubtless approximately true on the average and in the long run.

Another matter on which these figures throw light is the taper of spruce logs. This varies so much that when it is of account it is far better measured in each case, but so far as an average is of use it may be obtained from these figures. These logs contain long and short, large and small, with even a few top logs for variety, and the average taper of them all is an inch in six and one-half feet. As affecting the reliability of this figure, it should be said that in calipering the butt of the logs care was taken to measure above the swell frequently found, and to avoid any marked irregularity.

It is generally known that trees taper faster in the upper portion of their length than near the ground. Long trunks that have for many years been clear of limbs are sometimes nearly cylindrical, while in the same trees up among the live limbs a very quick taper may be found. For logs topped off at about the lower point of the crown, an average taper of an inch in eight feet would be near the fact. Assurance of this is given by the studies of Mr. Turner Buswell of Skowhegan, 1000 logs cut in the way mentioned were measured under his direction, and the figures obtained footed up to that effect. A timber tree is very nearly represented by a cone of true taper set on a shaft of slower taper, the division line between the two coming as a rule near the lower limbs of the tree.

These figures also define our ideas as to the longevity of spruce. Out of 1050 trees it is seen that fourteen in number, or thirteen per cent, are over 300 years of age. Of these only one was over 312 years, that being a tree of only thirteen and one-half inches butt diameter showing 363 rings. The very oldest spruce log that in the course of my field work I have come across showed 372 rings in the butt. This was a very large tree, twenty-eight inches through and ninety-seven feet high, containing in its central stem about 200 cubic feet. It was grown in a little sheltered valley in the mountains of Kilkenny, N. H. Since the three feet of stump of this tree probably represented as much as twenty-eight years of its early height growth. I can fairly name as the age of the oldest spruce I have ever examined 400 years. This tree had a long full crown, and was still growing in diameter, though only an inch in thirty years. Sixty-five feet of the tree was cut off for a log. Of this the butt was sound and good. At the top, however, the wood inside the sap was becoming brown and soft.

This brings up another matter worthy of attention. Old age in a tree shows itself naturally in the crown. The leaves are its active organs and when their activity slackens, and the crown is thin and dull, then old age is made apparent. Some explorers say they can also depend on the drooping of the limbs. Not so easily detected is the mark I have mentioned, yet it seems to be a true one, for in the very oldest trees, those say of 250 years or more and without any apparent determining cause, a gradual softening of the heart wood and the assumption of a brownish tinge, proceeding finally into evident decay, is very frequently seen. Generally if any section is so affected the whole area of its heart wood is involved. The softening begins more frequently I should say at the butt than near the top. Frequently trees that outside appear perfectly vigorous are greatly impaired in value from this cause.

As to the longevity of the trees, I should say that for black spruce in Maine 250 years corresponds to about the age of seventy in the human being. Three hundred in the same way parallels ninety or ninety-five; while a 400 year old tree is as rare as a person of 120. Had we the statistics on both sides of infant mortality, I have no doubt quite as interesting comparisons could be made.

While carrying out the field work which is behind all these statements, facts were found proving the influence of the weather on the growth of trees. In May, 1893, while at work on the Androscoggin river, word came from Mr. J. A. Pike of Berlin, N. H., that record was to be seen in the spruces of a series of cold years which occurred in the early part of the century. This was richly worth examination and I immediately set about investigating the matter. Beginning the count of rings with the bark, it was found on the first log examined that a number of rings, being in that case the seventy-ninth to the eighty-third from the bark, were very distinctly thinned. Continuing the search, every tree was found to have a belt of thin rings in substantially the same position, these being reduced in some cases almost to microscopic.

As soon as access could be had to books, the history of the matter was looked up, and it was found that the years 1812 to 1816 in Maine were very extraordinary years. The temperature was unusually low as an average and in 1812, 1815 and 1816, at least, frosts or snows or both occurred in the summer. In 1815 and 1816 crops through the State were very seriously impaired, and many people despairing of the agricultural prospects of the country, emigrated to the Ohio valley. This severe weather then was without doubt the cause of the thin rings so regularly found in the spruce trees.

Since that time this zone of rings has been found in spruce trees in all parts of the State and in the northern portion of New Hampshire. Careful notes of its character and occurrence were taken, in the course of other study, and the facts observed and inferences drawn will be found in full in the publications of the United States Forestry Division.

This belt of thin rings can be seen by anyone who will take the trouble to examine carefully any good sized spruce log. It demonstrates the effect of inclement seasons on the growth of trees, and it is further of value in that while there is some variation about it, the approximate regularity of its position, the close correspondence in number of the rings outside the thin belt with the seasons that have elapsed since the cold year, gives added confidence in the substantial regularity of ring deposit and consequently in the results of investigations which proceed on that assumption.

An instance of the effect of exposure on the growth of trees, I am able to present through the interest of Mr. William Monroe of Bangor. In the winter of 1893-4 he scaled a landing of spruce hauled into Silver lake in the town of Katahdin Iron Works, from a piece of ground on the south slopes of Saddle Rock Mountain, which had never before been cut. The soil was a deep red loam, and the spruce was gathered along brook runs or scattered amongst the hard wood growth intervening. But the point is that the timber was divided between two separate slopes of the mountain, the upper one of which was some 200 feet above the lower, and considerably more exposed.

The timber from each slope was yarded on the more level land at its base, and Mr. Monroe kept a separate scale of the two lots. A marked difference in the size of the trees is found. The logs cut on the upper and more exposed slope were 4,377 in number, and scaled 435,726 feet B. M. or ninety-nine and one-half feet to the piece The lower lot numbered 2,598 sticks, and the total scale was 320,811 feet or 123 1-2 feet to the piece. The difference is twenty-four per cent of the smaller piece. No other cause for it being apparent, the difference in the size of the trees seems to be due to their greater or less exposure.

EARLY FOREST FIRES IN MAINE.

The greatest forest fire that has occurred in the State of Maine within historic times was doubtless that of the year 1825. It is known to many people in the State as the "Miramichi" fire, but though it occurred the same year and month as the forest fire which destroyed many lives as well as much property in the province of New Brunswick, it was a distinct fire, being separated from the other by many miles.

The fire of 1825 in Maine seems to have started in the towns in and near the Piscataquis valley. Here it did much damage, burning up the wood lands, destroying several sets of buildings, and otherwise injuring the settlers. Thence it spread north and east, burning up mile after mile of timberland, till it reached and crossed the Penobscot river. The boundaries of the fire where they are not obscured by clearing or later fires are yet, by the charred stumps and the nature of the growth, perfectly distinct, and the area of the fire has by these marks been approximately determined. The map which embodies these results and the limits as well of the other great fires which are later spoken of, has been reserved for another year, when it is hoped that much more information regarding the forests of Maine will be ready for record in this form.

In this connection it is right to acknowledge the assistance that has been received in the prosecution of this work. Personal exploration of more than a small fraction of the territory was not possible. The boundaries of the second growth have thus far been obtained almost entirely from land owners, lumbermen and explorers; while as regards the history of the fire and the nature of the growth upon its territory, much assistance has been derived from similar sources. To all who assisted in this way, hearty thanks are due.

Written history, confirmed by the recollection of people yet living who were witnesses of the fire, furnishes pretty satisfactory information as to the conditions which were responsible for it, and also tell graphically of the conflagration in the neighborhood of the settled towns On all points the account in the history of Piscataquis county by Rev. Amasa Loring, who was a witness of the fire, would seem to be trustworthy. Beginning on page 231 of his history he says:

"The most severe and extensive calamity that ever befell this county was the great fire of 1825. Previously the annual rain fall had been sufficient to secure good crops, and to prevent extensive conflagrations. But in August and September of that year no rain fell, and a severe drought extensively prevailed. The crops had grown and ripened. By the beginning of October, the wells were without water, the small mill streams had failed, the brooks ceased to flow and the fish gathered in the deep pools, or lay dead upon their dry, stony beds. Much of the cleared land contained decaying stumps, and was enclosed by log fences, while the stubble upon the grain and mowing fields was thick and rank, and all as dry as tinder. Still those who were clearing up new land, in their eagerness to burn up the fallen growth, set fires as fearlessly as ever. And these fires did not go out, but lingered and smouldered still.

"In the evening of October 7th, after a still, smoky day, a violent gale arose from the north and northwest, fanning these smouldering fires into a furious and rushing blaze. In the wood-lands the flames rolled on in solid column, while the wind scattered the sparks and blazing fragments like chaff, lighting up stumps, fences and often the dry stubble."

Everybody, the writer continues, was awake. Fences were torn down, water carried, and back fires set. The night was the wildest in the experience of most who witnessed it The next morning, however, the wind subsided and peril to life and farm property ceased. But smoke hung over the country dense enough to sicken cattle and great enough in volume to be seen outside the state. The fire hung in the bogs and timberlands, and it was only some weeks later, when the heavy rains of the fall came down, that it was finally quenched.

Mr. Loring's account agrees perfectly with information received from other eye witnesses of the fire. As to the origin of the fire and the cause of its severity there is little doubt that his account furnishes the true explanation. Clearing fires were probably the center of the conflagration. Proof of this is the fact that the fire sprung up in so many places at once. It was in several towns the same night, and men found it all about them when they turned out to fight it. So strongly were they impressed by this feature of it, and so impossible was it either to quench or curb, that the fire was attributed in the minds of the superstitious to a supernatural origin. Men thought the fire rained down.

More worthy of note are the conditions which made this great fire possible. The season of 1825 was doubtless a dry one, so that not merely the brush of the woodlands furnished food for the fire, but the leaves and vegetable soil of the forest floor. At this time came on the gale of October 7th. Old settlers testify graphically to its severity. The fire, they say, travelled as fast as a horse and the air was filled with flying brands. Thus the fire was spread from many centers, and fused into a great body of too great volume and power to be fought. It overpowered the settlers. In Cambridge and Ripley numerous sets of buildings were burnt, and scattered buildings were destroyed elsewhere. Then when the gale went down, from the extent of the fire it was beyond control. It maintained itself in spite of the settlers, while spreading north and east, it ravaged the timberlands unhindered for weeks. The history of the fire in a word is this—small and seemingly insignificant fires were allowed to continue in a dry time. Then a sudden gale sprung up which spread the fire from these centers and fused them into a great body of fire which was beyond all human control. The warning to be derived from these facts is not likely to be mistaken. It is far less likely that it will be heeded

Without a map the bounds of this great fire can be only roughly given. 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 Seboois 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 takes in parts of Kingsbury, Mayfield and Wellington, touches Harmony on its northeast corner and includes all of Cambridge and Ripley. Owing to the large areas of settled land along the Piscataquis, the fire in that region burnt very irregularly. It reached, however, in places into the third board of towns below the river. Making no deduction for water areas, nor for small oases too that no doubt make up in the aggregate a considerable area, the territory covered by this great fire is estimated at about 1,300 square miles

In tracing the outlines of this fire of 1825 we are brought in contact with two other great fires of early times, the bounds of which have likewise been approximately ascertained. From Mr. Fred J.

Fiske of Mattawamkeag I am in receipt of a sketch map of the region south of Mount Katahdin. On this, from personal knowledge of the country as well as the notes of the first surveys made there, he is able to trace the limits of an area of second growth lying on both sides the West Branch Penobscot and embracing an area of about 200 square miles. This district Mr. Fiske believes, judging from the surveys just mentioned as well as from examination of the trees themselves, was burnt about the year 1795. From it much good-sized pine has been taken of late years, but so far as I have learned no other kind of lumber. The fire of 1825 apparently, crossing the West Branch below the Twin lakes, either ran to the southern edge of this earlier fire or over a portion of its territory.

The third great fire that has been mapped is one that occurred in the year 1837. Starting on the meadows of the Seboois river it spread northerly, burning the northwest portion of Patten and more than half of the two towns north, sweeping westerly to the East Branch Penobscot and north through township eight in the sixth range and so out into Aroostook county.

The origin of this fire is interesting. In those times the State was the owner of much of the timber lands within her limits, on whose property of course all good citizens were in duty bound to poach. In 1837 the State land agent for the time being sent up to this region a man by the name of Chase to look after the public interests. Finding on the Seboois meadows a lot of meadow hay ready cut for a winter's operation in the woods, this zealous officer, thinking he would put a stop to one piece of pilfering, set fire to the stacks. It was a dry time, the fire spread, and Chase himself as the account goes, barely got away with his life. The conflagration which he started spread through township after township, consuming as above outlined some 200 square miles of the State's best timberland. This burn though less than sixty years old has furnished for some years considerable quantities of pine lumber. Considerable study has been made of the growth that has come up on the territory covered by the fire of 1825. For this there are two reasons. In the first place a body of timberland a thousand square miles in extent is an appreciable quantity in the forest resources of the State, and any general impressions as to its present condition and value, still more as to its future production and management are of direct utility. The other object of such study is to ascertain for the sake of general application, the character and value of the growth characteristic of burnt land. It is now sixty-nine years since this great fire took place, while all about it are tracts that were never touched by fire. Here then is a chance to learn, on a large scale and in a variety of conditions, what change in the nature of the natural growth fire causes, and what is the yield that sixty-nine years will produce. These then have been the objects held in view. In carrying them out there has been neither much time nor money to spend, while we have had no precedents to guide us Such estimates of stand, as are of service to an owner, could not be attempted, and those it is not the business of an investigation like this to furnish It is rather the general considerations that can be derived from the study of sample territories.

The first cruise in the interest of this work was taken in November 1893 along the newly opened Aroostook Railway from Brownville across the East Branch of the Penobscot. The line of the road was traveled on foot, and notes of the land and growth taken. Later a tramp was taken through Abbot, Parkman and Dexter, while at various points in the tract in the course of other business the growth upon it was made the subject of observation and inquiry. The newly cut road from Brownville east to the Penobscot offered excellent opportunities for observation. The soil through that region, beneath the leaf mold, is composed of the mingled clay and stones of a deep glacial deposit. Uneven, but not rough, the country lies in alternate ridges and hollows, each with their characteristic growth. This growth for the swamps is oftenest cedar, mingled with a varying proportion of spruce, while in many such places the tall hackmatacks that were killed by insects some years ago tower far above the other species. Hackmatack springing up unobstructed has proved itself a very quick growing tree. For many years before its destruction the hackmatack of this region furnished the finest of ship knees. On sites adapted to it the tree evidently reaches early a merchantable size, and should it again become of value it is probable that if no calamity again befalls it, one stock of this timber will be renewed in the course of forty or fifty years.

Thousands of railway ties, recently cut and piled near the track gave good opportunity to see the size and quality of the ceder grown. The largest and best of the ceder seemed just fit for this purpose. Butt cuts of about twelve inches diameter seemed to be the largest, and whenever standing trees of larger dimensions were found, their appearance and the surrounding circumstances pointed to the conclusion that they were old growth trees that escaped the fire. The dimension named above may therefore be set as the upper limit for cedar of this age grown up in this way. Vastly more numerous were the trees of somewhat smaller dimensions. In swamps where the trees grew thickly the usual diameter was perhaps four to six inches. Numerous such swamps were seen, closely filled with clean straight trunks evidently to be the source of large supplies in the future.

The concerns lumbering along the line of the new road in the winter of 1893-4 were as a rule cutting pine. An exception was a crew cutting hard wood to saw into veneer, the source of supply proving to be an unburnt tract of about a square mile in the east part of the town of Brownville. Otherwise pine was the staple of the cut. Township Long A for instance with other districts on the burnt tract are known among lumbermen as "latter pine" country. Arising from the fact that pine is the only timber there which has arrived at a condition to be profitably cut, the term "latter pine" has further a restricted or technical meaning. It refers to the short, stout, limby timber found on most such tracts in distinction both from the old growth "timber" pine and from the longer bodied and cleaner "sapling,"—varieties of the tree which seem to be due, not to heredity through the seed, but mainly, at least, to the influence of circumstances. This class of timber is familiar enough in the State, both in the market and standing. In the market most of it appears as boxboards, though butt cutts from the trees frequently are sawed into clapboards. It is frequently cut as young as forty or fifty years of age—has been cut on this tract for more than twenty years, and places are now being culled over a second time. Good sized trees were two to three feet through, sixty to seventy feet in height, and presented a total bulk far greater than individuals of any surrounding species.

