A SILVICULTURAL RESEARCH PROGRAM¹

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At the present time it is appropriate to review the silvicultural research and progress made to date by the Woodlands Department of the Spruce Falls Power & Paper Company Ltd. This silvicultural program was introduced in 1928 while R. W. Lyons was Woodlands Manager, and, with the exception of some of the war years, has been carried on continuously since that time.

Woods operations at Kapuskasing began in 1922, but at first had to do mainly with purchased wood and not until after a re-organization in 1928 were limits operated on a large scale. By then, wood requirements were large but the limits were still undeveloped and without adequate transportation facilities. Thus, the first concern was to keep the mill supplied with wood and, at the same time, to get underway a long range program for the development of the limits. An integral part of this major program was silvicultural research into the growth and management of the clay belt forests of Northern Ontario. Volume tables were constructed, site and type classifications determined, and stock taking surveys instituted. All of these are basic to the management of forest lands, but the first two are particularly essential.

A brief description of the region is necessary in order to give a clear picture of the silvicultural problems. The Spruce Falls limits are in the clay belt of Ontario in the James Bay drainage and with the northern boundary of the limits about one hundred miles from Arctic salt water and much less than that from the limit of commercial tree growth. The average yearly temperature is only a fraction above freezing and the growing season, i.e., from last spring frost to first fall frost, is about seventy to eighty days. The forest stand consists mainly of spruce, balsam, poplar, birch and larch. Jack pine occurs on the occasional outcrops of sandy soil and cedar regularly along river banks and in similar locations.

In 1930 a series of sample plots were laid out. These have since been added to and re-measured. The early plots have now been measured four times and with later additions there is a complete series of measurements covering the life of the stand from twenty-five years on. As there are no old cuts in the region these plots were necessarily in even-aged fire stands, but as the cutover stands increase in age it will be possible to develop a relationship between the two and thus forecast the yield of cutover. Based on the data obtained from the sample plots, growth and yield tables have been made and a rotation of 100 years determined. It is company policy that stands of less than 100 years of age must not be cut.

Regeneration surveys are made annually to determine the silvicultural results of the logging methods in use today and in the past. The early surveys were of the belt transect type and gave only the average number per

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acre, but in 1935 a change was made to the stocked quadrat method of survey. This system has proven so satisfactory that it has been used annually since that time. A plot of 1/600 of an acre is examined at the end of each chain of strip. Stocking to spruce and balsam is determined on each, and on every tenth quadrat a complete tally is made to determine average stand per acre. As ground cover and advance growth have a profound influence on the character of the new stand after cutting, the ordinary forest types have been subdivided on this basis to make them satisfactory for use in regeneration surveys.

These surveys were first made five years after cutting, but as older cutover became available, were extended to ten and fifteen year old areas. Some of next year's surveys will be in twenty-year cutover. In most cases it has been possible to re-survey the same general areas and obtain data as to average changes.

The results of these surveys may be briefly summarized. The spruce flats and swamps, i.e. the wet sites, are 70 per cent or more stocked to spruce, and with 2,000 to 5,000 per acre. Interpreting these figures, they mean that if the average acre were divided into 600 plots each 8'6" square the several thousand spruce would occur not evenly distributed, but on only 70 per cent or 420 of these quadrats. The merchantable muskegs, a minor type occurring only on the border of the true muskegs, are generally 100 per cent stocked with spruce. In addition these types have fair to good balsam regeneration, except for the merchantable muskegs where it occurs very sparingly.

The remaining type is the high ground, on which were found the spruce slope and mixedwood types before cutting. This is a well-drained site with a thin humus layer over heavy clay soil. Here spruce regeneration, although about 1,000 per acre, is poor being only 36 per cent to 48 per cent stocked. Balsam advance reproduction on the high land is excellent, both as to stocking and stand per acre.

With increasing age of cutover changes in the degree of stocking are small and hardly significant, but the numbers per acre do indicate certain facts. Apparently there is little change in the spruce stand, but balsam, on all types except the spruce swamp, is very definitely reduced in numbers, often 30 per cent to 40 per cent during the five year period. Thus, by merely holding its own, spruce is definitely improving its proportional representation as compared to balsam, but on the high ground at 15 years, there are still about five times as many balsam as spruce. There is sufficient "seeding in" of spruce to offset decimation of this species. As the losses of balsam are not affecting the degree of stocking, decimation must be occurring in the clumps rather than among isolated individuals.

