ARTIFICIAL REGENERATION OF WHITE SPRUCE.

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With the continuously growing scarcity of available pulp resources, the governments and the executives of large pulp and paper companies are giving more and more thought to the possible sources of raw material to supply the newsprint for the next generation. It is natural that among other methods the possibilities of artificial regeneration would occur to many.

Therefore, the Laurentide Company, having a knowledge of the slow growth in the forests, the large percentage of jackpine and balsam in the second crop, fungus and insect attacks and long drives, decided that their large plant investment demanded a certain dependable supplementary supply of raw material. With this end in view, they commenced artificial regeneration experimentally.

Before adopting any planting policy even experimentally, the following elements had to be considered, namely;

1. Land
2. Species and method of planting.
3. Administration and protection.
4. Taxes.
5. Thinnings and ultimate yield.

Planting land in Canada naturally falls into two classes, farm lands and exhausted limits with minor conditions such as blow sand, reclaimed lands, etc., which

are slightly apart from the problems of the average pulpwood planter. For experimental purposes, the company preferred the purchase of farm lots.

The next step is the selection of a native tree which will pulp well, show a certain shade tolerance and that regenerates naturally at times in pure stands.

Four year old WHITE SPRUCE TRANSPLANTS (2-2) at the Laurentide Nursery, Grand Mere, Quebec.

Thus, after considerable thought and experimentation, the company has selected from the list of available native trees White Spruce (*Picea canadensis*) as the most satisfactory.

White Spruce in nature furnishes a large yield per acre in a short time, is tolerant of shade resulting from the competing hardwoods, and finally shows a

partial immunity from the ravages of insects and subsequent diseases. It, on the other hand, due to its tolerance, does not clean well; this, while important in lumber production, is not so vital to the success of a pulpwood plantation.

One phase of greatest importance, on which hinges the success of any reforestation project is the source of seed. When a native species is being regenerated, this factor can be placed under absolute control by the elimination of sites in cone-collection which are non-similar to the one on which the trees will eventually be planted. Experimentally it has not been definitely proven, but it is rather a safe assumption that any considerable difference in latitude or altitude is highly undesirable. Thus seed collection should be made from a more or less restricted area in close proximity to the planting land.

In the selection of trees from which cones are to be picked, those still growing vigorously, with a maximum of crown, are the most suited for the purpose. Such a factor, however, is more or less self-controlled, as the trees which can be most economically picked are in the great majority of cases the most satisfactory from a forestry standpoint, - trees growing in the open with a large crown development. The practice of following logging operations in spruce seed gathering is dangerous, as collectors are wont to pick insufficiently mature cones from very over-mature trees.

In the nursery, the most economical rotation for our Canadian conditions is two and two stock (two years in the seed beds and two years in the transplant rows). Our neighbours to the south prefer a two year-old seedling followed by one year in the transplant row. The wisdom of this procedure seems open to criticism, as the cost of the final year in the transplant areas never exceeds forty cents per thousand, and the resultant tree is certainly vastly superior, as may be seen from the accompanying illustration.

Due to pressure of spring work the sowing is done in the fall, although equally satisfactory results may be obtained by early spring seeding. The beds are four feet wide and one hundred feet long; the height depends on moisture and drainage (as we have very heavy rains and snow-falls). Seed is sown 3 to 4 pounds per 400 square feet. Having then covered the seed slightly with soil, a layer of sphagnum moss is laid over the bed. Sphagnum has been selected after using a considerable variety of materials such as straw, leaves, canvas and blankets; it is most convenient, acts as a good mulch, and at the same time allows the penetration of rain water and is cheap to obtain. It has also more or less of an antiseptic value, being entirely free of damping-off spores. The crucial stage comes in the spring, as the young seedlings are breaking ground. Great care and considerable judgment must be exercised in the removal of the moss, especially as germination is never very

uniform throughout the beds in spruce.

The care of seed beds for the succeeding two growing seasons is not extremely difficult. The beds are covered with screens giving half-shade for three-quarters of the first summer, and in addition, the use of dryer felt which is strapped across the beds at will is necessary for the protection of the very young seedlings, as the St. Maurice Valley region is subjected to heavy seasonal thunderstorms accompanied by gales of wind. Beds are watered during the evening or at night. Commercial fertilizer cannot be used on spruce beds in the same proportions as on pine beds, but if judgment is used and care taken good results are obtained.

In the transplant areas, we have a spacing of ten inches between the rows, with the individual trees three inches apart in the row. The transplanting is done by gangs. A gang has four cabins, the spade crew and rakers. A cabin unit has two threaders and one carrier. The planting instrument is a seven-foot machine modelled after the Yale board. The spade crew are the three men equipped with shovels who make the trench, while the three rakers follow behind them banking in the trees and tramping the earth around the roots. Such a gang will plant over 50,000 seedlings in a nine-hour day. The care of the transplants for the next two years is merely a question of weeding and cultivation.

General preparation of the nursery areas is an application of 20 to 25 tons of green manure, and one ton of powdered limestone, per acre, followed by a soiling crop of buckwheat. The seed beds are treated similarly with the exception that well-rotted manure is used.

PLANTING.

Blunders may be made later in the management of the stand, but it is certain that the most serious mistakes can be made and, what is more, will be made in the first setting-out of the trees. It is evident that a tree improperly planted is starting into its plantation life handicapped seriously. Thus it may be stated that a cheap plantation is quite often a dear plantation before the end of the rotation. Therefore, it is our policy to depend entirely on grub-hoe planting or hole planting with shovel; using a small wooden contrivance designed to hold the plant in the proper place and at the proper depth while the planter is packing earth around the roots,--thus cutting to a minimum the great "don't" of sinking too deeply. In planting farm lands, straight hole planting after the removal of a square of sod has been satisfactory. The shovel men make holes for two to four planters, depending on the facility of the "going". A line of planters for five or six shovels makes a satisfactory working unit and is about all one foreman can handle in order to insure good planting.