Examination was made of this timber at numerous points on the burnt tract, while at three different places full measures were taken of the trees for the records of the United States Forestry Division. As just mentioned, they were, so far as they went, the dominant growth. Far beyond serious limitation by other species, the pines did not as a rule crowd one another. In fact, generally, even in these so-called pine countries, they seem to have come up very sparsely.

These facts of arrangement are the key to the character of the lumber. Pine on open land where its sunlight is unobstructed takes a quick start and grows very rapidly, distancing its neighbors. If not crowded by other trees of its own species, a long, spreading stout-limbed crown is formed which enables the trunk to put on diameter quickly. Sometimes such trees will add an inch to their diameter in a year. Lumber so grown however is weak, and is further weakened and rendered useless for the better purpose to which pine is devoted, by the large and numerous knots. Too rough and knotty to ever furnish a higher grade of lumber, the question of when to cut this "latter pine" is the question where to get the most bulk and value from the land.

Two areas of pine were seen, however,—and these were, doubtless, typical of others,—of a character to command more respectful treatment. A small area above the village of Katahdin Iron Works and considerable ones between the two branches of the Penobscot came up quite thickly to pine. Naturally the trees did not reach merchantable proportions so soon as on tracts where each individual had more room, but the promise which those trees did give and do still give of producing lumber of a high grade puts them and the land on which they stand in an entirely different category. This matter is thought worthy of a little close consideration.

For the life of a tree the crown is the important portion of its anatomy, since, in the chemical action of the leaves is the center of its life processes. The trunk is in large part dead. For the purposes of man, however, the trunk is the main thing to be considered. That should be straight and smooth, long-bodied and clear of limbs. For the production of these qualities of good timber it is essential, therefore, that the lower limbs of a tree, those that nourish it in the early portion of its life, should not grow to any considerable size. If the live limbs of a tree as it grows in height are confined to the upper half of its length, the dead ones below in time drop off and the succeeding rings of growth as they are deposited round the trunk are uninterrupted and clear.

This process is essentially a limitation of the life of a tree, a specialization for the production of a trunk of certain character. These characters in the ordinary course of nature are produced by competition. If a tree is closely surrounded by neighbors of equal vigor, its lower leaves become shaded, their life processes grow dull and they and the limbs supporting them die out. The tree is compelled to shoot upward to meet the light that is denied to it below, while the trunk becomes long and clean, forming the basis on which a later growth may most profitably be deposited. Quality, however, in a given tree is obtained at the expense of quantity, while the crowding may apparently go to too great an extent, dividing too minutely the growth on the tract and perhaps even lowering its actual volume. It is in fact one of the problems in the practical cultivation of forest trees, involving the balancing of these opposite considerations how many trees at any given age should be allowed to stand to the acre.

Applying these principles to the areas in question it is seen how, having grown up thus in full competition, it is comparatively recently that the trees have reached a size when they were thought fit to cut, while on the other hand in respect to future value, they make great and unusual promise.

I have most facts relating to a piece of ground in Township 1, Range 7. Finding a camp at work there full measures were made on some of the trees as elsewhere described, while to confirm and add point to conclusions derived from general observation in respect to the relation and comparative size of the different species, a half acre of pine land was staked off and the trees upon it counted and described. Some seven years before this ground had been lightly cut over, and the stumps were seen much eclipsing in size any of the trees now standing. Of the latter the largest were thirteen to fifteen inches in diameter and eighty feet high. The trunks of these trees were clear of limbs for a considerable distance, and the butt logs of the best trees were to be sawed into edged boards. Here a distinct rise in quality is seen. I fully believe, and shall try to point out, that a still further rise, one that would multiply many times the value of the product of the land, might be reaped in time with conservative treatment

The half acre selected was as good a one as I could find in the vicinity, one, that is, as well covered with pine as could be found. In speaking of results those taken in the field will be multiplied by two so that our dealing will be with the acre as a unit This being understood, there were on the acre 228 pines of which only five were under six inches diameter while seventy-eight were twelve or over—diameter being measured always breast high from the ground.

Nearly all of these seventy-eight would doubtless be cut and the estimated scale that I place upon them is nine thousand feet. Putting these facts aside for a time, let us look into the makeup of this stand more closely.

Of the total number on the acre the seventy-eight above mentioned might be cal ed the dominant trees. Their crowns reach above the general surface of the forest cover and are of good size and vigorous. Yet the lowest live limbs are high above the ground and the trunks are moderately long and clean. Standing among them are trees of smaller diameter. Of these the stems were longer while the crowns were smaller and higher from ground. In all degrees these characteristics are developed until we find trees whose foliage is a mere tuft, trees whose vitality has been lost so that they would not revive if the obstruction was cleared about them,—even some trees already dead.

Now with the present cutting the history of the land is not ended. These remaining trees will fill up the space, the larger ones among them going ahead with spreading crown and swelling trunk And note that the lower trunk by the agency of competition is cleared of limbs, and the wood that in the future may be deposited will be clear. Thus has the basis for future growth been constructed.

What somewhere near will be the rapidity of such growth? What is the product that may finally be arrived at? The answer to the last question will be first attempted. and it is grounded on much observation and inquiry. Given time, I see no limit to the product we may expect, short of the limit of the species as that was seen in the original growth of the country. This may be inferred from varied testimony. Some old burns in the first place, burns that were found when the timberlands were first surveyed. have yielded much large pine timber On favorable sites, frequently in the edges of our towns trees may be seen that are well on the way to such a denouement. The finest landing of pine I have seen in two winters largely spent in travel in the timberlands of the State was hauled into tide water from just outside the limits of the city of Portland. At an age of 125 to 140 years, trees that had evidently grown up on cleared ground had reached a diameter of two to three feet and a height of 120. Such trees were already far on the road and must prove, it would seem, to the satisfaction of any one that in reproducing such trees as gave our State her early reputation, nature will do her part if only we give her opportunity. As for the particular tract in hand a growth in diameter of an inch in five years might reasonably be expected of the trees left, at which rate it would take them about fifteen years to double in volume of merchantable timber. The yield now of the acre is about nine thousand of second grade lumber. I think it not unreasonable to think that, if allowed after this cutting to remain untouched for fifty years it might produce five times that amount, much of the cut of the finest quality.

It is understood of course that this is an exceptional acre, but it is probable that on tracts less heavily timbered proportional results would hold. Devoting so much attention to the pine let us turn to the subsidiary species on the ground. The number and size of them will best be understood if the score of the whole acre is before us. This can then be compared with subsequent figures of the same nature and what is general and typical gathered by comparison and from the general description and discussion.

Summary of growth on an acre of land in Township 1, Range 7, Penobscot County. Land burnt in 1825. Diameter of trees measured four and one-half feet from the ground.

Species.	Number.	Average diameter.	No. over 12 in. diameter.	Estimated volume.
Pine,	228	10.3 in.	78	4,780 cu. ft.
Pine stumps,	12	20	6	
Spruce,	194	3 5	24	230
Yellow Birch,	96	4.7	30	250
Maple,	38	3.7	14	140
Hemlock,	22	1.7	2	2
Fir,	18	.6	0	1
Striped Maple,	8	4	2	12
Cedar,	6	2.8	0	2
Poplar,	4	11.2	4	90
White Birch,	4	7	2	50
Beech,	2	6.5	2	8
				5,565

Next in number to the pine it will be noted are the spruce. One hundred and ninety four to the acre is probably more than would usually be found, but the size and development of the trees are thoroughly typical. The two largest are nine and ten inches in diameter and represent, it may be said, about the largest development of the species seen. They are long and full crowned trees in open situations, are nearly all crown in fact, the stem as a whole being short and of quick taper. Of the whole number only twenty-four are over six inches in diameter while many are extremely small. The difference between even the backward pines and the spruce is very great, and this is due not only to its much slower rate of growth but to the fact that spruce will spring up in a dense shade as pine will not. Could all the pines in this acre be cut, large and small would show approximately the same number of rings. They started up together soon after the fire. Should the spruce be examined in the same way some would be found of the full age, while many would have started up later. Here then, in the relative nature of these two species, is an indication of what the future of the land will be, should no further accident befall it. The pine treated rightly may be expected to yield a large and valuable crop. But that reaped, the steady output of the land, so far as these two species are concerned, will be spruce.

This is an important matter worthy of further attention. Confirmation of the idea stated is received from many sources. Observations made on the upper East Branch lakes are to the point. In March, 1893, I visited a camp on Ellis brook which runs into Chamberlain lake from the west. The staple of the cut there was large sapling pine. The trees were two feet or more through and one hundred feet tall, two logs making generally a load for a team. In counting the rings at the butt the trees were found to be somewhat over two hundred years old, and as the work proceeded there was found to be close agreement in this matter. The result of the count of the fifteen, which could be certainly counted, showed that all ran between the limits 196 and 223 while twelve of the number ran between 205 and 211. Thinking that such agreement as this could not be due to chance, but that probably these trees grew up together, after clearing, the test was extended to the spruce on the tract. The number of rings still agreeing, I was compelled to believe that at some time during the Indian occupation this piece of ground was the scene of a clearing, a fire, or a blow-down, of which perhaps if closely questioned the soil might furnish indisputable proof. Pine then was the main part of the present crop from the land, but there was no young pine. A limited number of spruce had come to maturity while the young spruce standing numerously among the other species furnished the promise, so far as evergreen growth was concerned, for the future. These facts are thoroughly typical. If it could be closely examined into, I think it would be found that a large portion of the early pine of the State sprung up on land that was in some way cleared. Certain it is that in the dense forest pine does not extensively reproduce itself. We must look elsewhere for the supplies of the future.

We have wandered widely from the original topic of discussion. The other species on this half acre can be disposed of briefly. The few white birch and poplar doubtless started with the pine. Probably many more started which were crowded out, for the seeds of these two species travel so widely that they can be thought of as everywhere present. They form no part of the undergrowth however. A few cedar and hemlock were noted. Both species of a slow growth that stand shade well, everything contributed to their being small and inconspicuous. Yellow birch and some kind or other of our maples seem to be species that will be found almost everywhere. In many places on this burnt tract they form the predominant species. Small fir forms a feature of most acres of timberland. Much less frequently does it persist to a merchantable size.

A paragraph as to the annual production is well worth insertion. The total stand of this piece of ground is estimated at nearly 4,800 cubic feet for the pine and 5,365 for all species This is the product of sixty-eight years growth which on the average comes to about eighty-one cubic feet per year. However since during the adolescence of the trees it must have been extremely small, the yearly growth now must be at least 100 cubic feet. This cannot be taken as an average of the country, for this is professedly an extra well covered acre. Neither can it be considered typical for any other species, since pine grows much faster than most of its competitors. Such inferences as can be drawn however are worth drawing. If we suppose fifty cubic feet to be added to the merchantable timber, and that in this case would seem to be within the mark, the yearly addition to the stand of lumber per acre would be something like 3 0 board feet.

A prominent feature of the growth on this burnt district is white birch. From the lightness of their seeds it appears that birch and popular are widest spread and fill up when other species and modes of reproduction fail. A mill on Schoodic lake makes available the birch in its neighborhood, and others are located at various points in the tract. On Seboois stream a camp was found cutting this wood and opportunity to study the trees both down and standing found. As is the case with all species grown up in this way, the largest trees are not the best or most promising. Twenty inches in diameter perhaps represents the maximum of development, but trees approaching that size limb out low, and are valueless for lumber. In real birch growth, six to twelve inches is the usual size, and of these trees the smaller are frequently the better. Seventy years is evidently the beginning of old age with birch, for many of the trees on this ground showed internal discoloration, softening and other imperfections. Not very many more years could birch be expected to dominate the ground. As with poplar, quickly growing up, it early dies out as well, and leaves to slower, tougher species the occupancy of the ground.

The value of white birch, when it can be made available is as great as almost any class of timber. It quickly brings a crop to maturity—in thirty or forty years the larger trees of a birch grove will be fit for spool stuff, and successive cutting may be made thereafter. It frequently stands in nearly clear groves and thickly covers the ground From fifteen to twenty cords is not an unusual yield for birch land on the territory of this fire. Located where it can be hauled to market it commands a good stumpage price. On the other hand birch is not a long lived tree, and it seems probable that it will not on this tract hold its dominance or retain its quality for very many years longer. Similar in all respects with poplar. Neither of these trees is extensively found in virgin forest, for they do not readily start under its shade. On land where they form the dominant growth hardly a small specimen will be found In requiring plenty of sunlight for their early growth pine, birch and poplar are alike. They are therefore the characteristic species of burnt land.

Probably it will be hailed as a dangerous heresy, but it seems to me nevertheless true, that fire, from the money point of view, is not always a damage. To clear off a thin, culled over growth of deformed individuals and undesirable species to be replaced by purer growths of these quick growing species characteristic of burnt land, is sometimes the means of profit. Whenever in the future we come to the cultivation of trees, it is probable with these quick growing species that we shall begin. A forecast derived from the foregoing considerations is well worth statement. It is that as with increasing care for our forests fires are checked, our supplies of these woods will become smaller.

Two pieces of ground covered with mixed growth in which birch was predominant, were studied in the region mentioned, and the results reduced to the acre unit are here given. The relations of the different species in number and development vary considerably, but there is nothing to modify seriously the statements already made.

SUMMARY OF TREES ON AN ACRE OF LAND IN TOWNSHIP LONG A, PENOBSCOT COUNTY.

Land Burnt in 1825.

Species.	Number trees.	Average diameter —inches.	Estimated volume—cubic feet.	Number over 6 inches in diameter.
White birch	204	7.1	1,800	140
Cedar	692	*6.3	748	108
Spruce	100	3.0	112	20
Pine	32	6.1	228	16
Poplar	28	9.6	384	28
Maple	120	2.3	184	12
Fir	216	....	40	0
	1,392	....	3,496	224

* For 28 largest most much smaller.

SUMMARY OF TREES ON AN ACRE IN TOWNSHIP NUMBER 6, PISCATAQUIS COUNTY.

Land Burnt in 1825.

Species.	Number trees.	Average diameter —inches.	Estimated volume—cubic feet.	Number over 6 inches in diameter.
White birch	156	10.5	3,200	156
Yellow birch	84	3.0	88	8
Maple	212	5.8	360	16
Fir	508	5.0	96	8
Cedar	120	6.6	160	12
Pine	8	9.8	120	8
Beech	12	5.0	64	4
Poplar	4	11.0	80	4
Spruce	96	*	12	0
	1,200	....	4,180	216

* All under 3 inches diameter.

Any general conception of the proportion of growth of different kinds through this burnt tract would be very hard to arrive at. There is an infinite variety and mixture, and second-hand information as to anything but merchantable lumber is seldom available. Katahdin Iron Works and the board of towns east and west from Brownville have furnished and still possess large quantities of "latter pine." The townships below Long A have furnished largesupplies of poplar to the pulp mill at Great Works. The region about Shirley and Monson, in fact all the western part of the burnt district, is covered largely with poplar and birch. Much has been consumed for excelsior and spools, but very large amounts remain standing. Close about settlements all woods become of value and of more nearly equal value. The proportion of cedar on the burnt tract is probably much what it was in the original growth As to the little spruce that has been cut in the district, most of it doubtless, has been of trees that escaped the fire. Anything else must have been merely poles, or else very limby white spruce that grew up in openings. Black spruce however is there. In fifty years more it will come into use for saw logs, and thence forward, if nothing happens to it, will form a prominent portion of the output of the land.

In September 1894 opportunity was had to inquire into the condition of the timberlands on the Machias and Schoodic rivers in Washington county. Large amounts of long lumber were formerly shipped from this region. In recent years staves, laths and other small lumber, manufactured from small growth that has come up near tide water has formed a steadily increasing proportion of the output. The entire drainage of these rivers has been cut over, and the shrinkage in size and number of logs is due to a real encroachment on the source of their supply.

