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BY

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FOREST MANAGEMENT IN MAINE.

BY AUSTIN CARY, A. M., FORESTER TO THE BERLIN MILLS CO.

[Read before the Boston Society of Civil Engineers, May 10, 1899.]

In any broad view of the forest interests of Maine we should begin with topography. The ruling topographical feature of the State is a broad plateau* stretching from west to east, dividing its area into a northern and a southern slope. Of these slopes the northern is the smaller, embracing the watershed of the St. John river. The southern slope is a belt along our entire coast line on the average 140 miles wide.

A further feature to be noticed is the fall of the divide from west to east, from the foot of the White Mountains, in New Hampshire, to Mars Hill, on the borders of New Brunswick. The Rangeley lake system at the west is between 1,400 and 1,500 feet above sea. Moosehead lake, at about the center of the line, lies at 1,020 feet. The highest point on the boundary between Maine and New Brunswick is about 500 feet above the sea level.

The botanical features of the State hang largely on the topography. In the southwest, for instance, a large district, low-lying and with a mellow soil, is united botanically with Massachusetts and Southern New Hampshire. Oaks are prominent in the woods here, and white pine was the staple of the original soft wood timber. On the other hand, the plateau country presents a Canadian flora. The hard wood trees are the birches, maples, etc., characteristic of a colder region, and spruce forms the largest and most valuable part of its soft wood timber. In the west, where the boundary of the plateau is sharp, and where it has its greatest elevation, the contrasts in timber stand are greatest. Eastward, with the easier topography, there is more variety and mixture.

We must next observe that a large part of the State of Maine is destined to remain permanently wooded. The bulk of our population is now and will continue to be located in the lower southern part, where milder climate, abundant water power and areas of fertile soil offer advantages. Again, there is a strip of land with easy topography and very fertile soil along the New Brunswick line in Aroostook county. Out of these areas indeed a large proportion is wooded, and some bodies of land included

*For the original statement of these relations, and valuable information as to Maine's natural features and resources, see Wells' "Water Power of Maine."

within them are of such a character that they never will be inhabited or cultivated. For the great district remaining, about half the area of the State, the same thing is true. It is high in the first place, and the season of growth is short. As a rule the topography is rough and the soil poor. Considerable of it, indeed, is little more than ledges and piled up rocks.

Half the area of the State, then, about 15,000 square miles, seems destined to be permanently forest. This is an area twelve times as large as the Black Forest* in Germany. The states of Massachusetts, Rhode Island and Connecticut, taken together, just about equal it in area. The importance of this body of land as a source of wood material is evident from the statement. The relation to it of business development will be seen later on.

Since its settlement Maine has always had a lumber business; that is to say, lumber has been cut and sawed here not only for local consumption, but to export to other communities. Many of the earliest settlements in the State were built about accessible mill privileges, and later movements of population have in considerable measure been related to woods and mills.

The development of the lumber business has proceeded according to evident laws. In the natural condition pine was at once the largest, most valuable and most accessible timber that the State possessed; pine, therefore, was the first timber to be taken. It was taken, too, where most easily accessible, along the coast and on the banks of the rivers, where it could be floated to mills, run by tide or located at the first powers above their mouths. As the best class of timber failed in the first locations men pursued it further up the streams, or spread along the coast to other regions which had not yet been drawn upon. For a long period, however, they cut only pine, even after they had to go long distances for it. In fact, the State had been settled nearly two hundred years, and the larger rivers had been culled for pine clear to their sources on the plateau, before there was a profitable market for other soft wood timber. At length, however, the limits of the pine supply, a supply never so abundant per unit of area in the northern wilds as in the low-lying parts of the State, began to be approached, and spruce began to take the place of pine as the staple of lumber export.

Since about 1840, then, the bulk of the lumber exported from Maine has been spruce, which was cut in the great forests of the plateau and sawed at mills located low down on the Penobscot, Kennebec and Androscoggin rivers. Since the early 70's, however, the sawmills have had a competitor in the log markets of the State in the shape of mills manufacturing wood paper. Beginning about 1870 in a small way, pulp and paper manufacture rapidly increased, and in ten years had become well established. After a period of experimentation spruce wood was

*The amount of actual forest land is here meant, not the gross area.

settled upon as by far the best technically for most uses, and it is now exclusively used in most mills. The amount of this use can be judged of from the mill capacity. In 1894 the pulp and paper mills of Maine numbered forty, and represented, as reported to the State Labor Commissioner, an invested capital of $12,000,000. They employed between 4,000 and 5,000 men, and had a daily capacity of 397 tons of paper and 765 tons of pulp. At the beginning of 1899 the mills of Maine reported to the directory of the trade a daily capacity (not production) of 650 tons of paper and more than 1,000 tons of pulp. In this respect Maine stands second only to New York among the states of the Union.

