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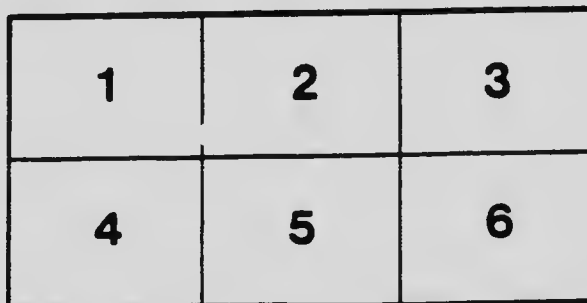
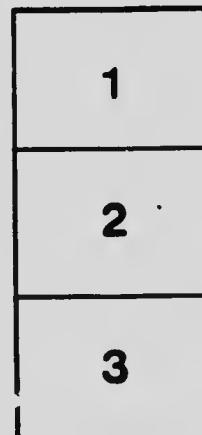
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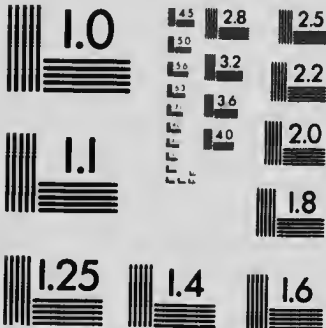
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Commission of Conservation
CANADA

COMMITTEE ON FORESTS

**Forest Regeneration on Certain
Cut-over Pulpwood Lands
in Quebec**

BY

C. D. HOWE, PH.D.
*Faculty of Forestry
University of Toronto*

Reprinted from the Ninth Annual Report of the
Commission of Conservation

OTTAWA--1918

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BEFORE describing certain investigations on cut-over pulpwood lands in Quebec, I desire to make a few remarks upon the general situation. The necessities of war are driving home to us the importance in our national economy of natural resources, among which our timber resources take a leading place. There never was, and, for years, never will be, a time when it is more important for us to know what our timber resources really are, not only in terms of board feet and cords, but also in terms of their application to new uses.

For thirty years, in meetings similar to this, we have been discussing the management of our timber resources, but what have we accomplished? Of many facts, fundamental in the efficient management of the timber resources of the country, we are woefully ignorant. For example, what do we really know about the extent of the timber and pulpwood resources of Ontario and Quebec, though these provinces, combined, contain the largest timber-producing area in Eastern Canada? Where else is there such a large timbered area, containing so many valuable species, with such wonderful transportation facilities, both natural and artificial, and so near, relative to the great markets of the world?

This great timber-producing area has been right in our backyard all these years. It now has along its borders a population of 5,000,000, whose consumption of wood products is increasing every day; and just over the fence are the populous Eastern States, with their urgent demands for Canadian wood products. In the face of constantly widening markets and increasing demands, have we really made a systematic, sustained effort to determine the possibilities and the actualities of the timber resources of Ontario and Quebec? Do we know whether this area can meet the demands now being made upon it, to say nothing of the much greater demands in the future? The United States is thoroughly alarmed over its declining pulpwood supply, we are so ignorant of ours that we do

not know whether to be alarmed or not. Is that an enviable situation for an intelligent and progressive people?

THE PROBLEM ANALYZED

Survey of Pulpwood Resources

There are at least three definite lines of enquiry to be pursued in connection with the problem of our pulpwood supply. In the first place, there should be a definite stock-taking of the commercial material now available. We must know what we have before we can make any sensible plans for the future. Not every acre, nor even extensive areas, should be actually cruised, for the results would not justify the expense; but sufficient cruising should be done and enough data gathered to permit of reliable estimates being made. Such work has already been done by the Commission of Conservation in British Columbia, and it is under contemplation for Ontario.

Estimates of the available commercial pulpwood supplies in the province of Quebec have been made, but, as yet, there has been only a partial methodical stock-taking, despite the fact that Quebec is the most important pulpwood area in Canada, supplying over one-half of the pulpwood produced in the Dominion. Nearly half of the pulp mills in Canada are situated in Quebec. With her long southward-flowing rivers, extending into the very heart of the pulpwood regions, with her water and rail connections, Quebec is much nearer the ultimate market for most pulpwood products than any other province with an equal supply of material. Indeed, this very accessibility increases the danger of early exhaustion of her supply. Logically and economically, Quebec should be the first to institute a thorough-going investigation of her present supply of pulpwood.