Inquiry into the history of the country develops the fact that fires have been largely responsible for this condition of things. Quantities of standing timber have at one time or another been destroyed outright, while most of the burnt tracts, covered with growth that is still young or of species that cannot under present conditions be utilized, brings no return to the owner. Neither stand nor growth is available to replenish diminishing supplies. The extent of the burns is surprising. On the Machias river a good half of the country has been burnt over. On the Schoodic river the proportion is nearly or quite as great. On the East Machias river a still larger portion, amouuting probably to three-fourths of the whole drainage of the river has at some time or other been burnt, perhaps half of it within the last thirty years. The cut of this river in spruce, fir, pine and hemlock is now about three millions, whereas it seems probable that had it not been for fires, the yearly growth might be twice that amount.

The most destructive single fire in Washington county occurred, according to my information, in the year 1827. Starting in the neighborhood of Chain lakes, in the town of Wesley, it burnt clean a broad belt through to the coast in Jonesboro, a distance of some twenty-five miles, which it travelled in two days. The bounds of this fire are now largely blotted out. Numerous fires have run over parts of its territory since. Large areas still remain as barrens. A comparatively small portion of it is covered with growth of full age. Except near the coast the only species that has been of value for lumber is pine Considerable areas are partly covered with this tree, generally arranged in a scattered, open growth Such trees, as has been elsewhere remarked, never will become first class lumber. Neither do they fully utilize the ground as would a thicker growth of the same species. Some areas of the latter character I believe are found on the tract, doubtless on better land than the average. Little or none of it has yet been cut.

Another great fire occurred a little over forty years ago on the East Machias river. Townships eighteen and nineteen were nearly all burnt, and a large portion of fourteen, Crawford and Cooper, a territory in all equal to about one-third the drainage of the river. On portions of this tract, personal inspection and study was made. The greater part of it, with some adjacent lands, were again burnt over about twenty-four years ago, so that all but little patches of the growth found on lands that escaped the latter conflagration, had grown up since that event. It was interesting to note the difference between trees of the two ages, and figures representing it will be found later on. Between the two fires this country was burnt very severely. Originally much of it was covered with the finest pine, only part of which had been cut previous to the fire. The stumps of these trees still resist the attacks of the weather, and what is remarkable about them, and shows that the fire was severe, they stand on top of, not in, the ground. Of this, rocks or the mineral soil formed the surface. Doubtless six inches to a foot of vegetable mold was consumed in the fires.

The loss of this deep, moist, porous bed of rotted wood and leaves is one of the main effects of a forest fire. In very dry land, or especially in a dry climate, the damage from this cause would be much greater than under ordinary conditions in Maine. Not only would it be made difficult for young sprouts and seedlings to get a start, but on account of the loss of protection from evaporation the dryness of the soil would have an effect upon the growth for many years. In our own State greatest damage from this cause occurs on rocky ground. Here frequently fires burn practically all the soil, so that the reliance of the trees for moisture and for mineral food is taken away. Probably all observing men are acquainted with tracts which illustrate this. Barren rocky ground where generation after generation of gray birch or other worthless growth springs up, rising to the height of a few feet and then dying down for lack of food and water. The general trend of these processes is worth pointing out. This is nature's way of reclaiming land for more valuable growth, and given time it will avail. The original growth of the country was the resultant of all natural forces operative upon it. Were fire and the influence of man eliminated, we must believe that the country would return in time to its primeval condition. The species would be the same, and their relations to one another would be the same.

After ordinary fires, the reforesting the ground is largely brought about, not by seeding, but by sprout growth of one kind or another. The stems only of the trees are killed. In some species the roots persist and the portion of the stem below the ground, so that from these after an ordinary light fire a circle of young suckers comes up. Such growth has a great advantage over seedling growth in the possession of a fully developed root system, and species which reproduce in this way, therefore have an advantage, other things being even, over others which grow only from seed. But a fire which burns up the vegetable soil kills also the roots of the tree and leaves no chance for such a process. Here seeding must take place, and the question of the succession is largely a question of available seed. Frequently the two methods of reforesting go on together. Then seedlings and sprouts of the same species may be seen in competition side by side.

This was the case with the white birches on the burnt tract on the East Machias river. However the country may have been re-covered after the first fire, on some portions of it the growth withstood the heat of the second. Frequently birches were seen standing in groups indicating their sprout origin, while frequently in the centre were the remains of the parent tree. Clumps of maples too, stood in the same way, and their arrangement was to be attributed to the same origin. Then among these grouped trees stood others single and erect These were taken to be seedlings, and a proof of the corrections of this determination was the difference in the number of rings shown in the butt of the two trees. Sprouts spring up rapidly. A fire of the middle of May, 1894, showed birch and maple sprouts already two to four feet high. Seedlings in such instances would be a year belated, while in developing their root system they would be put at further disadvantage. The seedlings on this twenty-four year old burn showed almost uniformly two less rings at the butt than the sprouts. As to size four to five inches by thirty to thirty-five feet was the maximum for the white birch sprouts. Gray birch and seedlings were distinctly smaller.

Traveling over a considerable area of this tract, showed a marked division of it as regards the most prominent species. Birch was decidedly the dominant tree of the tract, being mixed in all parts with more or less poplar; but the difference was this,—in one region the birch was the white birch, (B. papyrifera,) in the other the gray birch, (B. populifolia.) This fact, sharply defined as it was, and having a possible bearing on the future value of the land, is thoroughly illustrative and suggests a line of investigation that later on, as our forest resources come to be the object of more solicitude, will be developed. That is the seeding habits of our trees. Doubtless in this case the determining fact was neighborhood, proximity of seed trees of one or the other species. At other times the question is complicated by another matter, the question of which tree has seed at the particular time that it is required. Among certain species a year's start would make all the difference possible, determining frequently whether a valuable or worthless species should occupy the ground. These matters have various and practical bearings. It seems probable, for instance, that if the seedling habits of our trees were fully and generally understood, the periodicity and other habits, that due regard to them in clearing land might very much influence the character and consequently the value of the succeeding growth.

So much for the dominant growth on this burnt tract. If less conspicuous, yet no less important, is the undergrowth. For without waiting for the history to develop, a thorough knowledge of the elements that are there, and the nature of each of them, will enable the future of the land to be predicted. In the first place it is worthy of remark that very seldom are there on such a tract any young trees of the species which form the overgrowth. Birch and poplar spring up because sprouts or seeds are available, and they distance other species because in unobstructed sunlight they grow faster. On the other hand they will not start under a shade, and however much seed may be supplied, except in openings it is entirely unavailing. The species which do grow up in such a situation are largely those which constituted our original forests. Spruce and fir to a less degree, cedar and hemlock, and in open situations pine will generally be found coming up on any such piece of burnt ground. These trees are propagated by seed, and the extent and thickness of their distribution is measured by the volume of seed supply and the distance to which it may be distributed. Of all the means of distribution, and the limit of it in different cases, we are not yet informed, but any observer can testify that seeds of our coniferous trees travel many hundred yards in the wind. Of these species on burnt land, specimens would be found of all ages,—some that seeded immediately after the fire ran, others that have grown up as undergrowth since. The willow and cherry trees frequently found scattered through growth of this nature are often no doubt the remains of thicker sowings. These trees are sometimes thickly found on a new burn, but so far as my observation has gone they do not long hold the ground against the competition of other species.

In respect to the reproduction of different species after fire, it will be well to make the following general statements. Evergreen trees reproduce only by seed. Birches and maples after light fires send up freely sprouts around the stem. Poplar and beech carry over frequently by means of the root, which may send up shoots at a considerable distance from the parent stem. As to resisting fire, holding over unharmed in spite of scorching, pine, so far as noted, seems to be among the most hardy species.

The exact study of the yield of land of this kind has not been carried far enough to be made the basis of generalization. That it might be extended, and figures representing closely the average and aggregate production of burnt land be thus arrived at, cannot be disputed. The work of this nature already done is, however, well worthy of record. In respect to the species concerned it gives a close idea as to the maximum, in number of trees and in volume of wood, that may be produced. Not that the tracts examined had a specially deep or fertile soil—that is not needed for the production of the maximum crop of timber. The pieces of ground selected for study were rather rocky, with only a moderate amount of soil. They were uneven and well drained. The vegetable soil was only such as the trees now standing had produced.

Growth on quarter acre of land in Township No. 19, Washington county. Land burnt twenty-four years ago.

Species.	Number.	Number over 2 in. diam.
Gray birch	839	114
Poplar	119	43
White birch	3	3
Cherry	16	0
Willow	41	0
Maple	2	0
Hackmatack	2	0
Spruce	4	0
	1,026	160

Four thousand, one hundred and four trees per acre.

This quarter acre was covered very thickly indeed. Most of the trees were merely hoop poles. About four inches diameter by thirty feet high is the maximum size of the trees.

Summary of growth on one-quarter acre of land in Township No. 18, Washington county. Land burnt twenty-four years ago.

Species.	Number trees.	Volume (estimated.)
Whi e birch	534	325 cu. ft.
White maple	114	40
Others including yellow and gray birch, rock maple, willow, beech, cherry and cedar	58	15
	706	380

Multiplying by four gives number of trees per acre, 2,824; volume of growth, 1.520 cubic feet.

Another quarter acre of same description.

Species.	Number trees.	Estimated volume.
White birch	559	330 cu. ft.
White maple	77	30
Others including gray and yellow birch, poplar, cherry, willow and spruce	134	20
	770	380
Multiplied by four	3,080	1,520

These were picked quarter acres and show about the most that ground will produce of this species. The close agreement of the two pieces of land in number and volume of trees produced is from this point of view very interesting. The height of the grove in each case might be set at thirty feet, though, perhaps, a quarter of the trees would over run that height. Very few trees in such thick growth over ran four inches in diameter. The gray birches and maples were distinctly smaller.

An island of larger growth that by the grain of the trees was judged to be thirty-five years old, contained some clear and thick white birch growth in which an acre was staked out for study and comparison. Following is a summary of the growth upon it:

Species.	Number.	No. over 4 in. diam.	Volume, cu. ft. (estimated)
White birch	828	280	1,630
Gray birch	12	0	18
Yellow birch	288	2	85
Maple	212	31	175
Poplar	16	4	21
Fir	105	1	25
Spruce	50	0	15
Hemlock	82	0	5
Cedar	63	0	4
Beech	2	0	1
Pine	12	2	8
Total	1,670	320	1,987

Maximum development of white birch 8–9 inches diameter and somewhat over fifty feet high Three or four cords of spool wood might have been taken from this acre.

No other species approached in size the white birches The general surface of the grove was about forty feet from the ground, a height to which of the other species, only a few much crowded poplars and some of the maples attained.

Note further the effect of competition as seen in the number of trees. The younger areas were covered with about 2200 birch trees to the acre. The thirty-five year old growth had only 828, showing in comparison a very strong competition among the trees. Evidence of this was seen in the numerous dead stems while of those standing 100-150 were under three inches in diameter and evidently in process of extinction. This killing out of the smaller trees partially neutralizes the growth per acre.

The value of the observations which have been gathered in this paper rests on the fact that for large areas of land they are typical. It will be well, therefore, to sum up briefly the general conclusions arrived at. These might be stated as follows :—

1. Gray and white birch, poplar and pine may be called the characteristic species of burnt land By this is meant that by reason of their sprouting and seeding habits and from the fact that they start rapidly in unobstructed sunlight these species are apt to take possession of such lands and become the dominant growth. On the other hand they seldom occur as undergrowth, and will not start in a dense shade.

2. Starting up in this way these species are quite frequently in pure or nearly pure growths—which fact renders their product easier to market and of more value.

3. Spruce, fir, hemlock and other species characteristic of our old-growth forests, even though sown with the before-mentioned species, are generally distanced in competition. They remain as undergrowth however, and some of them, being long-lived and hardy, will generally outlast the other species. Then since they propagate freely in a shade, they retain possession of the ground. How long it will take to replace the earlier growth depends on the species. Probably one hundred years is old age for our birch and poplar, so that by that time they will considerably give way. Pine on the other hand lives to be several hundred years of age, and if uncut will long maintain a dominant position on the ground.

As to the age after fire at which trees may be cut, the following statements will prove in general approximately true.

Birch and poplar groves at thirty years of age have some trees that may be utilized. A large crop might be reaped at fifty years of age. At seventy to eighty such growth begins to go back in quality.

Pine standing in open growth may be utilized for saw logs in forty to fifty years. Close to market it might even furnish box boards profitably at thirty years of age. All such lumber, however, is coarse and rough. Good quality timber is only to be grown in thick growths, and it will take at least seventy or eighty years to produce it.

White spruce growing up in very favorable situations approaches the growth of pine. In general, however, and in the case of black spruce a valuable crop of saw logs need not be expected under 150 years at least. Hemlock would doubtless take much longer to come to large size.

Without an exploration of the whole State a certain prediction can hardly be made; but it certainly seems probable that as our forests are better cared for and fires more thoroughly checked, birch and poplar wood, if uses for them continue, will be in demand and of more value. As to our future supply of pine this investigation gives considerable light. It is to come not from the great unbroken forests of the State, the permanent forest areas that escape fires and close cutting. It is to be looked for rather from the confines of civilization, from farm lands and the nearer timber lands, where on burnt, cleared or abandoned areas the conditions of its growth are supplied.

FOREST MANAGEMENT AND REFORESTING.

Reprinted from the Report of the New Hampshire Forest Commission for 1885.

In this country the attempts at forest culture, and the planting of waste lands, have been so few that there are no examples for the people generally to imitate. Our ragged forests are said to present the most marked contrast possible to those of Europe, where many years of careful working have produced woods containing trees of uniform height, evenly distributed over the ground. The trees there are usually planted, or the seeds sown thickly and then thinned at stated periods, so as to produce a tall trunk with few branches. The product of the various thinnings pays a handsome profit above the expense of the care and work. With us, the winds, birds and squirrels are the chief tree-planters. In some cases they do their work effectually, but on the highest and most exposed lands sparse seeding results in a scrubby, heavy-branched growth, fit for little except fuel.

The common custom of allowing cattle to run into young woodlands is almost as injurious as to allow them to be overrun by fire. They destroy the greater part of the seedlings, and browse the young trees so as to greatly injure them for making good timber.

It is the European practice, in order to quickly re-seed a forest, so that it will take the place of one cut off on the same ground, to first remove a portion of the trees—say one half or three-fourths. The remainder being thus opened out to light and air, will, in the course of two or three years, seed very freely; and the underbrush and dead branches having been removed, the young seedlings spring up thickly and evenly over the whole ground. The large trees are then carefully removed, and the young forest comes forward very rapidly.

This method could be adopted with great advantage in the working of New Hampshire forests, for it would give an even young growth, without vacancies, in far less time than the usual method of cutting clean and leaving the brush upon the ground to smother the seedlings, and liable to fire.

Hill-tops, steep valley sides, and thin, ledgy places, should never be cleared entirely The better way would be to remove the largest trees only, leaving the smaller ones to come forward and take their places, never exposing the soil to the washing of the rains and the drying influences of the sun and winds.

REFORESTING WASTE LANDS.

There are only a few ways of reforesting the waste lands of the State. First, by allowing nature to do the work of sowing the seeds of indigenous species in her own way; second, by planting or sowing the seeds of the most valuable species and varieties, where they are to grow and mature; third, by transplanting small trees from the forest, directly to tracts to be re-stocked; fourth, by growing seedlings under glass, or in prepared beds out of doors, and transplanting when of suitable age and size; or, fifth, by purchasing seedlings grown in the manner last named, and re-stocking all waste places at once.

Much may be accomplished in any one of the ways named. It may be well to consider for a moment some of the advantages and difficulties attending each method.

Where seeds are sown by the winds, and by birds, squirrels, and other small animals, we are not sure of an even distribution. The light seeds are blown into thick undergrowth, or under fences, where they form hedge-rows, while most of the land remains open and unoccupied for years. This method, therefore, is slow and unsatisfactory.

Some have been successful in planting trees where they are to grow, and claim that this practice is the most simple, certain, and inexpensive. There is no doubt but the oaks, hickories, walnuts, and chestnuts may be successfully planted by simply opening furrows with a plow, dropping the seed, and covering, as the farmer covers his potatoes. When the land is so rough as to preclude the use of a plow, a grubbing-hoe may be substituted. Planted in this way, the maples, ashes, and other small-seeded species will in many instances fail, and, as a rule, the conifers will fail entirely.