Here we get at what is at once the big and the pressing matter in connection with the forests of Maine. Paper making is one of the great, stable and growing industries of the country. It is mainly dependent on spruce wood because spruce excels in length and strength of fiber, and is most readily reduced to the macerated condition. Now the woods of Maine possess the largest stock of spruce wood existing within the limits of the United States, while probably in a still greater degree they embody growing capacity. The question what that resource amounts to, the question, too, how it is being used and what may be done to foster it, are questions of concern to the whole country.

The people of Maine have been behind in the appreciation of their natural resources. The State is approximately 31,500 square miles in area. Wells in 1869 estimated, excluding water and cultivated land, that two-thirds of it, or 21,000 square miles, was covered with woods, and the conditions since then have not greatly changed. The area destined to be permanent forest, as earlier defined, we may set at about half the area of the State, or 15,000 square miles. Probably more than that, even taking out waste areas in the shape of burnt land and barrens, now possesses spruce of at least some small value. As to amounts of timber standing, no careful summaries have ever been made, except for some comparatively small portions. Much of the country never has had the timber upon it estimated, and if that had been done a vast amount of digestion and re-exploration would be required before the figures could be safely compared and summarized. The best that can be done here to give an idea of the condition of the Maine woods is to describe very generally and cursorily different tracts of country.

Some 12,000 square miles on the St. John and upper Penobscot are timber land of very varying quality, containing every variety of stand natural to the region. Considerable areas in the aggregate have never been cut for spruce, and the cutting that has been done has generally been for saw logs of good quality merely, and pretty loose and unsystematic. The area named has not been seriously damaged by fire. Here, due to its area rather

than quality, is the great supply of spruce wood now existing in the State.

The Kennebec river drains 5,800 square miles, but less than half this area could be classed now as actually spruce producing. But at the heads of the streams, in very difficult situations, small tracts yet remain that never have been cut for spruce; but the remainder has been cut through, much of it severely and several times over, while both in early and more recent years the region has suffered severely from fire.

The Androscoggin river possesses about the Rangeley lakes the best spruce timber land in the State. It has been saved from fires, and, due to the roughness of the land, much of it has thus far escaped cutting. The drainage is of small area, however, 2,750 square miles in Maine, and half of that, in the lowlands of Southwestern Maine, cannot be considered as spruce producing. There is also a great mill capacity located in this region. At Berlin, Livermore and Rumford are some of the largest paper mills in the world, and while they draw in a considerable portion of their wood supply from Canada and elsewhere by rail, the Androscoggin drainage itself is being called upon for timber at a rate and in a matter that will within a few decades, if continued, blot it out as a source of spruce timber.

Other items of the timber supply of Maine are of minor importance, at least in the present connection. Southwestern Maine has white pine as its main soft wood growth. This is a quick-growing wood, and on it that part of Maine does a considerable lumber business. This item is seldom thought of in connection with the lumber supply of the State, but, as a matter of fact, wooded lands in this region are probably producing more per acre than the backwoods. Pine, however, is seldom used in the manufacture of paper.

Most of Washington and Hancock Counties, in the southeast, consist of poor and rocky land, fit for nothing else but the growth of timber. This country, however, has been long and hard cut. A good half of its area, too, has been burned over, and while burned land almost always quickly grows up again, fire changes the character of the growth and sets it back as a producer of lumber. As to spruce supply, as available now and in the next fifty years, the main items have been considered already.

Under the circumstances it is perhaps rash to set any figures for the timber resources of Maine. In stating clearly, however, that such a figure can be merely a rough guess consequences of presumption are deprecated. It seems probable, then, that twenty-five billion feet, board measure, may approximate the amount of spruce wood standing in the State. The total lumber cut in the State in 1896 was something over six hundred millions. Of this probably five hundred millions was spruce. About two-fifths of this went to the paper and pulp mills.

Six hundred millions is equivalent to 30 feet per acre on the gross area of the State. Five hundred millions may be 50 feet per acre on the area of what we might call spruce producing land. These figures are within the amounts which such studies as have been made attach to ordinary cut-over land as its yearly growth. Certainly, they are small in comparison with what we know scientific forestry has produced elsewhere.

The general inference to be drawn from these facts is not a discouraging one. Our resources are still great, and we may feel justified in using them freely. It is to be remarked, however, that paper mill capacity in the State is being rapidly increased at the present time, and promises to reach in the near future a much greater development.