Rate of Growth

Once we have taken the initial step of ascertaining how much pulpwood we have in Eastern Canada, its distribution and its accessibility, we can, with a known rate of consumption, make a reasonable prediction as to the duration of the supply. Since, however, we are dealing with living wood substance, which has the wonderful power of regenerating itself each year, we must take another factor into consideration, namely, the rate of growth or, in other words, the annual accumulation of new wood fibre in our spruce and balsam forests. This brings us to our second line of enquiry, viz. a detailed study of growth and production, involving the making of stem analyses on carefully selected areas. To be sure, this is little less than drudgery; it is tedious, heart-breaking work, especially if done in 'fly' time; but it is only this kind of investigation that can furnish data by

which a ratio between the annual accumulation of wood fibre and the amount annually removed by the pulpwood operations, can be established. This ratio is essential to a reasonably accurate prediction of the duration of the pulpwood supply.

Product of Pulpwood Species The replacement of the pulpwood removed by any agency is brought about in the first instance by the growth of the small non-commercial trees already on the area. These, in turn, become of commercial size, they are eventually cut, and their place must be supplied by new individuals. New spruce and balsam must establish themselves in the forest if the supply of pulpwood is to be continued beyond one generation of trees. Therefore, the third line of enquiry to follow in order to solve our problem, is the rate of reproduction of the pulpwood species on the cut-over pulpwood lands. If the logging operations, or the fires which often follow them, change conditions to such an extent that spruce and balsam cannot maintain themselves in their former commercial quantities, the supply of pulpwood on those areas cannot be maintained.

GROWTH AND REPRODUCTION IN ST. MAURICE VALLEY

Investigations to determine the rate of replacement of pulpwood material by growth and by reproduction on cut-over lands, were carried out by the Commission last summer. Through the generous co-operation of the Laurentide Company and its forester, Mr. Ellwood Wilson, the work was carried on in the holdings of this company in the lower portion of the St. Maurice valley in Quebec.

Balsam Predominant The forest here contains patches of pure hardwoods and patches of pure conifers, but mostly they occur in mixed stands. Numerically, balsam leads in the mixture, with 36 per cent, yellow birch comes next with 26 per cent, and spruce, which, by the way, is practically all red spruce and not the same as the black spruce, as is generally supposed, makes up 20 per cent of the forest. The minor species are cedar, 7.3 per cent; sugar maple, 5 per cent; paper birch, 3 per cent; hemlock, 1.4 per cent; and beech, 1.3 per cent. This type of forest occupies between two-thirds and three-fourths of the region studied. The old burns and the swamps were neglected.

It must be borne in mind that the results and conclusions herein stated refer only to this particular forest type and are in no way to be construed as applying to other portions of the St. Maurice valley, or of Quebec.

**Survey by
Strip Method**

As already stated, the chief object of the investigation was to determine the condition of these cut-over lands with respect to the degree of regeneration and the rate of growth of the present pulpwood-producing species, namely, spruce and balsam. Sample plots were made by the strip method. These strips, run on a compass line, were one-half chain wide and varied in length from 1 to 80 chains. All the trees on the strips above 8 inches in diameter were calipered. Those from 8 to 4 inches in diameter were classed as poles, while those 4 inches in diameter down to trees breast high, were designated as saplings. At the end of every second chain, a square rod plot was marked out and the number of seedlings on it counted, any tree less than breast high being considered a seedling without regard to its actual age. The number of seedlings per acre was calculated on the basis of these square rod plots. The ages of the seedlings in relation to the time of the cuttings were also determined. The stumps on the strips were also calipered and the age of the cutting determined. The total area of the sample strips on which the trees of all sizes were thus measured, counted, and classified, comprises 60 acres.

The growth studies were made for the most part on four sample plots varying from 1/10 to 1 acre in size. Every coniferous tree larger than a seedling on these plots was cut and a complete stem analysis made of it. In this manner, the rate of growth of some 2,000 trees was determined.

**The Forest
Primeval**

The original forest in the southern portion of the St. Maurice valley was undoubtedly dominated by pine, probably, for the most part, white pine. We found, on the average, 6 pine stumps to the acre still standing. This is the average of all the sample plots taken in all the various conditions. Only 8 of the sample plots failed to reveal at least one pine stump, and on some, the pine stumps ran as high as 20 per acre. Considering that the first cutting of pine in this region took place between 60 and 70 years ago, and that there has been practically no cutting of it for 30 years, thus allowing 30 to 70 years for the stumps to decay, it is quite remarkable that the average of all conditions should yield 6 stumps to the acre still recognizable as pine. Undoubtedly, we are safe in assuming that the original number of pine trees was considerably more than 5 per acre.