There is great danger that nuts and acorns will be appropriated by squirrels, and that mice, birds, and insects may destroy the smaller seeds. It would be well to make a liberal allowance for contingencies where this practice is adopted.

The third method,—transplating trees from the forest—is practicable, and may sometimes be advisable, but it is more expensive, and attended with some difficulties. Small trees of the most desirable varieties are not often to be found in sufficient numbers for the purpose, and if found, could only be procured by purchase. It should be borne in mind that there is much more risk and labor in transplanting from the forest, than from the seed-bed or nursery row.

As to starting seeds in boxes under glass, though possibly the best method, few have the facilities for so doing, and it is not likely to be extensively practiced. It has several advantages,—namely, the temperature and humidity of a glass structure are under complete control at all times, the seeds are exempt from the depredations of animals and insects, and, as they are sown in autumn, can be kept growing all winter, so that the trees will be ready to plant out in spring before those sown out doors have germinated. These seedlings escape the sudden and extreme changes peculiar to our climate, so destructive to young plants, especially of the conifers. In this way not a root is destroyed in transplanting, but every fiber is preserved intact. At the end of five years trees thus grown will have attained a much larger size than by any other method But most seedlings will be grown in the open air, and we may well consider how this can best be done.

With the nuts and acorns, there need be no failures if the seeds have been properly wintered, kept from becoming dry and exposed to frost. They may be planted in drills, with as little danger of failure as sets of a potato. Select land free from rocks, to avoid hard work in digging. Make the soil mellow and fertile, to ensure a strong and upright growth. Avoid land that is liable to be washed or flooded with water, in case of heavy rains. Plant in rows wide enough for a cultivator to pass, and place the seeds three or four inches apart in the drills, and two inches deep. Give clean cultivation.

Some take up the seedlings in the fall, and "heel them in," to prevent their being thrown out by frosts, but this is not necessary if the land is well-drained, sandy loam. Take up the trees in spring, grade them as to size, cut back their tap-roots, and reset, giving greater distance in the rows. If any are ill-formed, cut back to a bud near the ground, and this will send up a straight shoot.

There is little danger of transplanting too often, but it is not best to do so every year. The effect is the production of numerous fibrous roots, and thus renders the work of final planting out perfectly safe. It is almost impossible to transplant the nut bearing and evergreen trees directly from the forest with success, owing to their lack of fibrous roots. It can only be done when the trees are small, so that the whole system of roots can be removed, with sod or soil attached. After being two or three times transplanted in the nursery, they may be as safely moved as a willow.

SELECTION OF SOIL.

Many species usually found only in low swamps can be successfully propagated and grown in high and dry situations. Our native spruces (Picea nigra, Picea alba, and Abies balsamea), larch (Larix Americana), and cedars, will flourish equally well and make a more rapid growth on elevated land, even though it may be light, and wanting in fertility

While I would not select, as best for the purpose, a thin, starving soil, I should not hesitate to plant trees, especially evergreens, upon almost any of our sandy plains. The white pine (Pinus strobus) and hemlock spruce (Tsuga Canadensis) would doubtless attain greater size eventually on stronger soil; yet it is a matter of common observation, that they make a rapid growth, and seem perfectly at home on gravelly plains and ridges, so poor as to be worthless for any other purpose. For evergreen, a mellow surface, with a somewhat porous sub-soil of sand or gravel will ensure a vigorous, healthy growth Such tracts have the additional advantage of being more easily stocked with seedlings than any other. The thick seeding that often occurs on the windward side of a pine growth, without the aid of cultivation, must have attracted the notice of the most casual observer. This should serve as a hint to every owner of such waste land, as it shows how easily it may be covered with a valuable forest. It is only necessary to sow the seed broadcast, and cover lightly with a smoothing harrow, to ensure gemination These natural nurseries often contain, on a small area, seedlings enough, if transplanted at proper distances, to cover tracts of several acres.

NATURAL SEEDING.

The spruces and larches, native and foreign, scatter their seeds without our aid, and these spring up in pastures and wild lands generally. A few trees of the Norway spruce (Picea excelsa), of the black spruce (P. nigra), and European larch, set in the grounds of the writer, when small, thirty years ago, have attained a diameter of eighteen inches, and are seeding a neighbor's pasture and wood-lot in all directions. If not dug up for ornamental planting, they would soon cover the ground with a beautiful forest. These seeds mature annually, and are carried by the winds, so that the young trees may be found at a distance of a hundred rods. The seeds of the pine, arbor-vitæ (Thuja accidentalis), elm (Ulmus Americana), maples, ashes, and birches are sown in the same way, only a small percentage of which ever germinate.

Other trees produce seeds too heavy to be widely scattered in this way, and are dependent on the agency of birds and small animals for their dissemination. Among these are the oaks, hickory, walnut, cherry and beech.

The hedge-rows by the sides of fences are the result of seeds dropped by birds, and secreted by squirrels for winter food. It is not uncommon to see the ground under hickories in the forest thickly set with young trees, the nuts having fallen and been covered by leaves. They have been placed in just the condition best suited to their preservation, germination and growth. The much of leaves has prevented drying, the shells have been opened by frost, and the young plants have been screened from the hot sun and drying winds—all conditions most essential to success in growing seedlings of nut bearing trees.

Old lumbermen tell us that white pine (Pinus strobus) is the most rapid and profitable growth among all our forest trees, and it is certain that it is the one most easily propagated.

The pitch pine (Pinus rigida) and red pine (Pinus resinosa) will flourish on even poorer soil, if possible, than the white pine. The pitch pine plains are among the poorest soil of our State, yet they seem well suited to the growth of the different species of pine. They will grow in the most barren drift, and on the moraines and knolls composed of coarse gravel and rocks, from which nearly every vestige of clay, loam, and vegetable matter have been washed in past ages.

There are thousands of acres of pitch pine now growing in the pure sea sand of Cape Cod, the seed having been sown in furrows six or eight feet apart. A large amount of fuel is obtained by thinning, as the trees increase in size and become too thick to admit of full development. The planter is thus early getting a return for the trifling expense of seed and sowing, with a prospect of reaping a more valuable harvest of lumber in the future.

PREPARING A SEED-BED.

The seeds of the conifers are small, and should be sown in drills a foot apart, and be covered from one-fourth to one-half an inch deep, and the soil over them should be made quite firm. A plot where no water will stand on or near the surface, and still not liable to be washed by heavy rains, must be selected. A sandy loam, with a mixture of well decomposed muck, leaf mold, or peat, with a little of old manure added, and the whole worked firm, will be favorable for the germination of seeds and the growth of the plants.

The common cold frame used by market gardeners—six feet wide, and as long as may be desired—will be found convenient, and all that is needed to give protection in winter or summer. When the seeds are sown in autumn, sash or shutters are to be placed over the frames and tilted when the weather is warm, so as to give air, and avoid too great an accumulation of heat.

As spring approaches, the seeds will germinate, and the young seedlings begin to push above the ground. They will require watching daily, to prevent their becoming dry, or burning by too high a temperature. Light watering must be given from time to time, so as to preserve a humid air inside of the frame. Shading the beds by lath screens, as elsewhere suggested, is always safe until the plants have become well established.

Mr. Meehan, editor of the *Gardiner's Monthly*, recommends the following method: "A common board frame is placed over a carefully prepared bed of light mold, and covered with shaded hot-bed sash. Under each corner of the frame is placed a prop, raising the bottom about three inches above the surface of the ground. The advantages of this contrivance will be appreciated, when we consider that the most essential conditions, in raising evergreen seedlings, are to obtain a moist atmosphere, protection from the direct rays of the sun, and at the same time a free circulation of air through the plants."

SOWING SEEDS OF EVERGREENS.

Seeds of the red cedar (Juniperus Virginiana), and a few others, should be mixed with sand, and allowed to freeze during winter; but the pines, spruces, etc, may be sown early in spring, in cold frames, secure from heavy frosts. If not sown before April, it is hard to get them through the summer. The first three months is the critical time with such seedlings. These seeds are sometimes sown late in autumn, but many of the most successful propagators prefer the early spring.

Too thick seeding is to be avoided, as the tender plants are more likely to damp off or draw up, when shorter and more stocky seedlings are desirable. The native evergreens are not tender, and the young plants are more likely to be injured by heat and drouth, than by cold. For this reason the bed or frame containing seedlings should be located on the shady side of some fence, building, or hedge, secure from the direct rays of the sun, and from drying winds. Partial shade may be secured by a screen made of laths, nailed one inch and a half apart, or by evergreen boughs, during the hottest part of the summer, to be removed as the cooler weather approaches, and the plants acquire age and size. At no time should the tender seedlings become dry, as drouth, followed by copious watering, is fatal.

To prevent the seed-bed from becoming dry, mulching with sphagnum, chaff, sawdust, or pine leaves, will preserve a more uniform degree of humidity than can be secured by the frequent application of water. If, however, watering becomes necessary, which will not often occur when mulching is practised, it must not be neglected. The directions here given are intended as a guide only to those wishing to grow the hardy evergreens, and do not apply to tropical species, which would require different treatment.

Seeds should be sown in rows running across the beds, one foot apart, with paths between the beds at least two feet wide.

HOW TO OBTAIN SEEDS.

There will be no trouble in obtaining seeds of the oaks, walnut, hickory, beech, and chestnut, but of some other species they are not equally accessible. The elm and maples sometimes ripen their seeds in such profusion as to cover the ground. How best to secure them is a conundrum that we leave others to solve. There is the same difficulty in obtaining seeds of evergreens, as they shed their seeds in the fall, as soon as the frost lifts the scales of their cones. If the cones could be gathered before being opened by frost, they would give us an abundant supply of seeds; but unfortunately they are beyond our reach. Seeds of the pines can sometimes be obtained when timber is being cut in the nick of time.

We have often seen the ground so covered with the pill-like seeds of the European linden, that, if sugar coated, the dealer in patent medicine might make them available in his business. Fortunately there are persons who know how to secure all the different seeds required, and there are dealers who make a specialty of supplying them in large or small quantities. Forest-tree seeds can be ordered of almost any seedsman, who will furnish them, if not in stock, with very little delay, and at reasonable prices. There is always more or less uncertainty about their quality, as there is no general demand for them, and they are liable to become so venerable with age as to lose their vitality.

The best time for gathering all seeds of forest trees is as soon as they are ripe, and unless they are planted at once they must be carefully preserved. There is no better way in which to keep the seeds of conifers than in the package nature has provided for them. Some of the small seeds may be kept in the ordinary seed-bags of cloth or paper, and, if stored in a cool, dry place, they will retain their vitality for several months, possibly for years.

But dried seeds start slowly; many never grow, and others remain in the ground one, two, and even three years before germination. For this reason it is better to mix seeds with damp—not wet—sand as soon as gathered, especially if the sowing is to be deferred till spring. They may be put in boxes having holes in the bottom to ensure drainage, and the whole buried in the ground during winter. The seeds may be separated from the sand in spring by screening, or they may be sown together in shallow drills, as elsewhere directed.

The large seeds, such as the hickory and the oak, must never become dry, neither should they be kept wet and warm. They require exposure to frost, which opens their shells and allows the germ and radicle to escape at the proper season.

Spreading nuts and pits upon the ground as soon as gathered, and covering lightly with sand or with boards to prevent the depredations of squirrels, will carry them through the winter in a perfect condition The shells, having been kept moist and acted upon by frost, will be found so loose as to be easily removed with the fingers; but if any are still inclined to adhere, a slight tap with a hammer will be required.

The seeds of the chestnut, beech, and some others, are covered by a thin and not very hard shell; and if the nuts are planted where they are to grow, or in nursery rows, before becoming dry, will germinate with no further trouble.

SOME CAUSES OF FAILURES.

One cause of failure with all seeds arises from too deep planting. As a rule, they should not be covered to a depth greater than twice their diameter. If the soil is loose, the planting may be deeper than where more compact. It is never safe to plant seeds in wet or very heavy soil. All seed beds must be well drained.

It will be seen that when the seeds are small the covering must be very shallow; if too deep, they germinate and decay. Make the covering over the seeds firm, and mulch lightly to prevent evaporation and drying. If a seed swells and again becomes dry, it receives a shock from which it is not likely to recover. Remove the mulch from directly over the plants as soon as they appear above the surface.

The seeds of conifers germinate readily, but the plants are exceedingly liable to be lost by unfavorable conditions before the formation of their true seed leaves. It is at this point that experiments in growing evergreen seedlings are most likely to fail. When the plant has so far advanced that the true leaves have become well developed, and the radicle is able to furnish the required nourishment, less care will be required.

As elsewhere stated there are a few species of deciduous trees that mature their seeds in spring or early summer. The seeds of all such, may and should, be sown at once. They will germinate in a short time; and if properly shaded, watered, and otherwise attended to, will make a good growth by fall. When such seeds are simply sown by the wind, probably not one in a thousand ever germinate, and of these only occasionally one survives, owing to our hot sun and drying winds.

Many seeds will fail from lack of vitality They may germinate, but never grow. The vitality of seeds will continue for only so long a time as the various substances of which they are composed remain unchanged. Many seeds contain a large percentage of oil, that, under certain conditions, soon becomes rancid, and destroys their vitality. The same effect is produced by undue moisture and heat. When a seed absorbs moisture, oxygen is also absorbed, the starch and other substances are decomposed, and if heat is present, germination commences. Small seeds that are to be transported long distances, by mail or otherwise, should be dry, and so packed as to exclude moisture. Before planting, soak the seeds in tepid water for two days, or until they have become swollen If seeds of the maple are kept dry through the winter, but few of them will germinate before the second year.

Mr. Jackson Dawson, of the Arnold Arboretum, says: "In sowing in the fall, begin with the oak, chestnut, hickory, and beech nuts, which do not retain their vitality long, and must be either planted, or put in boxes of earth as soon as practicable. The maples, with the exception of the white and the red, which ripen their seed in June, should be sown as soon as possible after gathering. The ash must also be sown at once. The hornbeam and hop-hornbeam will not come up until the second year, unless sown in the autumn. The tupelo, flowering dog-wood, shadbush, nettle tree, viburnums, and thorns, seldom come up till the second year. The plum, peach, apple, and pear never come up evenly the first year unless the seed has frozen or kept in boxes of moist earth. The tulip-tree invariably takes two years. The ailantus, catalpa, mulberries, button-ball, birches, and alders, are best sown in spring. The white and scarlet maples, the elms, and the red or river birches, ripen their seed early in summer, and should be sown in freshly prepared beds as soon as gathered."

PURCHASING SEEDLINGS.

There may be some who will distrust their ability to grow the more delicate seedlings successfully. For the benefit of such, it may be stated that small trees may be purchased at a very low price. There are parties at the West who, having the requisite facilities and skill, make the growing of evergreen and forest-tree seedlings a specialty. They supply them at what would seem to be merely a nominal price, and there are dealers much nearer who would furnish them cheaper than they can be grown by a novice. In a catalogue before me, trees from six to twelve inches high are invoiced at $3.00 per thousand.

It will require but 544 trees to cover an acre when set eight by ten feet apart, at an expense, with purchased seedlings, of $1.63. To this should be added packing and freight; but even then it may be thought advisable to purchase seedlings rather than to purchase and sow the seeds.

HOW TO TRANSPLANT.

In transplanting, whether from the seed bed nursery row, or from the forest, great care must be exercised in taking up the tree. To be transplanted in the best manner practicable, a tree should be moved with its system of roots entire and uninjured. This can seldom or never be done when the trees are large, while with small seedlings the process is perfectly feasible. For this reason, it is advisable to transplant seedlings to the place they are to occupy when from one to three feet high.

Always use a sharp spade that as few roots may be injured as possible. Let two persons work together, on opposite sides, and the tree be carefully lifted rather than pulled from the ground by force. If soil adheres, all the better. Let the roots be at once protected from the sun and wind by hay-caps, rugs, or old sacks, and the trees taken as soon as may be to the spot they are to occupy. Trim the injured roots, if any, and prune the top if pruning is required. Deciduous trees may be greatly improved by a judicious use of the knife. The holes must be so large as not to cramp the roots, and of such a depth that the crown of the roots, when the tree is planted, will be even with the surface of the ground. Spread the roots in all directions, like the spokes in a wheel; fill fine dirt under, around, and over the roots, and make the ground compact by pressure with the foot. The use of water is seldom required, and then only to moisten the roots so that dirt will adhere. Mulch in time of drouth.