It might be remarked of the foregoing that it is business and not forestry. The reply to that is that whatever forestry we are to get in Maine, at least in the near future, must be worked out under business conditions. The State of Maine is not likely to interfere by law with the conduct of private business. Neither does it appear that State ownership of wild lands to any great extent is likely to be brought about. Maine is poor in comparison with the states that have inaugurated that policy, while it is not called to that course by such urgency. Agriculture has not, to our knowledge, been affected by the cutting of our forests. The flow of our rivers has not been affected to such an extent as to elicit protest or a call for investigation. The climate of Maine is such that almost all denuded or burned areas very quickly reclothe themselves with growth which, if not valuable at once for timber, at least protects the surface of the ground beneath it.

The man therefore who would throw in his lot with the forests, who would economize in their use and maintain their growing power, must bring himself to bear on the forces in the field. He should not be choice in his weapons. The spread of information will accomplish much, but competition, when it can be brought to bear, may prove a more effective tool. Forestry should seek to ally itself with business, to promote the success of careful and foresighted concerns. The forester, if he would work directly on the problem of management, must work in private employ and in accordance with its fundamental conditions. First among these is the necessity of making profit. Should the forestry practiced lead to loss, the business goes down and the forester's position and opportunity go with it.

The lay of the land in this quarter will become more evident if we briefly review the systems of landholding and management existing within the State. First is the stumpage-selling system, long current and now in vogue in the timber lands of central and northern Maine. The land title in this case is held by men who neither own mills nor cut logs. Neither, as a rule, are they practical woodsmen. They are simply men of means who have acquired lands by inheritance, or who, having found out that

timber land is a safe and profitable investment, have bought it on the judgment of others. They sell lumber standing at so much a thousand, and do not as a rule exercise, either directly or through their representatives, any effective supervision as to how it is cut. The man who buys the stumpage may or may not own mills. At any rate, he is interested in getting as good a lot of logs as possible for the stumpage paid and with the least outlay of time and money. He cuts accessible bunches therefore, and leaves distant or scattering timber. He cuts his stumps as high as is convenient, and throws away a quarter of his lumber in the shape of knotty tops, which, though capable of use, are of distinctly less value. He slashes through the country anywhere with his roads, and makes no attempt to spare young growth or to save such as is killed if it comes below the class of most desirable timber. In examining these matters a few years ago for the United States Forestry Division I found concerns where only 60 per cent. of the whole volume of trunk wood was saved from the largest and finest trees, and where, taking into consideration the small trees killed and left, the lumbermen put into the water less than half of the timber killed.

Such methods as these are an heirloom from former times, but they are rendered possible in the present only by the system of landholding under consideration. The trouble is the interests of the man who does the work are divorced from those of the land on which he is operating, and that this is not offset by strict contract and supervision. The power of remedy lies with the landowners, who are strong parties and who would benefit by careful handling of their lands. In a few cases this has been done. Thus the only really conservative force on the Androscoggin to-day is a large body of land held in this way which is operated carefully, and with a view to the future. In many cases, however, nothing can be expected from present owners. The only remedy is to buy them out.

Again, landownership in the past has often been a subsidiary part of the sawmill business. Men engaged in lumber manufacture found they could buy land cheaper than logs, and did so, going on often to do their own lumbering. In their cases logging work is frequently somewhat more economical, but it can hardly be said to be more foresighted. The man's object here is to stock his mill. Beyond that the land has no value.

An example here, an extreme one, to be sure, will serve to show what is sometimes lost under the present methods of conduct of the lumber business. I happen to know where a very large amount of spruce timber, belonging to one concern and standing in one compact body, was killed by the ravages of insects. Within two years from the death of the trees there must have been a loss on the lumber not far from 50 per cent. After five years or so there would be nothing there worth going after. And yet, due to stupidity, obstinacy or to financial pressure, no

adequate measures were taken to save it. In fact, the dead timber was left to rot, while nicely growing land that had once been cut through was stripped off beside it because logs could be got there a little cheaper. What good forest management consists of in such a case is very evident. The fact illustrates the principle that good forestry is very often identical with sound business. Neither one is possible if there is too great financial pressure.