**Formerly a
Black Forest**

However, I do not think of the original forest as having been a pure stand of pine. Although pine was biologically dominant, it was outnumbered by other species. I picture the original forest as having a distinctly two-storeyed crown cover. The lower storey was a mixed forest of

yellow birch, maple, spruce, and balsam, in abundance in the order named. Towering 50 or 75 feet above this were scattered giant pine trees from 3 to 6 feet in diameter, from 100 to 150 feet high, and probably 200 to 300 years old. Had there been only six such trees to the acre, they would have dominated it, but there were probably more, but not sufficient, however, to form a complete crown cover in this upper storey, except on rocky ridges. In the latter situations we often found from 20 to 30 big pine stumps to the acre, evidently indicating a pure stand. To one flying over the region at that time in an airplane, it would have appeared as a 'black' forest, that is, one in which the pines predominated over the hardwoods.

Passing
of the
White Pine

To-day the conditions are reversed; it is a 'green' forest, that is, one in which the hardwoods predominate. This change of conditions in the past 50 to 70 years is very interesting biologically, but it also has an important commercial significance. Those areas which have yielded enormous quantities of white pine are, commercially speaking, denuded of that species to-day; only scattered groves on rocky, inaccessible ridges and elsewhere an occasional tree towering above the hardwood forest, remain. Not only this, but of still greater significance to the future, white pine is not reproducing itself; there are practically no young trees in the forest. Except on the borders of lakes, the margins of swamps, and around old camp clearings, we did not see, under the normal forest cover in our investigations last summer, two dozen young pine trees. Yet we found old pine stumps everywhere. I can show you areas which once had 20 pine trees to the acre, but are without even a young pine tree to-day. Moreover, there are no coniferous trees in the crown cover—only a solid mass of yellow birch and hard maple.

Why a Green
Forest Now?

There are, however, abundant balsam and spruce beneath this crown cover ready to push through whenever opportunity offers. Note especially that the areas of which I am speaking have never been seriously devastated by fire, the chief cause of the failure of white pine reproduction in Canada. Why, then, have these areas changed within the life time of some of my audience, from a dominant pine to a dominant hardwood forest? Why did the pine not reproduce itself after logging and so maintain itself in the forest? The hardwoods were probably originally more or less suppressed by the pines, both by shading and root competition. The removal of the pine stimulated the development of the hardwoods so that they soon filled up the gaps. The crown cover below the pine was probably continuous and cast a deep shade. The luxuriant underbrush formed another

shade-producing layer. These two layers excluded so much light that the young pine trees could not develop. The seeds doubtless germinated and the seedlings may have persisted for some years, but not receiving sufficient overhead light, they were eventually crowded out by the shade-enduring hardwoods.

**Over 100 Years
for Spruce
to Grow**

These some-time white pine areas were subsequently cut over for spruce saw logs or pulpwood at least twice and some of them three times. Our growth studies show that all the spruce trees since removed by lumbering operations were present in the original forest beneath the pine trees. They were at least 6 inches in diameter and about 100 years old when the pine was cut. Many lumbermen think that the second cutting on an area is from young trees which have grown since the last cutting. The area which we are describing has been cut two or three times in the last 30 years and the youngest spruce cut was over 100 years old, most of the trees being more than 150 years old. This is the length of time that it takes to make a spruce forest from seed to pulpwood size, when the spruce grows up in company with hardwoods.

**Seventy Years
for Balsam**

The situation is somewhat different, however, in the case of balsam. Some of these trees now being cut for pulpwood were seedlings scattered on the floor of the original forest at the time the pine was first cut, that is, 70 years ago.

We counted and measured the stumps on all our sample plots. The spruce stumps averaged 22 per acre. At the present time, there are 6 spruce trees per acre entering the crown cover and over 70 years old. Therefore, at the time of the first cutting 70 years ago, there were 28 spruce trees 8 inches or more in diameter on the average acre. It is interesting to note in this connection, that according to Mr. Ellwood Wilson, forester to the Laurentide Company, there are 26 spruce trees 8 inches and upward in diameter in the virgin forests farther northward in the St. Maurice valley. This result is derived from cruising surveys, totalling over 1,000 acres and representing about 3 per cent of the area through which the strips were run.