When the land to be planted will admit, the ground should be plowed in the fall previous, and harrowed and furrowed in spring with broad furrows at suitable distances for rows. This will aid very much in the labor of transplanting. Seeds of the white birch may be sown between the rows, and they will arrive at maturity and may be cut before pine will be of suitable size.

WHAT TREES TO GROW.

This question should be well considered before the work is commenced. In the first place it will be well to confine ourselves mainly to a selection from native species. Foreign trees, though they seem to be hardy, do not continue to flourish for many years in this climate, not even when petted as ornamental trees. In making a list they had better be omitted, with few exceptions.

Select trees of rapid growth that make valuable lumber. The white, or Weymouth pine stands at the head of the list. The red pine (Pinus resinosa) is not only a valuable, but also a beautiful tree. It will succeed on, and in fact prefers, a dry, sandy soil. It is everywhere hardy, and makes a quicker and straighter growth than the pitch pine (P. rigida). All of the pines will grow on a a poor soil, but the two first named are best for timber.

Among the different trees suited to our soil and climate, the pines, hemlock, larch, spruces, hickory, walnut, chestnut, oak, beeches, birches, linden, ashes, and maples, will be found the most profitable for the purpose under consideration.

It seems hardly necessary to suggest that the species and varieties to be planted should be adapted somewhat to the soil and situation they are to occupy. The young man who should plant the oak, hickory, or cedar, on a dry, barren plain, would hardly live long enough to reap a harvest of timber. The same tract planted with the pines, larch, or white birch, would be fit to cut in thirty years. There are some trees, such as the willows, that flourish on the borders of streams and on land too wet for growing the most valuable lumber. The cedar, larch, spruce, and arbor-vitæ will all grow on swampy ground, but the growth will be slow.

THE TIME TO TRANSPLANT.

The best season for transplanting all trees in this latitude is early in the spring, as soon as the ground has become warm and friable, and just as the buds begin to swell. The habit of the different species should be watched, and it will serve as our best guide. Some few commence their growth almost before the frost leaves the ground, while others sleep till June. As a rule deciduous trees require transplanting earlier than the evergreens, the buds of which seldom push before the last of May.

All hardy deciduous trees may be safely moved in autumn, and this season has the advantage of affording more leisure for per-forming the work with care. When the fall is chosen, let it be as early as possible,—as soon as the leaves drop. If all bruised and broken roots are smoothly cut back to sound wood, the wounds will callous over, and new roots push before the ground freezes. Such trees, if not injured by extreme cold, will start early, and make a much stronger growth the following year.

TRANSPLANTING EVERGREENS.

The work of transplanting evergreens had better be deferred till spring. Instances occur where they are successfully moved in autumn, but it is hardly advisable to try the experiment. They may be transplanted later than other species, as they remain dormant till about the first of June. When the sap moves they push rapidly and make their entire growth in a few weeks, after which they do little more than ripen the wood already formed. Were it not for long months of exposure to our drying winter winds, during which time no roots are formed to supply moisture, the fall would be the preferable season for transplanting them. When the trees have been repeatedly moved in the nursery, so as to form a perfect mass of fibrous roots, they may be transplanted at almost any time. In this case the whole system of roots, with soil attached, is simply transferred from one spot to another, and the tree receives no shock.

Many thousands of small evergreens are annually shipped from Maine, taken directly from the pastures, that are thickly seeded with them, and are sent to all parts of the country, mostly to nurserymen. They are thickly planted in rows, in some half shady place, and grown till they are in condition to sell. These trees usually cost four or five dollars a thousand. Many die the first year, but when well established they may be handled with little or no risk.

PRUNING AND THINNING.

Evergreens require little or no pruning, as they naturally take the most desirable form. It is only when they are to be trained as specimen trees that the nurseryman uses the knife or shears. Young forest trees of any kind are likely to get very little pruning. Yet the labor is less than many might suppose, and it would be poor economy to entirely neglect it.

In stocking a tract of land with trees, I would set ten times as many as could grow to full size, and thin out as it might become necessary. The trees cut out from time to time would amply repay for the labor. If evergreens are set at too great a distance, their lower branches will remain green and spread widely in all directions, giving a heavy growth wood, but timber of little value. If set ten feet apart each way, 435 trees will be required for an acre, while if set five by five feet, it will take 1,742 for an acre. By crowding the trees when young, they will take a more upright form, and give in the end a more valuable growth. Where trees such as the European larch, sugar maple, Norway spruce, or linden, are grown, an income may be derived by setting thick, and thinning to meet demands for ornamental planting. One tree to the square rod, when one foot in diameter, will make a heavy growth, but it would be absurd to set only 160 seedlings on an acre. Better plant thickly and transplant to other tracts, or cut out, as occasion may require.

Trees will make but a slow growth on land where the sod is unbroken, and thick planting on such land will soon completely shade the ground and kill the grass, ferns, and the like, so as to have the land loose and mellow. Trees thickly planted afford a mutual protection to each other against the summer sun and winter blasts, and the annual leaf harvest that they shed excludes frost from the roots, enriches the soil, and promotes a vigorous growth.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF FORESTRY.

Name of collector: Austin Cary. Species: Picea nigra.

STATION (denoted by capital letter):

State: Maine. County: Piscataquis: Town: 1, R. XIV.

Longitude: 69° 30'. Latitude: 45° 40'. Average altitude: Say 1,400 feet.

General configuration: Plain—hills—*plateau*—mountainous. General trend of valleys or hills: Drains south by Dead stream.

Climatic features: Cold winter, short summer; mean annual temperature, 42.47'; mean annual rainfall, 45.44 inches for Orono.

SITE (denoted by small letter): e.

Aspect: Level—ravine—cove—bench—*slope* (angle approximately: 7°.)

Exposure: West. Elevation (above average station altitude): 1,500 feet above the sea.

Soil conditions:

(1) Geological formation if known): ....

(2) Mineral composition: Clay—limestone—*loam*—marl—sandy loam—loamy sand—sand—gravelly.

(3) Surface cover: Bare—grassy—*mossy*. Leafy cover: Abundant—moderate—*scanty*—lacking.

(4) Depth of vegetable mold (humus): Absent—*moderate*—plenty —or give depth in inches: ....

(5) Grain, mechanical conditions, and admixtures: Very fine—*fine*—medium—coarse—porous—light—loose—*moderately loose*—compact—binding—stone or rock, size of: Some egg and smaller, few large.

(6) Moisture conditions: Wet—*moist*—fresh—dry—arid—*well drained*—liable to overflow—swampy—near steam or spring or other kind of water supply........................

(7) Color: Brown or red.

(8) Depth to subsoil (if known): Shallow, 6 inches to 1 foot)—*deep*, (1 foot to 4 feet)—very deep, (over 4 feet)—shifting.

(9) Nature of subsoil (if ascertainable): ....

Forest conditions: *Mixed timber*—pure—dense growth—*moderately dense*—open.

Associated species: See schedule of acre.

Proportions of these: See schedule of acre.

Average height: 60–70 feet for overgrowth.

Undergrowth: *Dense*—*scanty*—kind: Varies; in openings plenty.

Conditions in the open: Field—pasture—lawn—clearning (how long cleared): ....

Nature of soil cover (if any): Weeds—brush—sod.

NOTE.—As much as possible make description by underscoring terms used above. Add other descriptive terms if necessary.

Sample of report on timber trees as rendered United States Division of Forestry from this State and elsewhere.

BIOLOGICAL INVESTIGATIONS.

INSTRUCTIONS.

Upper parts of sheet contain all measurements and counts made in the forest (columns a to n).

Number trees measured in the same camp and conditions consecutively; underscore, whether standing free or crowded, or note briefly other conditions of position and give surrounfiing species. Use 4-foot rule and gauge. In all cases if possible take two measurements of diameter at right angles and note average.

(*a*) Take diameter about 4½ feet from ground (breast high) or from root collar if soil has sunk away.

(*b*) Timber: from butt to first limb of crown.

(*d*) From first crown-forming limb to top.

(*e*) Found by cutting leader off and back until only five rings can be counted.

(*f*) Height: taken from ground or collar. Age: supposed number of years for the young tree to have attained height of stump (three to ten years, according to height of stump).

(*h*) Sections are numbered beginning with butt section.

(*l*) Count along a rule laid across the heart of the cut, beginning from outer circle; note number of rings at each inch. If radii are of different lengths, as is often the case, then find the average radius to count on.

(*m*) Measure diameter with gauge and the wood with rule: difference will give double thickness of bark.

(*n*) Measure diameters with gauge at distances from butt-end as indicated in column.

Age of tree is found by adding columns *f* and *g*. Total height, found by adding columns *f*, *b*, and *d*.

(*o*) Age found by deducting each count in *k* from age of tree. Heights, by adding to height in (*f*) lengths in *h*, consecutively.

(*p*) Found from graphic chart by interpolation.

Millimeters.	Inch.
2	= 0.1
3	
4	
5	= 0.2
6	
7	= 0.3
8	
9	
10	= 0.4
11	
12	= 0.5
13	

Detail of Sections—Measures in Millimeters.

Section.	Distance from Bark through Ring. 10.	20.	30.	40.	50.	60.	70.	80.	90.	100.	Sapwood. Number rings.	Thick-ness.	Bark—thickness.
1	13	25	35	49	66	83	103	111	122	......	30	35	7
2	9	18	29	44	61	80	......	......	......	......	25	25	4
3	8	18	29	......	......	......	.. ...	......	......	......	21	20	2

TREE No. ONE.

POSITION: PARTLY FREE.

a Diameter breast high. in.	*b* Length of timber. ft.	in.	*c* Diameter below crown. in.	*d* Length of crown. ft.	in.	*e* Length of leader for last five years. in.	Stump. Height. in.	*f* Diameter at top. in.	Age. yrs.	*g* No. of rings on stump.	Sections. Number.	*h* Length. ft.	in.	*i* Diameter at top. in.	*k* Number rings at top.	*l* Number rings for every inch on radius.	*m* Thickness of bark at top.
15	25		11.3	35	6	23	22	15.8	16	159	1	27	6	10.5	94		
											2	12	6	7.0	64		
											3	12	0	3.0	36		
											4						
											5						

n Diameter at 4 feet, 14.4 inches.
" 8 " 13.3 "
" 12 " 12.8 "
" 16 " 12 "
" 20 " 11.3 "
" 24 " 11.3 "
" 28 " 11 "
" 32 " 9.8 "
" 36 " 8.6 "
" 40 " 7.5 "
" 44 " 6.1 "
" 48 " 4.8 "
" 52 " 3.4 "
" 56 " 1.5 "
" 60 "
" 64 "

o Height. Age of tree. Years.	From the ground. ft.	in.
81	29	4
111	41	10
139	53	10
175	62	4

p Height. ft.	in.	
		In the 10th year.
2		" 20th "
		" 30th "
10		" 40th "
		" 50th "
19		" 60th "
		" 70th "
29		" 80th "
		" 90th "
37	3	" 100th "
45	6	" 120th "
49	9	" 130th "
54		" 140th "

AGE OF TREE, 175 YEARS. TOTAL HEIGHT, 62 FEET, 4 INCHES.

Detail of Sections. Measures in Millimeters.

Section.	Distance from Bark through Ring.										Sapwood.		Bark—thickness.
	10.	20.	30.	40.	50.	60.	70.	80.	90.	100.	Rings.	Thick-ness.	
1	9	20	32	49	67	85	107	......	......	......	24	24	6
2	9	22	38	64	......	......	......	......	......	......	23	26	6
3	9	22	......	......	......	......	......	......	......	......	18	17	4

TREE No. TWO.

POSITION: PARTLY FREE.

a Diameter breast high.	*b* Length of timber.		*c* Diameter below crown.	*d* Length of crown.		*e* Length of leader for last five years.	Stump. Height.	Stump. *f* Diameter at top.	Stump. Age.	Stump. *g* No. of rings on stump.	Sections. Number.	Sections. *h* Length.		Sections. *i* Diameter at top.	Sections. *k* Number rings at top.	Sections. *l* Number rings for every inch on radius.	Sections. *m* Thickness of bark at top.
in.	ft.	in.	in.	ft.	in.	in.	in.	in.	yrs.			ft.	in.	in.			
13	32		9.4	30	8	18	20	14.8	14	148	1	30		8.9	75		
											2	14	6	6.2	45		
											3	11	6	2.8	27		
											4						
											5						

n Diameter at 4 feet, 12.5 inches.
" 8 " 12.1 "
" 12 " 11.5 "
" 16 " 11.2 "
" 20 " 10.5 "
" 24 " 10.1 "
" 28 " 9.9 "
" 32 " 9.4 "
" 36 " 8.8 "
" 40 " 8.4 "
" 44 " 7.1 "
" 48 " 6.0 "
" 52 " 4.4 "
" 56 " 3.0 "
" 60 " 1.5 "
" 64 "

o Height. Age of tree. Years.	*o* Height. From the ground. ft.	in.
87	31	8
117	46	2
135	57	8
162	64	4

p Height. ft.	in.	
		In the 10th year.
2		" 20th "
		" 30th "
9		" 40th "
		" 50th "
18		" 60th "
		" 70th "
28		" 80th "
33		" 90th "
38		" 100th "
48		" 120th "
54	8	" 130th "
59		" 140th "

AGE OF TREE, 162 YEARS. TOTAL HEIGHT, 64 FEET, 4 INCHES.

Detail of Sections. Measures in Millimeters.

Section.	Distance from Bark through Ring. 10.	20.	30.	40.	50.	60.	70.	80.	90.	100.	Sapwood. Rings.	Sapwood. Thickness.	Bark—thickness.
1	12	22	30	42	67	......	......	......	......	......	24	25	7
2	10	23	35	53	......	......	......	......	......	......	21	24	6

TREE No. THREE.

POSITION: PARTLY FREE.

a Diameter breast high. in.	*b* Length of timber. ft.	*b* in.	*c* Diameter below crown. in.	*d* Length of crown. ft.	*d* in.	*e* Length of leader for last five years. in.	Stump. Height. in.	Stump. *f* Diameter at top. in.	Stump. Age. yrs.	Stump. *g* No. of rings on stump.	Sections. Number.	Sections. *h* Length. ft.	Sections. *h* in.	Sections. *i* Diameter at top. in.	Sections. *k* Number rings at top.	Sections. *l* Number rings for every inch on radius.	Sections. *m* Thickness of bark at top.
12.5	25		10	34		30	30	13	20	205	1	29	2	8	59		
											2	11	10	5.5	46		
											3						
											4						
											5						

n Diameter at				*o* Height. Age of tree. Years.	*o* Height. From the ground. ft.	in.	*p* Height. ft. in.
Diameter at	4 feet,	12	inches.	166	31	8	
"	8 "	11.6	"	179	43	6	
"	12 "	10.8	"	225	61	6	
"	16 "	10.4	"				
"	20 "	10.2	"				
"	24 "	10	"				
"	28 "	9	"				
"	32 "	8.8	"				
"	36 "	7.3	"				
"	40 "	6	"				
"	44 "	5	"				
"	48 "	4	"				
"	52 "	2.5	"				
"	56 "	1.4	"				
"	60 "						
"	64 "						

AGE OF TREE, 225 YEARS. TOTAL HEIGHT, 61 FEET, 6 INCHES.

Details of Sections. Measures in Millimeters.

Section.	Distance from Bark through Ring. 10.	20.	30.	40.	50.	60.	70.	80.	90.	100.	Sapwood. Rings.	Thickness.	Bark—thickness.
1	13	26	39	56	73	88	101	109	123	138	28	36	9
2	14	29	44	63	88	......	......	......	......	......	23	34	8
3	16	32	46	......	......	......	......	......	......	......	20	32	5

TREE No. FOUR.