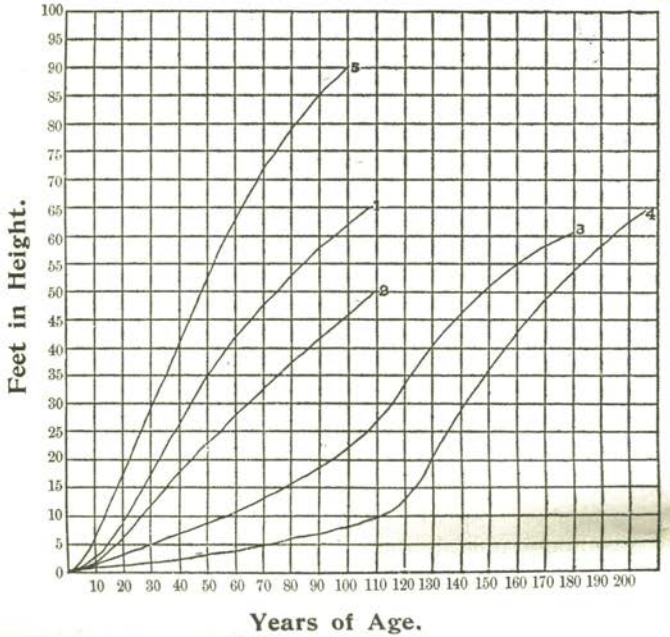
Whatever the economy of his work, from the point of view of forestry, there is one fundamental trouble with the sawmill man's attitude to his land. He regards it simply as a source of stock for his mill. He buys the land to strip it. He wants to get his money out quickly and put it into some other investment. So he takes principal as well as interest, the stock of wood needed for growth and reproduction, and not merely the mature crop. If, in years back, owing to slack methods and the condition of the market, a good deal of growing lumber has been left standing, that is entirely aside from his main purpose and intention. At present some of our most destructive and thoroughgoing cutting is being done by sawmill men.

Since the pulp and paper mills began to be a strong factor in the log market of the State a good deal of hue and cry has been raised, because they cut or caused to be cut much of the small growing lumber. Small logs could be used by them to quite as good advantage as large ones, while, since they were less desirable to the sawmills, they could be had much cheaper. There have been, therefore, of late years two classes of logs on our larger rivers, saw logs and pulp, selling at considerably different figures.

The pulp mills have been justly criticised on this head, and yet there are considerations here that should weigh strongly in their favor. They have worked great economy in the use of our forest resources, have taken vastly more from our lands than would have been possible under the old *régime*. The pulp mill can use the knotty tops; a seamy or crooked tree is as good as a perfect one; the small trees cut or smashed down, which in other times were left to rot, can all be utilized by the pulp mill. Sometimes tracts of land are given a value, and can be operated at a profit for pulp, which would never have been cut for saw timber.

And if, in the direction of economy, the paper mill has vastly raised the standard, it has seemed to promise the same in the direction of foresight. In beating about among the lumber consumers of the State, as just mentioned, the fact forced itself upon my notice that the men who were thinking pointedly about the matter of timber supply, the men who were most interested in anything that promised to increase and extend the yield from our forests, were the owners of pulp and paper mills. And, on consideration, the reason for this is plain. It is their great investment in mill plant, an investment dependent on forest sup-

plies for life and profit. The contrast with the sawmill business is striking, and, in the present connection, vital. A plant that will convert seven millions of spruce wood a year through the stages of ground wood and chemical fiber into finished paper



Height curves, showing comparative growth of spruce and pine and of spruce under different conditions.

1. Curve of spruce grown on good soil,—land cleared by fire.
2. Curve of spruce on very poor soil,—same tract of burnt land.
3 and 4. Curves of spruces grown up in mixed hard and soft wood under shade.
5. Curve of a pine on same site as No. 1.

requires a capital, mostly in the fixed form, of not far from a million dollars. Many of our operating sawmills, on the other hand, represent a valuation of only $10,000 to $20,000. The paper mill man is tied; he is in the business for a long period. The sawmill, when lumber gets scarce or business poor, may be abandoned.

Thus we have had a movement among the paper mills, yet in its infancy, but apparently increasing, to back themselves with land enough to render them independent. With that movement has gone the purpose to treat those lands carefully and with foresight.

In this movement it seemed as if the financial basis might have been attained for conservative forest management, as if we had solved the problem of so disposing of the ownership of our forests that their value might be preserved and the community at large derive most benefit from them. Still more was that hope

nourished last year when, at the organization of the International Paper Company, with control of 80 per cent. of the output of newspaper of the country, a professional forester was employed, and the intention expressed of living, so far as forest supplies were concerned, within the limits of actual growth. It looked as if the paper mill, backed by forest land, the two operated together as one great permanent investment, was the form in which the bulk of our Maine woods might in time be held. This appeared the more likely because, as many of the mills have been situated, land sufficient to so stock and fortify them could be had for a less investment than the cost of the mills, so that heavy profit from the land part would be a minor matter in comparison with the safety and prosperity of the whole.