Thus, you see that the number of spruce trees has been reduced from 28 per acre to 6, a reduction of nearly 80 per cent, by the lumbering operations of the past 30 years, the period during which spruce has been cut for saw logs. Our results show practically the same number of balsam as spruce trees taken from the average acre, namely 22, and the number of balsam larger than 8 inches in the present forest is also practically the same—6 per acre.

**Black to Green
in 30 Years**

Let us go back and look a minute at the original forest, a pine forest with a mixed spruce-balsam-hardwood under-storey, giving the general impression of a 'black' forest. The pine was cut and did not re-establish itself; 80 per cent of the spruce and perhaps the same amount of balsam was cut. The result: within 30 years a 'black' forest was changed to a 'green' forest; it was changed from a softwood forest, to a hardwood forest.

**Its Economic
Significance**

Very interesting, you say, but what of its economic importance? It is this: the pine and spruce and balsam are valuable, but the hardwoods, the beech, birch, and maple are, so far as we know, valueless, being too far from markets to be utilized at the present prices. Let me state the case from another standpoint. The sum of the basal areas of the spruce *stumps* of the various diameters on the average acre is 25 square feet. The basal area of the spruce remaining on the average acre is only 5 square feet. The volumes of trees are proportional to their basal areas. This means that the capital stock and, therefore, the earning capacity of those areas are only one-fifth of what they were originally.

**Young
Growth**

There is, however, at least one other point which we should investigate carefully before we become too pessimistic in regard to the future of these cut-over lands. I refer to the young growth, the spruce and balsam trees not yet of commercial size. Are they in sufficient abundance to insure another crop? If so, when can we expect that crop? As already stated, these are the two principal questions we had constantly before us in our work last summer.

Here is the answer to the first question:

Species	Seedlings (trees up to 1-in. diameter)	Saplings (1-in. to 4-in. diameter)	Poles (4-in. to 8-in. diameter)	8-in. to 12-in. diameter	Total	Per cent
Spruce.....	635	99	30	6	770	14.8
Balsam.....	3972	161	59	6	4198	80.8
Cedar.....	180	32	8	4.2
Hemlock.....	8	2	1	..	11	0.2

**Mortality
Rate**

At first glance, this looks very bright for the future, but let me refer once more to the mortality rate. There are 635 spruce seedlings per acre, but when they get up near commercial size, they are all dead but 6. The

percentage of loss is still greater in the case of the balsam. In the beginning, there are 6 times as many balsam as spruce, but when the balsam gets into its commercial class of 7 inches diameter, there are only about twice as many.

You may say that the conditions have changed since the '8-in. to 12-in.' trees came through the forest cover and a larger percentage of the smaller-diameter classes will survive. You may be right. Conditions certainly have changed, but my impression is that, from the standpoint of the spruce at least, and perhaps also for the balsam, they have changed for the worse. Each logging operation has stimulated the growth of the hardwoods more than that of the softwoods. The crowns of the large trees soon fill in the gaps and a dense thicket of hardwood shrubbery is developed on the forest floor, thus producing more shade and suppressing the spruce and balsam still more.

**Outlook for
Spruce**

Turning now to the '4-in. to 8-in. diameter' class, we find 30 spruce and 59 balsam on the average acre. Twenty of the spruce and 40 of the balsam are dominant and they stand a good chance of persisting. If they should all enter the commercial class, they would furnish a sufficient future supply *in time*. 'In time'—that is the second phase of our investigation. When can we expect another crop? Our growth studies showed that the spruce trees in the '4-in. to 8-in. diameter' class were from 80 to 100 years old, and those of the '8-in. to 12-in.' class were from 100 to 150 years old. Therefore, it would take at least 50 years for the upper range (8 inches) and 70 years for the lower range of the class (4 inches) to reach the 12-in. minimum diameter limit for spruce in Quebec. I think you will agree with me that 50 years is too long for any private concern to wait for another crop of spruce on these cut-over pulpwood areas.

**Outlook for
Balsam**

The present increased demand for woodpulp has led to a rapid increase in the proportion of balsam used. So, if our 40 dominant balsam between 4-in. and 8-in. on the average acre reach commercial size, they would represent a valuable asset. In fact, some in this class are already commercial, for the minimum diameter limit for balsam in Quebec is 7 inches, but, unfortunately, the number of this diameter cannot be segregated from the '4-in. to 8-in.' class. However, according to our growth tables, it takes only about 10 years on the average for a balsam to pass from a 4-in. tree to a 7-in. tree; so, within that time there will be another crop of balsam on these areas.