The new crop develops mainly from the advance growth and layerings that were established before the mature stand was cut. In this development poplar, birch and shrubs, growing from coppice or root suckers, have a decided advantage over the small conifers. Whereas spruce and fir seedlings

are adversely affected by the exposure and consequent drying out of the soil after cutting, the hardwoods develop on well-established root systems and make rapid growth even during the first summer. By the end of the first season, poplar has gained a dominant position among the reproduction on the well-drained sites.

The large advance growth that survives cutting requires several years to recover, but then makes rapid growth. During the first ten years after cutting, spruce and balsam grow from three-quarters to one and three-quarter inches in diameter.

The present good stands are the result of fire so the question may be asked "Why not burn the area?" The fire stands are the result of very severe fires which killed all the roots in the humus and reduced this layer to a fine textured material in close contact with the underlying soil. Thus all growth on the area, including the possibility of root suckers of hardwoods and shrubs, was destroyed and the only available seed supply was from the cones still retained on the black spruce. Then, with no competition and a good seedbed, black spruce took over the area.

In cutover fire will produce different results. If the fire is severe, as above, all growth is killed, including conifer advance growth; there are few standing black spruce to supply seed and the result is a barren area, depending for reestablishment on slow "seeding in" from adjacent stands. If the fire is not severe the advance growth is destroyed, but the humus is not reduced to a good seedbed and the hardwood roots are not destroyed. The resulting stand is a thick growth of hardwoods and shrubs. Burning, therefore, is not the answer.

From the above results, it was early evident that on the slopes spruce reproduction was inadequate, whereas on the remainder of the cutover, regeneration was sufficient and with good proportions of spruce. The clear-cutting methods in use are, therefore, satisfactory on the flats and swamps but do not give good results on the well-drained ground. This land, about one-third of the total, is potentially the best site and yet has insufficient spruce in the new stand. Further research was then concentrated on solving the problem of obtaining spruce regrowth on high ground.

Various experiments were initiated to determine how logging methods could be altered to assure good reproduction of spruce on the slope types. As the main dependence for the new crop is on the already established advance growth, the first investigation was a comparative study of the logging methods in use. These included "hand bunching" of logs of various lengths and skidding of sixteen foot logs. The result showed that "hand bunching" of sixteen foot logs was more destructive to advance growth than either skidding or bunching of short lengths, and this method has since been abandoned on the Spruce Falls operations.

A tract of timber was strip cut during a four year period. The first year, groups of two strips were cut, and six left uncut. The two strips cut cover an area of about one hundred and forty feet by one quarter mile. In

succeeding years, two more strips were cut annually. The strips were laid out so that one half advanced against the wind and the remainder against the sun. The four year period is sufficient to include at least one good and one fair spruce seed year. Surveys of the area have failed to show any improvement in regeneration from the changed cutting methods.

On a similar area on another watershed alternate groups of two strips were cut and left. The uncut groups were not operated until four years later. The strips were laid out at right angles to the prevailing winds. Again, regeneration appears to be no better than average.

Diameter limit cuttings have been tried, but the resulting improvement is small. The stands being operated are generally even-aged fire stands which have not yet developed an understory of smaller trees. The application of a diameter limit can save only the trees under the limit, and in these stands the number of such trees is not sufficient to justify the method. Under these conditions, the system practically amounts to clear-cutting. Seedbed conditions are not improved and this is necessary before spruce seedlings will appear in numbers.

Some 500 acres of burned cutover and 70 acres of unburned cutover have been seed spotted to spruce. Both fall and spring seeding were included. Although during the first season 25-30 per cent of the seed spots on high ground were stocked and 60 per cent on the wet sites, by the fifth season the former was almost a complete blank and the latter very poor. Two plots have been seeded broadcast but without success. Here seed was artificially supplied, and did, in many cases, germinate, but the cause of failure was too dry a seedbed.