Position: Partly Free.

a Diameter breast high.	*b* Length of timber.		*c* Diameter below crown.	*d* Length of crown.		*e* Length of leader for last five years.	Stump. Height.	*f* Diameter at top.	Age.	*g* No. of rings on stump.	Sections. Number.	*h* Length.		*i* Diameter at top.	*k* Number rings at top.	*l* Number rings for every inch on radius.	*m* Thickness of bark at top.
in.	ft.	in.	in.	ft.	in.	in.	in.	in.	yrs.			ft.	in.	in.			
19	40		11.8	29		28	28	23	16	229	1	38	9	11.8	103		
											2	10	9	7.8	55		
											3	10	4	4	32		

n Diameter at 4 feet, 17.8 inches.

n Diameter at	feet	inches
"	4	17.8
"	8	16.3
"	12	15.5
"	16	15.1
"	20	14.8
"	24	14.2
"	28	13.8
"	32	13.5
"	36	13.2
"	40	12.8
"	44	10.2
"	48	8.3
"	52	7.5
"	56	6.4
"	60	4.0
"	64	2.2

o Height. Age of tree. Years.	From the ground. ft.	in.	*p* Height. ft.	in.
142	41	0		
190	51	9		
213	62	1		
245	71	4		

Age of Tree, 245 Years. Total Height, 71 Feet, 4 Inches.

Detail of Sections. Measures in Millimeters.

Section.	Distance from Bark through Ring. 10.	20.	30.	40.	50.	60.	70.	80.	90.	100.	Sapwood. Rings.	Thickness.	Bark—thickness.
1	12	22	32	43	55	71	......	......	......	......	18	20	4
2	9	20	35	53	68	......	......	......	......	......	18	18	3
3	13	34	55	......	......	......	......	......	......	......	14	21	3
4	17	40	......	......	......	......	......	......	......	......	13	25	2

TREE No. FIVE.

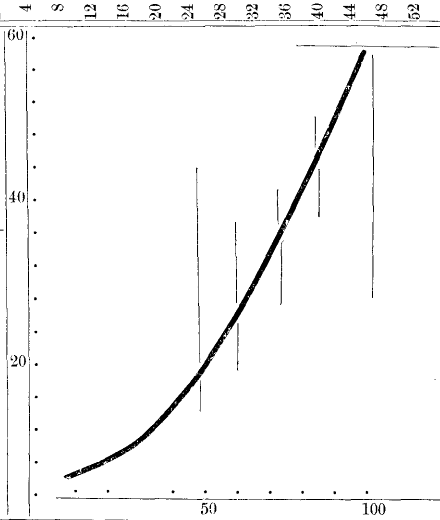
POSITION: SURROUNDED BY LARGER NEIGHBORS.

a Diameter breast high. in.	*b* Length of timber. ft. in.	*c* Diameter below crown. in.	*d* Length of crown. ft. in.	*e* Length of leader for last five years. in.	Stump. Height. in.	*f* Diameter at top. in.	Age. yrs.	*g* Number of rings on stump.	Sections. Number.	*h* Length. ft. in.	*i* Diameter at top. in.	*k* Number rings at top.	*l* Number of rings for every inch on radius.	*m* Thickness of bark at top.
6.5	15 6	5.7	40 6	54	12	7.5	10	102	1	8	6	65		
									2	8	5.4	50		
									3	8	4.8	36		
									4	8	4.1	24		

n Diameter at	Inches.
4 feet	6.5
8 "	6.2
12 "	5.8
16 "	5.5
20 "	5.3
24 "	5.0
28 "	4.6
32 "	4.1
36 "	3.6
40 "	3.1
44 "	2.5
48 "	1.5
52 "	
56 "	
60 "	
64 "	

o HEIGHT.

Age of tree. Years.	From the ground. ft. in.
47	9
62	17
76	25
88	33
112	57



p Height. ft. in.	In the—
	10th year.
2 6	20th "
5	30th "
7 6	40th "
10 6	50th "
16	60th "
21 6	70th "
27 6	80th "
34 6	90th "
45	100th "
	120th "
	130th "
	140th "

The curve represents graphically the growth in height.

AGE OF TREE, 112 YEARS. TOTAL HEIGHT, 57 FEET.

Details of Sections. Measures in Millimeters.

Section.	Distance from Bark through Ring. 10.	20.	30.	40.	50.	60.	70	80.	90.	100.	Sapwood. Rings.	Sapwood. Thick-ness.	Bark—thickness.
1	9	18	22	27	34	46	55	......	......	......	20	18	3
2	11	23	29	37	47	......	.....	......	......	......	20	23	2
3	16	34	......	......	......	......	......	... ..	......	.....	12	19	2

TREE No. SIX.

Position: Partly Free.

a Diameter breast high. in.	*b* Length of timber. ft.	in.	*c* Diameter below crown. in.	*d* Length of crown. ft.	in.	*e* Length of leader for last five years. in.	Stump. Height. in.	Stump. *f* Diameter at top. in.	Stump. Age. yrs.	Stump. *g* No. of rings on stump.	Sections. Number.	Sections. *h* Length. ft.	in.	Sections. *i* Diameter at top. in.	Sections. *k* Number rings at top.	Sections. *l* Number rings for every inch on radius.	Sections. *m* Thickness of bark at top.
5.3	8		4.8	32	8	54	6	6.2	6	119	1	8		4.5	73		
											2	8	4	3.8	50		
											3	7	8	3	23		

n Diameter at		
	4 feet,	5.3 inches.
"	8 "	4.8 "
"	12 "	4.4 "
"	16 "	4.0 "
"	20 "	3.7 "
"	24 "	3.1 "
"	28 "	2.5 "
"	32 "	1.9 "
"	36 "	
"	40 "	
"	44 "	
"	48 "	
"	52 "	
"	56 "	
"	60 "	
"	64 "	

o Height. Age of tree. Years.	From the ground. ft.	in.
52	8	6
75	16	10
102	24	6
125	41	2

p Height. ft.	in.	
1		In the 10th year.
2	6	" 20th "
4		" 30th "
6		" 40th "
8		" 50th "
11	6	" 60th "
15		" 70th "
18		" 80th "
21		" 90th "
24		" 100th "
36	8	" 120th "
		" 130th "
		" 140th "

Age of Tree, 125 Years. Total Height, 41 Feet, 2 Inches.

INSTRUCTIONS FOR MEASUREMENTS OF ACRE-YIELD.

1. Select the best covered piece of land.
2. Stake off one acre, preferably in the form of a square (70 by 70 yards) with lines running N. and S., E. and W.
3. Stretch a cord or string along the east side of the piece; then divide off a strip about 21 feet wide with another string so that the strip lies between the two strings and extends S. and N. along the east line. This is to prevent repetition of measurements.
4. Count, measure, and record all the trees of this strip in the manner described below; then divide off another strip by removing the first (outer) cord, placing it 21 feet to the westward of the second line cord which is left in place, and count and measure. Continue thus until the trees of entire acre are measured.
5. The record is kept on furnished blank sheets as per sample, and arranges the data for the various trees in nine classes according to their diameter (diameter-classes) and six classes according to their total height (height-classes).
6. The record also includes: Diameter (measured 4 feet from ground) and length of the merchantable timber of each tree large enough to furnish lumber (estimated).
7. For each strip use a separate sheet or sheets.
8. The record for each species is kept separate.
9. After finishing a strip, and before beginning another, fill out the blanks on the back of the sheet by underscoring or adding descriptive words.
10. Fill out a special "folder" (furnished), giving description of the region.
11. Describe more in detail the measured area as regards topography, soil, drainage, and cover, if possible adding a sketch map of the acre and the manner of its subdivision in strips.

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1. Openings: No openings or bare places.
2. Distribution of trees: In clusters. Smallest trees largely grouped by species.
3. Crowns of most spruce well developed; dense. Small spruce often small and crowded.
4. Trunks of most spruce straight; clear; covered with limbs above fifteen feet as a rule. Defective trees noted.

SCHEDULE FOR MEASUREMENTS OF ACRE-YIELD.

Station, Maine. Site, E.

NAME OF SPECIES.	18-24 INCHES		14-48 INCHES		10-14 INCHES		6-10 INCHES		3-6 INCHES		UNDER 3 INCHES		REMARKS.
	Over.	Under.	Over.	Under.	Over.	Under.	Over.	Under.	Over.	Under.	Over.	Under.	
	80 Feet.		80 Feet.		80 Feet.		60 Feet.		40 Feet.		20 Feet.		
Black spruce	*2 2 dead	†10 3 dead	‡1	§22 3 dead	......	‖36	1	55	3	57	20	741	265 under 3 inches, 476 under about 1 inch diameter and 6 feet height. 71 over 10 in. diameter, 948 in all.
Yellow birch (Betula lutea)	......	5	......	1	......	12	3	3	2	2	11	51	91 in all, 19 over 10 in. diameter, 1 over 24 in. diameter, 100 ft. height.
White birch (B. papyracea)	......	......	......	......	......	2	1	2	4	3	2	12	26 in all, 2 over 10 in. diameter,
Beech	......	......	......	......	......	16	2	24	2	11	1	37	93 in all, 16 over 10 in. diameter.
Maple (mostly A. Saccharinum)	......	......	......	1	......	4	2	1	......	4	......	4	16 in all, 5 over 10 in. diameter.
Fir	......	......	......	......	......	......	......	4	......	17	6	59	349 firs in all, 263 under 1 inch diameter and 6 feet height.
Dwarf maples	......	......	......	......	......	......	......	......	......	......	......	87	
Cedar	......	......	......	......	......	......	......	......	......	......	......	4	
Cherry	......	......	......	......	......	......	......	......	......	......	......	2	
Elder	......	......	......	......	......	......	......	......	......	......	......	1	
													1,617 trees in all, 113 over 10 inches in diameter.

* Diameter and length of merchantable timber: 12 in.—30 ft., cr.; 12 in.—40 ft.

† Diameter and length of merchantable lumber: 10 in.—30 ft., cr. s.; 12 in.—30 ft., imp. forks low; 8 in.—25 ft.; 10 in.—30 ft., cr.; 14 in.—30 ft.; 12 in.—40 ft.; 12 in.—30 ft.; 15 in.—40 ft.; 14 in.—30 ft.; 15 in.—25 ft.

‡ Diameter and length of merchantable lumber: 10 in.—30 ft., cr. s.

§ Diameter and length of merchantable lumber: 10 in.—30 ft.; 11 in.—30 ft.; 10 in.—30 ft.; 10 in.—25 ft.; 8 in.—30 ft.; 10 in.—30 ft.; 12 in.—30 ft.; 10 in.—25 ft.; 10 in.—25 ft., imp.; 12 in.—30 ft.; 10 in.—18 ft.; 8 in.—30 ft.; 10 in.—40 ft.; 12 in.—30 ft.; 10 in.—30 ft.; 9 in.—30 ft.; 10 in.—25 ft.; 12 in.—30 ft., cr.; 10 in.—25 ft.; 8 in.—25 ft.; 12 in.—30 ft.; 10 in.—30 ft.

‖ Diameter and length of merchantable lumber: 8 in.—25 ft.; 8 in.—25 ft.; 8 in.—20 ft.; 8 in.—30 ft.; 9 in.—15 ft.; 8 in.—30 ft.; 8 in.—30 ft.; 10 in.—30 ft.; 10 in.—20 ft., cr.; 8 in.—25 ft.; 8 in.—25 ft.; 8 in.—25 ft.; 8 in.—30 ft.; 10 in.—25 ft.; 7 in.—20 ft.; 8 in.—20 ft.; 8 in.—20 ft.; 8 in.—25 ft.; 8 in.—20 ft.; 9 in.—30 ft.; 8 in.—20 ft.; 8 in.—20 ft.; 8 in.—20 ft.; 8 in.—25 ft., cr.; 10 in.—25 ft.

Cr. indicates a strongly crooked tree; imp. one otherwise imperfect; seamed trees scored s.

SUMMARY OE TRFES UPON ACRE E.

Spruce:	
Total number on acre	948
Estimated volume of same	2,800 cu ft.
Number over 10 inches diameter, breast high	71
Estimated volume of same	2,050 cu. ft.
Lumber fit for saw logs, about	7,000 ft. B. M.
Birch--yellow and white:	
Total number trees	117
Estimated volume of same	900 cu. ft.
Number over 10 inches diameter	21
Estimated volume	765 cu ft.
Beech and maple:	
Total number trees	109
Estimated volume	750 cu ft
Number over 10 inches diameter	*21
Estimated volume	440 cu. ft.
Fir:	
Number trees	349
Estimated volume	125 cu. ft.
Cedar:	
Number trees	4
Total number trees on acre, excluding 90 above	1,527
Total estimated volume of wood	4,575 cu. ft.
Total number trees over 10 inches diameter	113

DESCRIPTIVE.

Larger yellow birch almost all crooked and worthless. with low limbs. Whith birch with long clean trunks. Maples and beeches tall comparatively, but rough, crooked and poor. Young trees of all species in the more open places, and grouped by species. Note the absence of large fir. The very small trees are numerous and look thrifty. Later on they grow scanty and die out.

Spruce. Usually live limbs begin at twenty-five or thirty feet from the ground in the log classes. Dead limbs and knots come down much lower. Seldom are trunks clear over fifteen feet. Crowns are large, full and thrifty in all except a few of the largest, a proportion of which are on the down grade. Trunks as a rule

*Ninety dwarf maples, cherry and elder.

are straight, exceptions being noted. Trees without special notes are nearly free of imperfections.

The 6-10 and 3-6 inch classes are proportionately more slender and longer bodied than the large trees On most, dead limbs come low down. They are mostly straight Few are badly overcrowded and suppressed. The smallest trees are largely in openings and appear full-crowned and thrifty. From about 2.500 square feet the young growth had been cut out.

Of the acre here described it is to be said, as all lumbermen will recognize, that it is far better than an average acre of spruce land. It was the best covered acre found after some search. the intention being to find as near as might be what the ground and climate would produce.

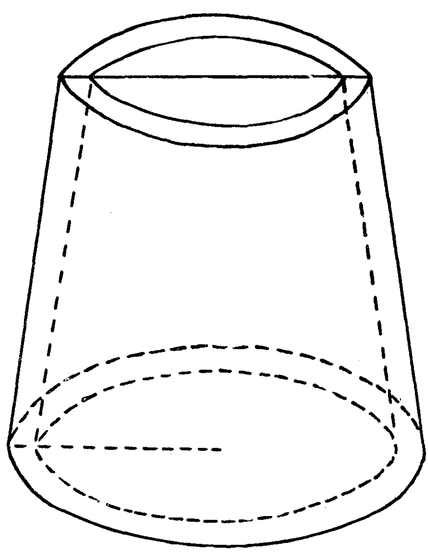
Concerning the trees scheduled I will remark, what will perhaps be better understood after reading the next four paragraphs, that Nos. 1 and 2 are representative thrifty trees, which have grown steadily and well throughout their lives. No. 3 was badly suppressed for 150 years or so, but more recently has grown rather rapidly. No. 4 is seen to have had a somewhat similar history, but when cut at about 250 years of age, was growing as vigorously, both in diameter and height, as either of the others. Nos. 5 and 6 were small trees, standing in openings however, and with long full crowns. They are typical trees, though No. 5 has had an unusually rapid growth in height.

A little study will show how completely these schedules, the form of which was devised by the chief of the national Foresrty Division for the purpose, write the history and character of the trees measured. Note of the external relations of a tree comes first—then the main dimensions of trunk and crown, and a caliper measurement of the stem at every four feet to ascertain volume and taper. The age of the trees is given by count of rings in the butt, and the shrinkage in number between the butt and top of the log tells how many years were consumed in growing that height. If top logs were cut, the growth in height in the later life of the tree is found in the same way.

Turning for instance to No. 6 of the schedules just given, we find that the stump showed 119 rings, while the top of an 8 foot section showed but seventy-three. That length therefore was grown in thirty-six years, fifty years more were consumed by the young tree in gaining its next sixteen feet, while as shown by column *e* it is now growing nearly a foot per year. Short-cut trees like this give the history of their early growth much closer than the long logs ordinarily cut in the backwoods.