Several factors, however, greatly reduce the value of balsam. As is well known, it is much subject to disease and windfall. Mr.

Wilson finds that, on the average, 44 per cent has butt rot. In certain conditions, we found as many dead trees as living. One rarely sees a balsam tree 14-in. in diameter and the great majority never get beyond 9-in. before death overtakes them. Such small trees scattered through a mixed stand may raise the logging cost to a prohibitive point.

MEASURES FOR REFORESTATION—HARDWOODS vs. SOFTWOODS

We come now to a consideration of what is to be done with these cut-over pulpwood lands. They belong to a provincial government and are leased by private corporations, chiefly by companies manufacturing paper pulp. They should, therefore, be considered from the standpoint of both these interests.

The Individual's Viewpoint

First, let us look at the matter from the standpoint of the private company. So far as another crop of spruce on these lands is concerned, the case is hopeless. No private concern could afford to wait 50 years, paying annual rental for that length of time for the sake of a few cords of pulpwood, probably less than three, per acre. The amount of balsam obtainable in the near future is problematical until we have had an investigation of the rate at which the everywhere prevalent heart rot is progressing.

Utilizing the Hardwoods

If the hardwoods could be utilized without too much destruction of the young spruce, the problem might solve itself. At present, the market for them is so far distant and the difficulty of transportation is so great that they are apparently valueless. However, some investigations of possibly great significance are about to be instituted by the forester to the Laurentide Company. Trials are to be made of the applicability of paper birch for pulpwood. There are enormous quantities of this in Quebec, impeding the growth of the spruce and balsam by its shade. It may be possible to establish a rotation between the softwoods and hardwoods and so keep the land continuously productive.

Birch for Railway Ties

The possibility of the use of yellow birch for railway ties is to be investigated. There is no doubt of the market for this purpose. The question is whether they can be profitably handled at present prices. If it proves profitable, the over-topping birch would be removed and a much larger portion of the 700 young spruce trees to the acre might develop into pulpwood.

If these possibilities become actualities, then the private concerns will not be compelled to surrender their leases.

**The
Government
Viewpoint**

Since these lands are to be held in perpetuity, it may be that their productive capacity in terms of spruce could be increased by raising the diameter limit, say to 14 inches. A conclusive determination of this point would involve a careful study of the comparative rate of growth of the trees 12 and 13 inches in diameter, and whether the increased growth, if present, or the increased stumpage value, would outrun the compound interest charges on the extra capital invested in the 12-inch and 13-inch tree. Since, however, at the present time, one finds only one 12-inch spruce tree on 5 acres and one 13-inch tree on 10 acres, and since, according to our growth studies, it will be 100 years before the 30 trees per acre in the 4-inch to 8-inch class will get into the 14-inch class, I have not made the computations necessary for the discussion of the benefit of raising the diameter limit.

There is, however, another consideration that seems to me important in determining the future of the lands from the government's standpoint. The hardwoods are at present biologically dominant on these areas. It may be that this is what nature intends, and that we have too great a handicap to overcome in trying to put the spruce back by natural means. Certain investigations to which I will refer later, may throw light on this point. If nature is really against us, it might be the best thing to cut every acre off clean, if a market could be found for the hardwoods, and start the spruce anew by planting. An experimental plot of this kind, of 60 acres, has already been inaugurated by the forester to the Laurentide Company, and its development should be watched with much interest. It may be that, even here, the biological conditions will prove the more favourable to the hardwoods and keep the spruce always in a subordinate position.

**Lack of
Accurate
Knowledge**

We talk easily of what we should do with a forest. In this particular case we want to increase the production of spruce, the most valuable species at present on this cut-over land, or at least, we would like to restore it to its former position in the forest. How can this be done? One man says: "Cut heavier, open up the crown cover, let in the light." Another man says: "Make a lighter cut, disturb natural conditions as little as possible." The result cannot be obtained by methods so directly opposed. What is the answer? The answer is that neither man really knows what he is talking about. Your opinion may be just as good as mine, because both have been spun out beneath our hats, or evolved from smoke rings, as we sat in our office chairs. We have no accurate knowledge, no definite records, no actual

measurements by instruments of precision, of the conditions as they really exist in Canadian forests. I repeat what I said in the beginning. We have been discussing the management of our timber resources for 30 years, but, as yet, we have not the fundamental knowledge of conditions on which it is necessary to base our plans, if we were asked to-day to put them into operation. What definite knowledge we do have as to conditions in which trees grow is borrowed from other countries, even European countries, whose conditions are not our conditions. Is it any wonder that we are groping in the dark? And we will continue to grope in the dark with this matter until we obtain actual experimental records of those environmental conditions that fashion a forest.