We may hope for much from this idea, and yet must be cautious in banking too heavily upon it. It seems sometimes as if American business enterprise were too grasping, reckless and shortsighted to have safely intrusted to it a great natural resource. Heedless desire for immediate gain tends to the overstocking of every profitable line, and ruinous prices and cutthroat competition follow in its wake. Thus men reckoning at the very closest on the price of paper are compelled to figure on the price of pulp wood as one element, and if that is done too closely it shuts out the opportunity to do anything for the land. On the other hand, the danger in combination is that business will be conducted with reference to the stock market rather than to sound business success. Either excessive competition or wrongly used combination is destructive of sound, liberal business. Either, in this case, will prevent doing anything to the advantage of the land.

At any rate, as a safe and satisfactory arrangement for the holding and operation of forest land, we have suggested to us the organization of companies of general investors. Forests, carefully handled, form a very secure form of investment, able to pay a moderate return without loss of capital. In Europe forests have proved the safest and surest investment, being used in that way not only by the noble families and others of the best class of investors, but being held for revenue by cities, towns and states. On the other hand, conditions are right here to keep the forest constantly producing. The investor looks only for interest, and wants his capital kept intact. By that means sufficient wood stock for growth and reproduction is left on the land.

There is vastly more in the woods business and in lumbering than might be imagined by the uninitiated. In developing a township of land for the first time the first thing to do is to get a road to it. Along that road, as business is now carried on in the most progressive localities, is strung a telephone wire. Supplies and communication are thus assured.

Next comes usually improvement of the streams. Our smaller streams are generally rough and crooked. Rocks have to be blasted out of the channel, abutments built to run the logs around

sharp turns and keep them out of the swamps. Dams are constructed to control and prolong the flow of water. These improvements are costly. Some of them have a short life. They sometimes compel a concern to log heavily on a tract while they are there.

This is but a small part of the expenditure, however. On large lakes logs are towed more cheaply by steamer than by hand. Three steamboats of different sizes and patterns are employed to get past the lakes of the Rangeley system, and booms, dams and piers are needed at various points below. Again, several hundred horses are used in the woods work of the company by which I am employed, so that even in the small matter of harness no small amount of care is required to keep a supply in stock, to keep run of its movement and to keep it in repair.

An Androscoggin logging camp contains as a rule forty or fifty men. A woodworker and blacksmith are in every crew to supply it with tools and sleds. Two men manage the cooking, and often another has special charge of the stable and horses. The rest of the crew are divided up by the boss into squads; a teamster with a pair of horses and sled as the nucleus of each, and with him, to do the cutting, a crew of usually four men.

This crew, under present arrangements, works largely by itself. The boss of the whole crew gives it ground to work on, and spots out its main road. He tells the men in general terms what to cut, and visits them once a day to see that they are doing as they were told. Further than that, however, the men run their own work. A man of experience leads off, spotting his road and having a man to help him fell the trees. These two men also cut the log off at the top, cut the limbs off and roll or swing it to where it can be hitched onto by the team. The third man has to trim the knots close, bark the log if necessary, so that it shall drag easy, and, when the teamster comes along, help bind the load onto the sled. The fourth man, meanwhile, is ahead of all his mates, making a road by cutting out the trees and windfalls, filling up the holes, bridging brooks, etc. In our woods the men are mainly French Canadians and immigrants from the British provinces, with some Yankees and a sprinkling of men from the northern countries of Europe. They vary much in experience and capacity. Good men, over and above board, are paid from $20 to $26 a month.

These are the men that the forester has to work with. This is the organization he will have either to utilize or modify in carrying out the purposes he entertains toward the forest. So far this organization has been trained simply to rapid, clean cutting. It has had to get its lumber and get it cheaply, and that is all there is to it.

The forester, in cutting through our spruce woods, wants to leave a stock for reproduction and growth. This, of course, can best be left in the shape of young trees. No one is more inter-

ested than the forester in removing, and so saving, all dead timber that can still be used, and also any defective and declining trees. Usually financial considerations will require much more to be taken, probably two-thirds of all the merchantable timber. If so, the forester is as interested as anybody in having that done thoroughly and well. It must be done economically, however, without waste of wood, and it must be done with as little damage as possible to the young growth which it is desired to retain. And right here, in the matter of saving and protecting the young trees to form a future stock, is where the forester meets his difficulty, both with the men he has in charge and with those who in turn are over him. The way ordinary lumbermen rip, smash and destroy young trees makes a forester sick to the stomach. And, on the other hand, the requirements imposed by his employers in respect to the amount of timber that shall be taken, the form in which it shall be got out and the expense of the operation make it often very difficult to do anything effective for the land. Not the least of the obstacles encountered is the logging boss. As a rule he is very efficient, but having up to the present been a despot in his own domain he is often as opinionated and self-willed an individual as can be met with.