As to growth in diameter an equally full history is given. The programme of field work was to lay off on the square-cut top of the log a radius of average length. On this the rings were counted beginning with the bark, and every tenth one marked. Then the total number was recorded, and the thickness of each group of ten.

To understand the upshot of this work, turn again to schedule six, to the "Detail of Sections." The thickness of the outer ten rings at the first section is nine millimeters or a little over a third of an inch. This is the thickness of the sheath of wood added to the tree in the last ten years, and twice that amount is the increase in the tree's diameter. Similarly for the next ten rings, the thickness of which was in this case the same. From twenty to forty years back, however, this tree must have been crowded or subjected to some other unfavorable conditions, for the growth in diameter was only a half what it was for the later decades, and much less than in those previous. Passing up the trunk, by means of the measures on the second and third sections, each group of rings is seen to grow thicker.



This brings us to another main branch of the inquiry—the volume of the year's growth, or as was in fact ascertained, of the last ten years. The figure will render the facts clear and be useful to refer to. A log is represented in diagram as the frustum of a cone.

The volume desired is that of the shell of wood on the outside of the figure, or the contents of the outer cone, less that of the inner one.

Under the circumstances, working the cumbersome exact formula for the theoretical figure was thought unnecessary. The volume of the outer figure is approximately the mean of the two rings at top and bottom multiplied by the length of the stick. The stump not having been measured like sections above it, the area of the top ring alone was used for butt logs. This being understood, the data of the problem is all found in the schedules, in the length of the logs concerned, the diameter of the wood at the top end of each, and the width at the same points of the outer ten rings. These given, with a table of circles, the areas and volumes desired are readily calculated.

I give here the schedule of a tree cut on the south slope of Little Squaw Mountain, and a solution of the problems involved.

Detail of Sections. Measures in Millimeters.

Section.	Distance from Bark through Ring.																			Sapwood.		Bark —thickness.
	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	Rings.	Thick-ness.	
1.	8	17	26	37	48	58	74	82	90	97	104	109	115	121	127	135	140	145	153	34	31	7
2.	9	20	34	48	61	71	81	88	96	103	114	121	128	137	148	....	....	....	....	33	37	6
3.	11	23	32	43	55	63	70	76	83	100	118	....	....	....	....	....	....	....	....	18	20	6

TREE No. THIRTY-TWO.

POSITION: PARTLY FREE. SURROUNDING SPECIES: HARD WOODS, ONE-HALF WITH SOME FIR, HEMLOCK, ETC.

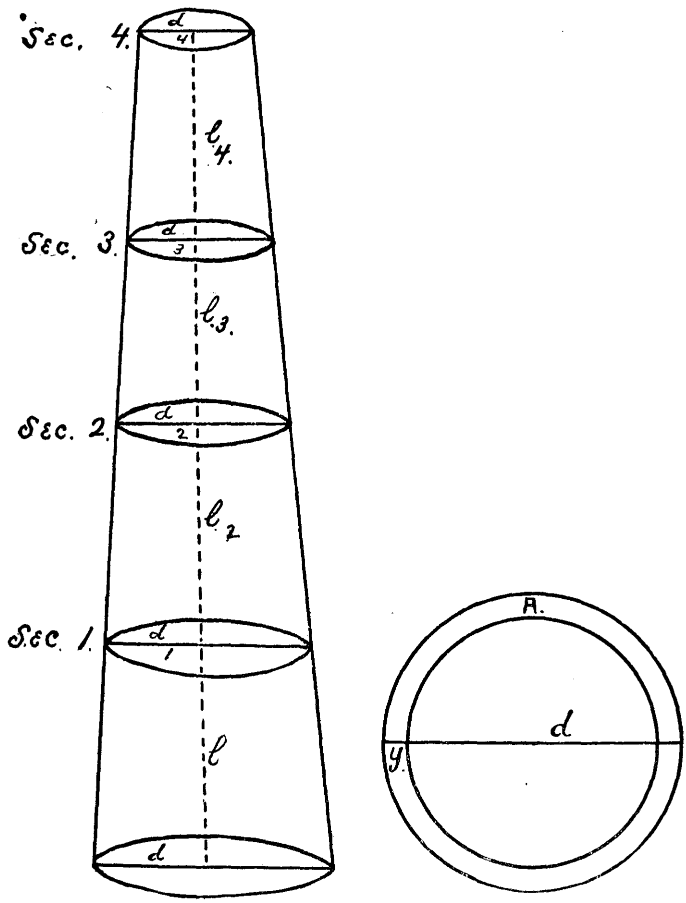
a Diameter breast high.	*b* Length of timber.		*c* Diameter below crown.	*d* Length of crown.		*e* Length of leader for last five years.	Stump. Height.	Stump. *f* Diameter at top.	Stump. Age.	Stump. *g* No. of rings on stump.	Sections. Number.	Sections. *h* Length.		Sections. *i* Diameter at top.	Sections. *k* Number rings at top.	Sections. *l* Number rings for every inch on radius.	Sections. *m* Thickness of bark at top.
in.	ft.	in.	in.	ft.	in.	in.	in.	in.	yrs.			ft.	in.	in.			
17.2	44	6	10.2	26		28	12	20.8	10	273	1	13	8	13	193		
											2	18	4	10.9	153		
											3	15	10	9.4	111		
											4						
											5						

n Diameter at		
4 feet,	17.0	inches.
" 8 "	15.6	"
" 12 "	14.5	"
" 16 "	14.2	"
" 20 "	13.6	"
" 24 "	13.2	"
" 28 "	12.8	"
" 32 "	12.0	"
" 36 "	11.3	"
" 40 "	11.2	"
" 44 "	10.2	"
" 48 "	9.5	"
" 52 "	7.0	"
" 56 "	5.5	"
" 60 "	3.6	"
" 64 "		

o Height. Age of tree. Years.	*o* Height. From the ground. ft.	in.
90	14	8
130	33	
172	48	10
283	71	6

	p Height. ft.	in.
In the 10th year.		
" 20th "		
" 30th "		
" 40th "		
" 50th "		
" 60th "		
" 70th "		
" 80th "		
" 90th "		
" 100th "		
" 120th "		
" 130th "		
" 140th "		

AGE OF TREE, 283 YEARS. TOTAL HEIGHT, 71 FEET, 6 INCHES.



The upright diagram represents the tree with the sections in place. These are numbered in agreement with the numbers on the schedule; l is the length of the log, the sub-number in each case corresponding with the number of a log or section. The circular diagram represents a section. The diameter is drawn and lettered d; y is the thickness of the outer ten rings. The area of these ten rings in the section is called A and equals the area of the circle whose diameter is d minus the circle with diameter $d—2\ y$. Sub-numbers are used with each term—that is A_2 is the area of the ring in section 2 etc.

In the butt log $l_1 = 13.7$ ft. $d_1 = 13$ in. $y_1 = 8$ mm. or $2y_1 = .6$ in.
$d_1 = 13$ in. Area circle from table $= 132.7$ sq. in.
$d_1 - 2y_1 = 12$ 4 in. " " " " $= 120.8$
$A_1 = 11.9$ sq. in.

In second log $l_2 = 18.3$ ft. $d_2 = 10.9$ in. $y_2 = 9$ mm. or $2y_2 = 7$ in.
$d_2 = 10.9$. Area $= 93.3$
$d_2 - 2y_2 = 10.2$. " $= 81.7$
$A_2 = 11.6$ sq. in.

$l_3 = 15.8$ ft. $d_3 = 9.4$ in. $y_3 = 11$ mm. $2y_3 = .9$ in.
$d_3 = 9.4$. Area $= 69.4$
$d_3 - 2y_3 = 8.5$. " $= 56.7$
$A_3 = 12.7$ sq. in.

$l_4 = 10$ ft. $d_4 = 4$ in. $y_4 = 10$ mm. $2y_4 = 8$ in. y here derived from estimate.
$d_4 = 4$ in. Area $= 12.6$
$d_4 - 2y_4 = 3.2$. " $= 8.$
$A_4 = 4.6$ sq. in.

$A_1 = 11.9$ sq. in. $\log A_1 = 1.0755$
$l_1 = 13.7$ ft. $\log l_1 = 1.1367$
Reduce to feet by colog $144 = \bar{3}.8416$
$\log V_1 = 0.0538$ $V_1 = 1.13$ cu. ft.

$A_1 = 11.9$ $\frac{1}{2}(A_1 + A_2) = 11.7$ | $\log = 1.0682$
$A_2 = 11.6$ $\log l_2 = 1.2625$
23.5 colog $144 = \bar{3}.8416$
$\log V_2 = 0.1723$ $V_2 = 1.49$

$A_2 = 11.6$ $\frac{1}{2}(A_2 + A_3) = 12.2$ | $\log = 1.0864$
$A_3 = 12.7$ $\log l_3 = 1.1987$
24.3 colog $144 = \bar{3}.8416$
$\log V_3 = 0.1267$ $V_3 = 1.34$

$A_3 = 12.7$ $\frac{1}{2} A_3 + A_4) = 8.7$ $\log = 0.9395$
$A_4 = 4.6$ $\log l_4 = 1$
17.3 colog $144 = \bar{3}.8416$
$\bar{1}.7811$ $V_4 = 0.60$
4.56 cu. ft.

This result is the growth of the tree for the last ten years. Its yearly growth is therefore .456 cubic feet. As in the case of all the large trees figured on, limb wood is left out of account, as well as the very top of the tree and the stump below one foot from the ground.

Further use can be made of these measurements and methods. Let us suppose this tree seventy years younger, or in other words suppose seventy of the annual rings to be stripped off the outside of it. In that case the diameter of the wood at section one, would be eight inches, and the thickness of the ten rings next inside eight millimeters. The same data are obtainable for the upper sections, and the yearly growth of the tree at that period can be ascertained as before. The data are as follows:

$l_1 = 13.7$ feet.	$d_1 = 8$ inches.	$y_1 = 8$ mm.
$l_2 = 18.3$ "	$d_2 = 5.1$ "	$y_2 = 7$ "
$l_3 = 15.8$ "	$d_3 = 4$ "	$y_3 = 6$ "

The problem works out with 18 cubic feet as an answer.

Now this tree 70 years ago at 4 feet from the ground was about 11 or 12 inches in diameter. The volume of its growth at that time therefore will stand as well as that of another tree as representative of the 10-14 inch class on that site. The same tree stripped to about 8 inch diameter at 4 feet showed an annual growth of about 1 cubic foot. These results and similar ones are utilized in ascertaining the growth upon acres at sites *c* and *q*. They would not be reliable unless logs were cut very short, and at those points a few were so cut in order to obtain material to be used in straight tests of timber.*

Numerous questions have come up in the course of the foregoing work, and their pursuit has brought out several interesting and valuable facts, facts however not new to forestry science.

First I will note that the ring of the year's, or ten year's growth is thicker high up in the trunk of a tree than it is nearer the ground. There are exceptions to the rule, and slight irregularities make numerous apparent ones. But the schedules herewith presented will bear me out, while the principle has been proved from much wider evidence. A corollary of wide application is that as long as a tree is growing, its trunk is decreasing in tapir or becoming more cylindrical. From this we learn that in reckoning the value of growth the added volume is not the only consideration. That volume is placed to best advantage, while in other respects the timber may be improved in quality In the region of the crown the rule will not hold as formulated. There is great variation in the matter; but according to the evidence at my command, in a majority of trees, the principle does hold there.

Then in reckoning the volume of growth the question arose—is the greater thickness of the rings as we go up the tree sufficient to effect the taper of the trunk, and give to the upper ring as great an area as the lower one? From the nature of the subject and

*For purposes and methods of this investigation see Bulletin No. 6 of U. S. Forestry Division—title Timber Physics.

the measurements a certain answer to this question could hardly be expected. I have however put considerable evidence together, and it fosters the conclusion that the taper of the tree will not be thus offset. I have concluded therefore that it would at any rate be safe and tend to conservative results if in the case of all butt logs, most of which are cut long, the area of the ring at the top end is assumed equal to its area it any point below.

Some general results of these calculations have been given. It remains to explain their use in ascertaining the growth on sample acres.

In the neighborhood of the first acre studied twenty-two trees were measured and scheduled. Following the methods outlined, the growth of each of them has been calculated. The results, dividing the trees into size classes, are exibited in the following table, where they are averaged. Then from the notes on the acre the number of trees is brought over by classes, and the necessary multiplications and discounts made. The final results are then stated, and they need no further explanation.

	18–24 inches.	14–18 inches.	10–14 inches.	6–10 inches.	3–6 inches.	Under 3 inches.
Yearly growth in cubic feet of trees measured on site, including trunk lumber above one foot from ground and up to four or six inches diameter. Figure in column of 3–6 inches trees is average of five trees and these were reckoned to the top.	.69	.59 .46 .44	.30 .47 .52 .33 .58 .42 .43 .29 .29 .39 .45	.16 .23	.07	
No. and average of above by classes	1 | .69	3 | .50	11 | .41	2 | .20	5 | .07	
Growth average revised.............	.6	.5	.4	* .15	* .05	† .001
Number spruce trees on acre	12	23	36	56	60	761
Multiplying through....	7.2	11.5	14.4	8.4	3.0	.8

* Trees measured in these classes were always choice trees, far above the average.

† This figure a mere guess.

Sum of these products	45.3
From this amount deduct 20 per cent for safety and because consciously and unconsciously better than average trees were chosen for measurement. This leaves total annual growth of spruce on this acre	36.3 cu. ft.
Per cent of yearly growth to stand..............	1.3 per cent.
Total growth on acre. supposing other species to add the same per cent to their volume..........	59 5 cu. ft.
Yearly growth on spruce trees over 10 in diam...	26.5 cu. ft.
Of this, there goes into defective trees about.	2.5 cu. ft.
Equivalent of 24 cubic feet in board measure about	144 ft.

Perhaps a further discount should have been made for the old trees that are past the period of most vigorous growth.

Site *c* was located on the lower south slope of Little Squaw mountain, just southwest of Moosehead. The trees measured were grown mostly on a liberal soil, in quite open growth, of which about one-half on the average was hard wood. The acre on the other hand was on steep, rocky ground, and more thickly covered with trees. In working from the increment of single trees to that of the acre, I have however, made no allowance for change of site.

The growth on the acre summarizes as follows:

Total number trees (leaving out dwarf maples, etc)		970
Number over 10 inches diameter, breast high,.....		87
Number under about 6 ft high and 1 inch diam....		450
Total estimated volume of wood		3925 cu. ft.
Spruce.	Number on acre	448
	Estimated volume of same.............	2300 cu. ft.
	No. over 10 in. diam. breast high	51
	Estimated volume....................	1800 cu. ft.
	Merchantable lumber about............	6000 ft B. M.

The other species present are white and yellow birch (some of considerable size) beech and maple, over 200 small fir and some few up to 6 or 8 inches diameter, a few cedar, ash, hornbeam, and a single pine.

Table Showing Calculated Annual Growth of Trees Measured on the Site.

	Tree No.	Over 24 in.	18—24 in.	14—18 in.	10—14 in.	6—10 in.	3—6 in.	Under 3 in.
	1				.18			
	2	.59						
	3					.14		
	4			.63				
	5					.43		
	6					.11		
	7				.23			
	8				.17			
	9		.63					
	10		.60					
	11				.46			
	12				.51			
	13			.50				
	14				.27			
	15			.57				
	16				.47			
	17				.44			
	18					.12		
	19			.53				
	20					.23		
	21					.12		
	22		.62	.56	.23	.15		
	23			.47	.39	.16		
	24			.46	.18	.10		
	25			.91	.64	.21		
Average eight trees	..						.06	
No. and average of above by classes	..	1—.59	3 | .62	8 | .58	12 | .35	10 | .18	8.06	* .001
No. trees on acre by classes	..	3	14	9	25	34	56	307
Multiplying through	..	1.77	8.68	5.22	8.75	6.12	3.36	.3
Sum of these products	..		36.9					

* This figure by estimate.

Deducting 20 per cent as before gives annual growth of spruce upon the acre .... 29.5 cu. ft.

Per cent of annual growth to stand .... 1.3 per cent.

Annual growth on spruce trees over 10 in. diam .. 19.6 cu. ft.