A selective or two-cut system of logging has been tried on high ground. Part of the spruce and all the balsam were cut and skidded, leaving a fair stand of merchantable spruce plus some sapling spruce and balsam and with scattered openings throughout the stand. An examination after eight years showed that the residual stand was making good growth and had suffered little windfall, but new spruce regeneration was non-existent. Here the seed supply was certainly ample and lack of reproductions appears to be due again to poor seedbed conditions.

In mixedwood stands of different ages, the hardwoods have been girdled to release an understory of conifers. In young stands, roughly less than fifty years of age, good recovery and growth of conifers results, but in older stands the results are much less definite and losses from windfall occur. Experimental thinnings have been made and have resulted in a good increase in growth, but not sufficient to justify the high cost of the thinnings at present wage rates. Sample plots are maintained in all these areas to obtain definite information as to comparative rates of growth. Neither the girdlings nor the thinnings have encouraged the establishment of spruce regeneration under the stands.

It is evident from the foregoing experiments, particularly those in selective logging and direct seeding, that the critical factor in establishing

spruce regeneration is not seed supply, but rather the development of proper seedbed conditions. A readily available and constant moisture supply is essential for the germination and establishment of spruce seedlings. Under the canopy of the mature forest, spruce advance growth occurs generally only on well rotted logs, patches of sphagnum and other favourable sites. Balsam, with its better root growth, is more resistant to drought and is fairly generally distributed over the forest floor. Poplar seldom appears until cutting or other disturbance exposes the forest floor and stimulates the growth of root suckers.

There is little seeding in of conifers after cutting and thus the main dependence for the new crop is on the advance growth and this is predominantly balsam. It is impossible to improve conditions for spruce without, to a much greater extent, improving conditions for balsam also. No matter how light the cut, the exposure of the forest floor causes some drying of the seedbed and is thus inimical to conifer reproduction.

Although experimental work to date has failed to show how logging methods may be changed to assure adequate spruce reproduction in high ground, research is continuing and meanwhile the silvicultural policy is clear-cutting. This entails the establishment of a forest nursery and the planting of a portion of the well-drained areas. These slopes represent about one-third of the annual cut, but they will not all require planting as a varying proportion is sufficiently stocked with advance growth of spruce. About one-third of each acre is easily accessible, i.e., the roads, pile bottoms and other openings. When this is planted at six foot intervals, one-third of the area will then be 100 per cent stocked, and combined with the scattered natural regeneration, the whole tract will be 50 per cent to 75 per cent stocked to spruce. This will produce stands comparable to those being operated at present.

The policy will be to plant during the first season following cutting. A crew of two or three men will work up each strip road planting three rows, one up the centre of the road and one along each edge. Additional spruce will be planted off the road on any readily accessible open patches. Where the wood has been skidded rather than strip cut some adaptation of technique will be necessary. There will be less regularity of spacing but by using skidding trails instead of roads the same proportions of the area will be planted. A light weight grub hoe with curved handle appears to be the most suitable planting tool for the region. It will be necessary to first rake aside the loose litter and humus and then make the planting opening in the clay soil. To compete successfully with the hardwoods, strong 2-2 stock of both black and white spruce will be used.

Sites which have been cutover and burned do not reproduce to softwoods in sufficient numbers to assure a pulpwood cut at the end of the first rotation. This applies to all types, whether slopes, flats or swamps. Such burns, if more than several acres in extent, must be reforested artificially. When a mature uncut stand is burned, it will usually reproduce naturally and planting will not be necessary.

As the forestry program will require large amounts of planting stock annually, a forest nursery has been established near Kapuskasing and during its first year of operations has produced two million seedlings. The construction of buildings and installation of an irrigation system is completed and the preparation of transplant and additional seedbed areas is proceeding rapidly. This year there will be twice as many seedbeds as last year. The capacity of the nursery will be increased to five million 2-2 stock per year which is sufficient for all requirements.

Briefly summarizing, the outstanding silvicultural problem of the clay belt is to obtain natural regeneration of spruce on the well-drained slopes. Although, by altering logging techniques, natural reproduction of spruce may be improved no method to assure adequate amounts of it has been found. On a portion of this site some artificial regeneration will be necessary.