Nothing will convey so clear an idea of the problem involved as comparison and a brief record of experience. In the Adirondacks, under the lead of Messrs. Pinchot and Graves, now of the United States Forestry Division, large tracts of spruce land have been taken in hand, carefully surveyed and examined, and cutting work has been begun in accordance with a carefully studied plan. The ground to be cut through there is traversed the summer before by the forester, and every tree that is to be cut is marked. The cutting itself is very strictly supervised, and no departure from the work marked out is allowed except for the strongest reason. Lumbering methods in the Adirondacks differ somewhat from those of Maine. There is less road cutting. Timber is cut into 13-foot logs where it is felled, and dragged from the stump onto yards by one horse. Now Pinchot and Graves state, in their volume, "The Adirondack Spruce," that in this way they can take out of the forest just such trees as they want, and do practically no damage to the remaining growth. A statement of what they found to be the average stand at Dr. Webb's Ne Ha Sa Ne park will make the matter clear. For spruce alone they found 158 trees per acre under 2 inches in diameter, 75 trees 2 to 6 inches in diameter, 37 between 6 and 10 inches and 31 trees 10 inches and over in diameter that would scale about 3700 feet. In reference to these they state that the 31 trees per acre over 10 inches in breast diameter can be cut out and yet leave practically all the 37 6 to 10-inch trees and the 233 of still smaller sizes to form, as they would, a good growing stock on the land.

In my experience of one year under conditions outlined above no such results were attained as that. First, as accounting for that, was the character of the timber stand. Here, for instance, is the average stand of about 15 acres calipered over on one particular tract. Spruce over 4 feet high and under 6 inches in diameter numbered here 64 per acre. Trees from 10 inches in breast diameter, inclusive, down to 6 inches number 29, and would scale, if cut, about 800 feet. Trees 11 inches and up in breast diameter numbered 47 per acre, and would scale somewhere about 8000 feet. We have here a larger amount of merchantable timber per acre than in the Adirondacks. It is, however, due to size rather than to the number of merchantable trees, while the number of small trees ready to form the succeeding stand is far less than there. To the landowner in consequence the grown timber is of more concern proportionately than the small, and the forester's task of keeping the land stocked is, outside of the natural disadvantages, rendered more difficult.

Again, the forester's work was impeded by the business conditions. The lumber cut on the tract I speak of was to be used, all the largest and best of it, in the sawmill. It was essential, therefore, in order that it might saw to advantage in filling orders for timber, that it be cut long. The logs were, in fact, cut as long as could be driven out of the stream, 35-40 feet. When a tree would make more than that it was sawed into two logs. Now the heavy logs on rough ground required two horses, particularly as they were not being bunched up into small yards for a wagon sled haul, but being dragged often a mile or more directly to the river. Now a road has to be cut out wide for two horses loaded with long logs to get through, and many young trees in consequence are sacrificed. Nor was that the only disadvantage. The weight of a big butt log was heavy for men to handle. It could not be moved far, but trees had to be laid in felling close to the road where the team could get at them, while stuff had to be laid crosswise to roll it on and keep it from bedding down in the snow. Thus in thick timber along a road practically everything would be cut or smashed, and about all that was left would be in the strips between. Much of this could not possibly be helped under the conditions and within reasonable limits of expense. It is often the case that the thinner stands are left with the more promise of growth upon them.

Still, something could be accomplished, and that appears on all accounts worth while. Setting a general size limit of 12 or 15 inches breast high, according to the stand, the crews would go through a country cutting out the dead stuff and the larger timber in a more or less bunchy fashion. On knolls and divides particularly exposed to winds they would be required either to cut everything or let everything stand. The ideal could not be accomplished anywhere. Some timber would be left above the size limit, some that had no promise of growth in it. On the

other hand, more than a third of the small stuff would be cut or smashed down. This, of course, would be hauled and used when large enough to be handled without loss, but it was material which we should have preferred to have grow. As a net result we would leave usually from 1500 to 3000 feet of growing timber on the land.

This is descriptive of a first attempt. In large measure it illustrates how not to do it. It is clear to me that if we are to do anything worth while in forestry our organization in Maine must be tightened up. This is necessary in order to accomplish the purpose of forestry, to leave the land in good shape to grow, but I believe it will pay on the score of simple economy of wood and labor. In particular, if we are to leave our forests in shape to do their best in the way of wood production, the choice of the trees that are to be cut must not be left to ignorant and shifting choppers, but the trees must be marked beforehand by some one who understands the methods and the purposes of the work. In my opinion the logging boss and not the forester is the one who in the conditions of our business here can best do that work.