Equivalent of this in board feet about 120

Annual growth on acre, supposing all species to add the same percentage to their volume as spruce .... 51 cu. ft.

In the preceding table I will call attention to the fact that two trees, Nos. 5 and 25, have a very unusual growth. As examples of extremely thrifty trees, not merely for the site, but of the species as a whole in the forests of the State of Maine their schedules are given. They stood in hard wood land, on fairly deep and generous soil. The larger one was chosen in collecting strength test material as the best developed tree in the vicinity, a judgment from outside marks which its internal structure thoroughly justifies.

No 5 similarly was picked as a very thrifty, full-crowned tree in favorable conditions. It was putting on diameter at the rate of an inch in five years, while its height growth for the last 18 years was 20 3-4 feet. This is very rapid work for a forest-grown black spruce. Yet this tree's prosperity is only of recent date; it probably began about 30 years ago. The inner rings in the butt were too fine to count with certainty, while the measures show that at about 150 years of age the tree was only about 4 inches in diameter and 20 feet high. It was not only at that time a very backward tree, but it has since changed entirely in shape.

This fact is brought out here not merely to illustrate the vicissitudes of tree life, but also to attest the vitality that remains in a spruce even after long and severe suppression. Such facts, confirmed as they are by others cropping up on every hand, characterize our spruce as a tough and long winded species so to speak, a tree that can be counted on to perpetuate itself by forcing its way when necessary through unfavorable conditions.

Detail of Sections—Measures in Millimeters.

Section.	Distance from Bark through Ring. 10.	20.	30.	40.	50.	60.	70.	80.	90.	100.	Sapwood. Number rings.	Thick-ness.	Bark—thickness.
1	25	45	58	65	71	77	86	......	......	......	18	40	5
2	27	57	......	......	......	......	......	......	......	......	16	44	4
3	32	......	......	......	......	......	.. ...	......	.....	......	11	37	4

TREE No. FIVE—SITE C.

POSITION: THINLY SURROUNDED. SURROUNDING SPECIET: ONE-HALF HARD WOODS AND SOME FIR, HEMLOCK, ETC.

a Diameter breast high. in.	*b* Length of timber. ft.	in.	*c* Diameter below crown. in.	*d* Length of crown. ft.	in.	*e* Length of leader for last five years. in.	Stump. Height. in.	*f* Diameter at top. in.	Age. yrs.	*g* No. of rings on stump.	Sections. Number.	*h* Length. ft.	in.	*i* Diameter at top. in.	*k* Number rings at top.	*l* Number rings for every inch on radius.	*m* Thickness of bark at top.
8.1	16	6	6.9	34	3	62	24	9.4	20	155	1	10		7	71		
											2	10		6	29		
											3	10		4.5	18		
											4						
											5						

n Diameter at		
4 feet,	7.8 inches.	
" 8 "	7.6 "	
" 12 "	7.1 "	
" 16 "	6.9 "	
" 20 "	6.3 "	
" 24 "	6 "	
" 28 "	5.2 "	
" 32 "	4.7 "	
" 36 "	3.5 "	
" 40 "	2.8 "	
" 44 "		
" 48 "		
" 52 "		
" 56 "		
" 60 "		
" 64 "		

o Height. Age of tree. Years.	From the ground. ft.	in.	*p* Height. ft.	in.
104	12			
146	22			
157	32			
175	52	9		

AGE OF TREE, 175 YEARS. TOTAL HEIGHT, 52 FEET, 9 INCHES.

Detail of Sections. Measures in Millimeters.

Section.	Distance from Bark through Ring.										Sapwood.		Bark—thickness.
	10.	20.	30.	40.	50.	60.	70.	80.	90.	100.	Rings.	Thickness.	
1	20	37	56	78	97	115	139	157	163	......	22	41	5
2	21	40	62	84	102	133	.....	.....	.....	......	20	40	5
3	17	37	58	83	108	......	.....	.....	.....	......	20	37	4
4	18	38	61	....	.....	......	......	......	......	......	18	34	4

TREE No. TWENTY-FIVE—SITE C.

POSITION: PARTLY FREE. SURROUNDING SPECIES: MOSTLY HARD WOODS.

a Diameter breast high. in.	*b* Length of timber. ft. in.	*c* Diameter below crown. in.	*d* Length of crown. ft. in.	*e* Length of leader for last five years. in.	Stump: Height. in.	Stump: *f* Diameter at top. in.	Stump: Age. yrs.	Stump: *g* No. of rings on stump.	Sections: Number.	Sections: *h* Length. ft. in.	Sections: *i* Diameter at top. in.	Sections: *k* Number rings at top.	Sections: *l* Number rings for every inch on radius.	Sections: *m* Thickness of bark at top.
15.4	22	12.5	47 8	27	30	16.2	18	152	1	13	13.1	93		
									2	15 3	11.2	66		
									3	12	8.1	53		
									4	11 8	5.7	37		
									5					

n Diameter at 4 feet, 14.8 inches.
" 8 " 14.3 "
" 12 " 14 "
" 16 " 13.2 "
" 20 " 12.8 "
" 24 " 12.2 "
" 28 " 12 "
" 32 " 11.3 "
" 36 " 11 "
" 40 " 9.5 "
" 44 " 9 "
" 48 " 7.5 "
" 52 " 6 "
" 56 " 5 "
" 60 " 3.5
" 64 " 2

o Height. Age of tree. Years.	From the ground. ft. in.
77	15 6
104	30 9
117	42 9
133	54 5
170	72 2

p Height. ft. in.	
1	In the 10th year.
2 3	" 20th "
4	" 30th "
5	" 40th "
7	" 50th "
10	" 60th "
14	" 70th "
18	" 80th "
23	" 90th "
28 6	" 100th "
44	" 120th "
50	" 130th "
55	" 140th "

AGE OF TREE, 170 YEARS. TOTAL HEIGHT, 72 FEET, 2 INCHES.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF FORESTRY.

FIELD RECORD OF TEST TREES.

Name of collector:................ Species: Picea nigra.

STATION (denoted by capital letter):

State: New Hampshire. County: Coos. Town: Thompson and Meserve Purchase.

Longitude: 71° 15'. Latitude: 44° 15'. Average altitude: Say 800 feet.

General configuration: Plain—hills—plateau—*mountainous*. General trend of valleys or hills: North and south.

Climatic features: Cold winter, short summer; mean annual temperature, 41°—26°; mean annual rainfall, about 40 inches, Stratford; about 84 inches, Mt. Washington.

SITE (denoted by small letter): g.

Aspect: Level—ravine—cove—bench—*slope* (angle approximately: 20°—40°.)

Exposure: East. Elevation (above average station altitude): 3,000 feet above the sea.

Soil conditions:

(1) Geological formation (if known): Samentian gneiss.

(2) Mineral composition: Clay—limestone—loam—marl—*sandy loam*—loamy sand—sand—gravelly.

(3) Surface cover: Bare—grassy—*mossy*. Leafy cover: Abundant—moderate—*scanty*—lacking.

(4) Depth of vegetable mold (humus): Absent—moderate—*plenty*—or give depth in inches: Six or eight inches.

(5) Grain, mechanical conditions, and admixtures: Very fine—fine—*medium*—coarse—porous—light—*loose*—moderately loose—compact—binding—stone or rock, size of:.........

(6) Moisture conditions: Wet—*moist*—fresh—dry—arid—*well drained*—liable to overflow—swampy—near steam or spring or other kind of water supply..............................

(7) Color: Brown.

(8) Depth to subsoil (if known): *Shallow*, 6 inches to 1 foot)—*deep*, (1 foot to 4 feet)—very deep, (over 4 feet)—shifting—Shallow except in hollow. Rocks form much of surface.

(9) Nature of subsoil (if ascertainable): Country rock.

Forest conditions: *Mixed timber*—pure—dense growth—*moderately dense*—open.

Associated species: Fir, birches, maples.

Proportions of these: Spruce, one-half—seven-eighths of large trees.

Average height: Say 70 feet.

Undergrowth: *Dense—scanty—kind*: Varies; Young fir and maple, moosewood, etc.

Conditions in the open: Field—pasture—lawn—clearing (how long cleared):...

Nature of soil cover (if any): Weeds—brush—sod.

NOTE.—As much as possible make description by underscoring terms used above. Add other descriptive terms if necessary.

Sample of report on timber trees as rendered United States Division of Forestry from this State and elsewhere.

SCHEDULE FOR MEASUREMENTS OF ACRE-YIELD—SITE G.

Name of Species.	24-30 Inche		8-24 Inches		14-18 Inches		-14 Inches		6-10 Inches		3-6 Inches		Under 3 Inches		Remarks.
	Over.	Under.	Over.	Under.	Over.	Under.	Over.	Under.	Over.	Under.	Over.	Under.	Over.	Under.	
	100 Feet.		80 Feet.		80 Feet.		80 Feet.		60 Feet.		4 Feet.		20 Feet.		
Black spruce	......	* 2	†2	‡ 9	** 2	†† 27	......	§§ 28	2	12	......	22	1	58	75 under about 1 inch diameter and 6 ft. high.
White birch (Betula papyracea)	......	......	......	§ 1	......	‡‡ 2	......	5	......	8	1	4	15	83	
Yellow birch (B. lutea)	......	......	......	¶ 1	......	......	......	1	......	1	......	4	2	15	
Maples (mostly Acer spicatum and Pennsylvanium)	......	......	......	......	......	......	......	......	......	......	......	2	......	102	
Fir	......	......	......	......	......	1	......	22	......	32	......	70	5	471	404 under about 1 inch diameter and 6 ft. high.

* Diameter and length of merchantable lumber: 16 in.–20 ft., and 12 in.–40 ft., sw. k.; 20 in.–20 ft., sw., and 10 in.–50 ft., k.

† Diameter and length of merchantable lumber: 16 in.–20 ft., and 12 in.–40 ft.; 15 in.–20 ft., and 12 in.–40 ft., cr.

‡ 1 dead. Diameter and length of merchantable lumber: 12 in.–40 ft., cr. k.; 14 in.–30 ft., cr. s.; 12 in.–25 ft., poor; 10 in.–30 ft.; 15 in.–30 ft., and 10 in.–50 ft.; 12 in.–25 ft.; 12 in.–35 ft.; 13 in.–35 ft.; 9 in.–40 ft. § 14 in.–20 ft., sw. ¶ cr., poor.

** Diameter and length of merchantable lumber: 10 in.–40 ft., sw.; 10 in.–35 ft., cr. above 20 ft.

†† 2 dead and 1 uprooted. Diameter and length of merchantable lumber: 14 in.–20 ft., and 9 in.–40 ft.; 10 in.–40 ft.; 9 in.–30 ft.; 10 in.–30 ft., sw.; 10 in.–40 ft.; 12 in.–25 ft., k.; 12 in.–25 ft.; 10 in.–30 ft., sw.; 10 in.–30 ft., sw.; 14 in.–20 ft., 12 in.–30 ft., sw.; 10 in.–30 ft., cr.; 10 in.–30 ft., sw.; 12 in.–25 ft.; 9 in.–30 ft.; 10 in.–40 ft.; 10 in.–40 ft., sw.; 10 in.–35 ft.; 10 in.–30 ft., k.; 10 in.–30 ft.; 12 in.–30 ft.; 10 in.–30 ft.; 10 in.–18 ft.; 11 in.–20 ft., s.; 10 in.–40 ft.; 11 in.–30 ft., s. k.; 11 in.–30 ft., s. ‡‡ 1 good, 30 ft.

§§ Diameter and length of merchantable lumber: 8 in.–20 ft.; 7 in–30 ft.; 10 in.–20 ft,; 9 in.–25 ft.; 9 in.–30 ft.; 8 in.–30 ft.; 10 in.–18 ft.; 10 in.–20 ft.; 10 in.–20 ft.; 8 in.–20 ft.; 8 in.–25 ft.; 10 in.–30 ft.; 10 in.–20 ft.; 8 in.–30 ft.; 10 in.–20 ft.; 10 in.–30 ft.; 10 in.–25 ft., worthless; 10 in.–20 ft.; 10 in.–30 ft.; 7 in.–30 ft.; 8 in.–25 ft.; 11 in.–20 ft.; 9 in.–25 ft.r 9 in.–22 ft.; 7 in.–20 ft., k.

Trees damaged by crooks scored cr. Sweeping stems scored sw. Lumber damaged by large and numerous knots marked k. Numerous logs are shortened because of sharp crooks high up in the stems.

1. Openings: Form about five per cent of the entire space.

2. Distribution of trees: In clusters, the smallest trees of each species notably so.

3. Crowns of large spruce well developed; fairly dense; 3-6 and 6-10 classes generally thin and suppressed. Crowns of large firs open, straggling, often dying.

4. Trunks of large spruce straight, unless noted; covered with limbs generally above ten or fifteen feet. About one-third of those over 18 inches in diameter are clear 20 or 25 feet. Trunks of large firs straight; covered with limbs from a few feet above ground.

On the east slope of Mt. Adams in the Presidential range, about 1,000 feet below timber line, on very steep and rough ground, rocks form a considerable portion of the surface, but clinging to the slopes and in crevices and hollows is enough soil to support a large crop of trees. Most of this soil, so far as could be seen, is of vegetable origin.

On the large spruce live limbs begin as a rule 25—30 feet from the ground; 40—45 feet is an average length of crown for the larger timber trees. The smaller ones in the 10—14 class would not equal these dimensions, while there is in all classes much variation. Crowns are fairly dense and in good condition being generally much heaviest down hill.

The birches on this acre were generally crooked, with low limbs. Crowns were not as a rule large, and the general impression was conveyed that they are above the level of quick and smooth growth.

As regards fir, the great number of small trees, and the comparative fewness and poor condition of the larger ones, are the most noticeable points.

SUMMARY OF GROWTH UPON ACRE.

Spruce:	
No. trees on acre	240
Estimated volume	2550 cu. ft.
No. over 10 inches diameter	70
Estimated value of same	2360 cu. ft.
Merchantable lumber about	9000 ft. B. M.
White and Yellow Birch:	
No. trees	143
Estimated volume	400 cu. ft.
No. over 10 inches diameter	10

Fir:

No. trees on acre........................ 1005

Estimated volume........................ 900 cu. ft.

No. over 10 inches diameter.............. 23

Total no. trees on acre excluding dwarf maples.... 1390

No. over 10 inches diameter..................... 103

No. under about 6 ft high and 1 in. diameter about 500

Total volume of wood on acre estimated.......... 3860 cu. ft.

Table Showing Calculated Annual Growth of Trees Measured on the Site.

	No. tree.	Over 18 in.	14—18 in.	10—14 in.	6—10 in.	3—6 in.	Under 3 in.
	1	......	.31				
	2	......	......	.25			
	3	......	.....	.24			
	4	......	......	....	.11		
	5	.29					
	6	......	......	....	......	.04	
	7	......	.59	.46	.32		
	8	......	.46	.43	.29		
	9	......	.31				
	10	......	......	.40	.20		
	11	......	.48	.50	.11		
	12	.56	.48	.35	.17		
	13	......	.46				
	14	......	......	....	.11		
	15	......	......	....	......	.02	
	16	......	......	....	......	.11	
	17	......	......	....	......	.08	
	18	......	......	....	.07		
	19	......	......	....	......	.02	
	20	......	......	.37			
	21	.47	.48				
	22	.45					
	23	.35					
	24	......	.. . .	....	.09		
	25	......	......	.23			
	26	......	......	.26			
Number and average of above by classes..	..	5 | .42	8 | .45	10 | .34	9 | .16	5 | .05	* .005
Average revised	..	.45	.45	.34	.16	.05	.005
Number trees on acre by classes	..	13	29	28	14	22	134
Multiplying through..................	..	5.85	.3.05	10.52	2.24	1.1	.67

* This figure by estimate.

Sum of these products 33.4. Deducting 20 per cent	26.7 cu. ft.
Percentage of annual growth to stand	1.05 per cent
Annual growth on spruce trees over 10 inches diameter	23.6 cu. ft.
Less amount added to defective trees	20 cu. ft.
Equivalent of 20 cubic feet in board measures about	120 feet.
Annual growth on acre supposing all species add same ratio to their volume as spruce	40.7 cu. ft.