YIELD.

A few years ago, when an attempt was made to calculate our returns from plantations, it was realized how great was the lack of definite knowledge regarding white spruce and the factors influencing it. First of all, the existing literature was based on European rotation, European species, and for saw timber. Nothing was available for the pulpwood planter. With a short rotation in view, we commenced studying crown development and root development in relation to maximum increment. These data which are interesting in themselves become absolutely essential in your future management to produce your maximum crop, and that is what the managers of pulp and paper companies are looking for to-day. Therefore the yield table given is calculated in accordance with crown development based on actual measurements of trees in the different age classes in close proximity to the planting land, soil conditions and other factors being the same. By using crown as a symbol of growth, we have been able to present practically and logically the number of trees that there should be to an acre in order to insure the maximum increment in a stated time. The ages given in the table were obtained by taking borings 18 inches above the ground, and as three years are needed in our plantations to reach 18 inches, allowed for stump, three years were added to the age.

WHITE SPRUCE YIELD PER ACRE.

Age	Stump Diam. (18")	D.B.H.	Height.	Crown Width.	Crown Area.	sq.ft.	Number of trees per acre.	Number of trees to be removed.	Volume of each tree.	cu.ft.	cords	Current yield per acre from thinnings	Yield of Rota for
years	ins.	ins.	ft.	ft.	sq.ft.								
20	4.3	3.5	15	8	50.25	866	481		536	2.86			
25	7.5	6.5	24	12	113.04	385	139		2.53	3.90	6.77		
30	10.7	9.4	30	15	176.68	246	30		6.26	2.08			17.3
35	13.	11.	35	16	201.02	216	45		9.68	4.84	6.93		
40	14.6	12.2	40	18	254.44	171	18		13.26	2.65			25.
45	16.	13.5	45	19	283.53	153	14		17.99	2.78	5.43		
50	17.5	15.1	50	20	314.21	139			24.782				38.

(1) Actual removals are made at ages 25, 35 and 45, but the more suppressed trees removed at earlier time are considered as having the volumes of trees 5 years younger; hence the division into 2 groups.

(2) Rate of growth percent for last ten years = 8.6

Volume of tree at 40 years = 13.26 cu.ft.

Volume of tree at 50 years = 24.78 cu ft.

Difference 11.52 cu.ft.

In the plantations we commence with 1700 to 2000 trees per acre, according to whether the planting is on brush land or sod. In brush land planting we make a cleaning or weeding at the end of 5 years, but no thinnings are attempted until the trees have reached the age of 15 years. At this age suppression will be creeping into the stand and lowering the yield. Therefore, the next 5 years will see a great percentage of the trees removed through suppression. The first returns will come from the 25-year-old stand; in this thinning the growth of the trees removed is considered as being suppressed and they are therefore measured as belonging to the 20-year-old class. However, at the same time the number of trees per acre is reduced to what the stand should be at 30 years, and these trees which are normal are measured as belonging to the 25-year-old class. In doing this, a stand is left in a good growing condition, and absolutely free of any suppression. Furthermore, in the thinning at the end of the 35-year period, the trees removed would have only 5 years suppression. The last thinning at 45 years is optional; it is more or less a preparatory cutting to establish reproduction before the final cut.

Coming now to the forested areas, at present being managed, we have stands of old hardwood, white birch and poplar, 20 to 40 years old, mature spruce and balsam, also coniferous reproduction. The old hardwood areas

present a very complicated proposition, as the cost of preparation will be heavy if the material salvaged cannot be disposed of. However, there is usually a fair sprinkling of reproduction and advanced growth, which augmented by "plants" make an excellent stand, its very being and safety increased by the heterogeneous mixture that usually results. Such a mixture is not a menace to the tolerant white spruce and most of the offending varieties may be removed, as cleanings or thinnings.

Thinking in terms of pulpwood, the white birch stands are thinned with the object of permitting the best to run on to be a crop, and underplanting with white spruce. The shelterwood of young birch will not retard the growth of the spruce seriously and will increase the early earnings. It also does away with that proverbial "ghost" stalking on the path of any silvicultural enterprise, "clean cutting".

In the softwood stands, we have one of the easiest to reproduce naturally. In fact, the future crop is assured under almost any system of cutting. However, to my mind, the one question lies after the reproduction has been established in solving how we can make it produce to its full productive capacity. To do this, we are attempting as far as costs will allow, experiments to ascertain the requirements of the species, thinnings and growth. So far, we have found that natural regeneration has to be continually aided

from the beginning and cannot pass the height of 30 feet without having been thinned once if not twice, to produce the maximum. On the other hand, if the stand is left until it reaches the age of 25 or 30 years, you will have in a great many cases a stand

that is very difficult to thin without opening up for fungus diseases which are going to offset any additional growth.

One other phase in the work is direct seeding. Our experience in this dates back to 1920, in which year we experimented in broadcast seeding and in seed spots. By the broadcasting method we obtained a scattered stand, and the trees now, after five growing seasons, resemble our 3-year-old transplants in the nursery. The seed spot results were negative. Besides results obtained, further experiments have shown that this practice is not applicable to all sites with spruce, and it is too expensive for the uncertainty of the issue.

In conclusion, I wish to emphasize that the foregoing paper has been prepared not to present the argumentative side, but purely to give you the results of our experience; and also to bring out and present forcibly the great importance of yield in any regeneration problem, whether it be by natural means or by planting.