In adherence to the main purpose of this address, I cannot omit a brief reference to another and in itself a more attractive branch of the forester's business, tree biology and the theoretical grounding of forestry work. Take the matter of tree growth, for instance, the measurement of producing capacity.

Each year's wood growth of a tree is deposited in a ring surrounding on all sides its previous volume. The boundary of each year's growth is usually well marked, and the thickness can consequently be measured. In practice it is better to measure the rings in groups, say of ten each, beginning at the bark. The numbers of rings, taken at several log-cuts along the length of tree, give us, with the diameter of each section, the means of computing the tree's growth for the last decade or for any preceding period. That gives us the individual tree. Hundreds of such computations, made on trees of different thrift and size, allow us to average, and, taken in connection with surveys of number and size of trees the country over, enable us to estimate the growth in a valley or a township.

From the same observations inferences of great value are drawn as to height growth. If a tree, at the ground, has 200 rings we know that it is, at least approximately, 200 years old. If 20 feet above ground we find 150 rings we know that the young tree consumed 50 years in growing to that height. So on up through the number of sections.

The facts are best represented in graphical form. Thus a spruce growing on a piece of burned land at Moosehead Lake was cut down, leaving a stump a foot high. There were 98 rings in it. Fifteen feet above there were 77 rings in the section, showing that 21 years were consumed in growing that height. Ten and one-half feet higher there were 66 rings, and the same

distance above 53. The tree, as cut, was 65 feet high, and, allowing ten years of height growth for the stump, it was grown in 108 years. These facts are represented in curve 1 on the diagram, which will need no further explanation.

The value of this method of representation will be best brought out by comparison. Curve No. 2, for instance, represents the height growth of a spruce which grew in the neighborhood of the other tree, and in the same conditions, except those of soil. It was standing, in fact, on a bed of rocks. No. 5 is the curve of a white pine which grew up with the first spruce, and was of the same age. It shows the rapid production of that species.

Curves 3 and 4 are still more interesting. They represent the growth of spruces which stood in mixture with hard wood in forest whose history had been unbroken for centuries, which had trees of every age and size. Young trees starting in such conditions have to bear shade; they grow slowly for many years, and only perhaps after a century of struggle do their tops get out into free sunlight. And the point is that our spruce can survive and retain its vitality through a long course of such treatment. The tree represented by curve No. 4, for instance, at 125 years of age was only 15 feet high, and contained probably less than one cubic foot of wood. Yet, even by that treatment, the vitality was not crushed out of it. Getting finally free from suppression, it began a height growth equal to that of young trees which had never been suppressed.

Now, study of our spruce timber shows that the bulk of it has come to us through some such history as this. Knowledge of this gives us an important rule for guidance in management. That is, that young spruce in our woods, no matter if they are thin-crowned and seedy looking, yet retain their vitality, and if in our cutting we will at the same time protect them and open them to the light they will reward us for it. This is one great advantage of our spruce. The species is remarkable in this respect.

Last in this line I will present some figures on the volume growth of spruce trees, illustrating what that is in percentage and actual amount. The trees taken for observation ranged from 7 to 14 inches in breast diameter. They were 340 in number, and observed results have been arranged and evened by drawing curves. Inspection of the last column, the amount of yearly growth in wood, shows that growth steadily increases as the tree grows larger; that up to the largest size here represented there is no slack. From this point of view trees of this size are not ready to cut.

Growth of spruce on thrifty spruce land on the Kennebec river, Maine, in volume and per cent. From third report of the Maine Forest Commissioner:

GROWTH LAST TEN YEARS.

Breast diameter.	Volume of trees.	In diam., inches.	In per ct. at compound int.	Yearly growth in cu. ft.
7 in.	6 cu. ft.	1.1	4.3	.26
8 "	8 "	1.15	4.1	.33
9 "	10.5 "	1.2	3.7	.39
10 "	14 "	1.23	3.25	.45
11 "	17.5 "	1.23	2.9	.51
12 "	21.5 "	1.23	2.6	.56
13 "	26 "	1.22	2.4	.62
14 "	31 "	1.2	2.2	.68

The column next preceding shows the percentage that the year's growth bears to the volume of the tree in the different sizes. Here the course of the figures is the other way. According to the table, a quarter of a cubic foot on a tree 7 inches in breast diameter amounts to 4.3 per cent., while twice as much wood on a tree 11 inches through amounts to but 2.9 per cent. Here the forester is checked by financial considerations. The larger he lets his trees grow the smaller is the rate of interest earning on his capital.