Experimental Procedure

Let me illustrate what I mean by using the Quebec cut-over pulpwood lands as an example. Here we have over 700 young spruce trees to the acre growing beneath a birch-maple forest. Normally, only one per cent of them lives long enough to make a commercial tree. The problem is to determine whether opening up the overshadowing crown cover to various degrees would bring a larger number of these suppressed spruces to maturity and thus increase the value of the land to the owner. To solve the problem, in certain plots, a light cull, a medium cull, a heavy cull, and a clear cut of the over-topping hardwoods should be made; and then, a definite record of results kept during a series of years. The intensity of the light exposure on each plot should be measured periodically; the rate of the filling up of gaps by the side growth of the tree crowns should be measured; the behaviour of the shrubby layer should be noted; any changes in the humus content or in other soil conditions should be studied; the height growth and the diameter growth of the little spruces should be measured periodically, at least every fifth year. The trees that show stimulated growth should be studied very carefully in respect to their root development, the moisture condition of the soil in which they are growing, the relative number and the size and vigour of their leaves.

Inherent Dominants

The necessity of studying the *successful* trees is emphasized because they may be the key to the whole situation. In a nursery bed, certain seedlings are more vigorous than the majority, making three or four times as much growth in a season as their companions. Now, it may be that they are inherent dominants, and once dominant, always dominant. We know there are inherent dominants among animals, including man. Why not among trees? If this be the case, why waste time and money planting any trees but dominants. It may

be that those which survive in the struggle for existence in the forest are those which are predestined to survive from the beginning. The truth or falsity of this suggestion is capable of being demonstrated by field experimentation and, logically, is the first problem to be solved, for, if true, it would automatically solve many other problems as well and render further experimentation along certain lines unnecessary.

**To Determine
Effect of
Light**

One more illustration of the necessity of field experimentation. Why is the young balsam so abundant and so aggressive in the logged-over forests; why is it more successful than the spruce, its principal competitor? Unless checked by its greater susceptibility to disease, balsam may, in time, dominate all our northern forests—no longer pine forests, no longer spruce forests, but balsam forests. Why the dominance of balsam reproduction? One man says it is because the balsam can endure more shade than the spruce, and another says the spruce can endure shading better than the balsam. One man makes the first statement in one of his papers, and the last one in another; and one of our best authorities makes the two contradictory statements between the covers of one book. Personally, I think the importance of light as a determining factor in the forest has been very much over-estimated by foresters. We have accepted it as a kind of tradition from our fathers, as we accept other traditions, without thinking very much about it and, still less, subjecting it to experimental proof.

Experimental plots should be established in the forest where the balsam and spruce seedlings are growing naturally and the light intensities should be measured in the two cases. Not only this, but other points need investigation, such as the comparative vigour of the roots of the two seedlings, their ability to penetrate the leaf litter in order to reach the mineral soil; their relative ability to endure drought; the rate and abundance of root growth in the two cases. With data of this kind, the result of measured records of environmental conditions, we could determine the reasons why certain methods of lumbering encourage the growth of balsam and discourage the growth of spruce. With such data, we could discuss with intelligence the means by which to increase the production of spruce pulpwood in Quebec.

To improve upon nature, we must first know how nature acts and reacts upon the thing we wish to improve. This is so self-evident as to be axiomatic, but, thus far, we have made no determined and sustained effort to get such data in regard to the forest. This has been the basis of plant and animal breeding and it must

be made the basis of forest breeding. We must not be deterred because trees grow more slowly than other plants and, definite results are, therefore, slower of attainment. It will require patience, perseverance, and time, but when it is done, we will have reliable data on which to base our plans and will be in a position to manage out timber lands intelligently. We could substitute a *real* policy for the trust-to-luck-and-nature policy of the past, in which both luck and nature have been against us, and which has already reduced a large portion of our incomparable forest heritage to the condition of waste lands.