Much might be brought out in this connection. I will draw only the practical inference that one prime object of the American forester, who will be required to gain as rapid returns as possible, must be to change over the stand as nature gives it to him, with its large trees and comparatively small rate of accretion, into a thick stand of smaller timber more quickly growing and reproducing. That is particularly applicable to spruce when it is to be used in paper manufacture.

For the present, however, all these matters will be secondary in the mind of the working forester. Conditions vary through the country, and everywhere investigation and instruction have their field. But the man who, in conditions similar to those of Maine, is bent directly on the task of bringing forestry actually to pass, will endeavor to secure first the right financial conditions for his work, and secondly to so organize woods work that it will carry out his purpose toward the land in lines both simple and plain.

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

and it cannot be conveyed to another man. The loss is particularly evident when one manager drops out of a business and his successor has to acquire his knowledge of locality all over again.

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

The basis of the height work is leveling. If possible, connection is made with points known from railroad levels or otherwise, giving thus elevation above sea; then a line of levels is run over roads, or whatever else may be the best route to run on, to the ponds and other suitable marks well distributed through the township to be surveyed. From the points so determined by level I work off with aneroids, returning for correction as often as may be to some accurately known point. Two aneroids are usually carried; a thermometer is read with them as often as necessary, and changes of pressure due to the weather are recorded meanwhile by a barograph run by an eight-day clock located at the main camp.

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

In these surveys the land has ordinarily been blocked up ahead of me into mile squares. It is a great advantage if, when the lines were run, marks were left every quarter-mile. Then one can locate himself quite accurately on a line by pacing and without going very far. These marks serve also as the starting point in examining the interior of a lot. For instance, after having traversed the lines of a lot, noted the crossing of brooks and

divides, taken the height of essential points and noted or sketched whatever topography could be seen, I might start from the middle of one side to run a line across the lot. In doing this I often use a staff compass with 3-inch needle and folding sights, but perhaps more frequently a common pocket compass with needle less than 2 inches long held in the hand. Indeed, direction can sometimes be held more closely with the latter instrument. For instance, a man climbing over the *débris* left by cutting or shoving his way, head down, through dense thickets of young fir loses direction in the course of a few rods. Now if he has a compass in hand he will stop and look at it. He will do so less often if he has to set a staff, level his instrument and wait for the needle to come to a stand.

Meanwhile distance is kept by counting steps. Six or seven years ago, when I first tried to keep run of distance in this way, in retracing old woods lines, I found I required about 2400 steps to the mile. Later on, either because with practice I became longer gaited or because, without knowing it or meaning to, I discounted more, the number required became less. I found at one time that I was using 2200, and finally I got down to 2000 to the mile. There I expect and desire to stay, because at that rate notes plot so readily. In field sketches and in final maps I have so far used a scale of 4 inches to the mile. On that scale, at 2000 steps to the mile, 100 steps are two-tenths of an inch, and a half-inch square, or a piece of ground 250 steps on a side constitutes 10 acres.*

By one who has practiced it, measurement by pacing can be made, even in rough land and bad walking, much more accurately than would be supposed. One travels along, looking at the country, keeping his count in some back corner of his mind. Every hundred passed is marked down or scored by breaking an elbow in a tough twig carried in the teeth or hand. When a brook is passed or a change in the land occurs note is taken, the barometer read and the count begins again. Steps taken to get round obstacles are not counted, and on strong slopes discount is made. On very steep ground, indeed, steps taken are not a guide to distance, and judgment has to be resorted to in order to fill in the count. As first remarked, however, long practice enables a man to reach greater accuracy than would be supposed. Thus I am seldom out over 100 steps from the 2000 in crossing a lot. The count tells me when a line is approached, and enables me to pick it up with certainty, though it may be blind. Then I go right or left till I hit a quarter-post, and so ascertain the variation from the true compass course. By this means locations are made with considerable accuracy along the whole line.

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

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

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

So far our maps have been constructed on the scale of 4 inches to the mile, and 50-foot contours in the rough land with which we have to deal serve to represent the topography. In addition, as a result of the examination, timber maps are constructed showing the character of the growth and the amount of merchantable timber judged to be standing on the land. On these sheets the progress of the cutting can be drawn in succeeding years. These timber maps are of transparent tracing cloth, so that they can be laid over the topography and the two seen in relation. Lastly, since contour maps are not easily read by most woodsmen, topographical models are constructed out of cardboard or veneer. These are perfectly comprehended by any person. With their aid a contract can be let or plans of work talked over in the office with the same clearness as to main features as if men were on the land.

The survey and mapping of a township six miles square has ordinarily cost me about two months' work, two weeks in the

office and six in the field. A township can be gone over conveniently from about four camps. If there are on the land places to live in the topographer requires the help of but one man.