THE STORY OF A CUT-OVER

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ABSTRACT

1. A considerable part of the mixed white spruce—trembling aspen stands in Saskatchewan appears to be forming itself in a cyclic process. After a fire, when poplar has established itself, the first wave of spruce comes in; the second follows in about 50 to 70 years. When the trembling aspen thins itself, the crest of the third wave comes and, together with the remaining aspen, the spruce of the first wave starts to deteriorate.

2. This cyclic development of such stands seems to provide an opportunity to apply management on the basis of a permanent forest.

3. Cutting by diameter limit in such stands results in windthrow and die-off, exceeding the increment of the residual white spruce.

4. Crown quality is a decisive factor with white spruce in its response to release in these mixed stands.

5. White spruce in these mixed stands responds to release even at the age of 100 years.

6. Insufficient regeneration of white spruce in the examined area appears to be due to lack of seed; heavy sod, invasion of shrubs and weeds seem to be main obstacles to regeneration.

A closer investigation of this particular area was forced upon the writer by the coincidence of several circumstances. The area was cut over for white spruce timber 12 to 13 years ago, and its present aspect is anything but pleasing to the eye of a forester. Windfall, dead trees, invasion by shrubs and undesirable ground vegetation, the majority of white spruce with round tops indicating that increment in height is poor, and low density of stand all indicate a stand of apparent low production. In addition to that, this stand practically borders an area which has been handed over for agricultural use, and in connection with that, the agriculturalists showed a lively interest towards that particular cutover. Thus fact and figures were required, not only as a guidance for finding an answer as to what would be the best action from the point of view of forest management, but also to provide material for an objective argument with the representatives of agriculture. In addition to these two angles, it was hoped that an investigation of the area might uncover some data which could be of some more general value.

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For these purposes 250 two-milliacre sample plots were taken (10 x 20 links) at the end of each two-chain band, these lines being put in four chains apart. A tree was considered to be in the plot if the centre of the tree was within the plot. When it started to appear that the sample plots would not yield enough material for more or less convincing figures for judging the effect of release on different groups of white spruce, additional trees, fully released and partially released, were measured outside the plots at random. The height and D.B.H. of tree were measured, the latter to .1 of an inch. Then several cores were taken to establish the age, the increment of D.B.H. during the last ten years and during the previous ten years. No increment was established for tA because of considerable rot, and for bS because of its insignificant number. These two species were just tallied, likewise tallied separately was dead standing wS and wS windthrow on the plots. Diameter of stumps and the age of cut wS was established.

Regeneration of wS and tA was recorded and classified. The main shrubs and components of ground vegetation were recorded, and an attempt was made to classify them in accordance with Brown-Blanquet's system. The general character of the soil was established as far as it could be done without an analysis in the laboratory.

The area of the cut-over which was investigated comprises portions of Sections 4, 5, 8 and 9 of Township 50, Range 7. It is situated in the so-called Carrot River plain, south of this river, close to banks of a post-glacial lake, the remainder of which appears to be the present Cumberland Lake and a major grown-in part of which can be studied just across the Carrot River in the lowland (swamp) of the so-called Carrot-Saskatchewan triangle. The shoreline of this pre-glacial lake was probably formed by a gravel ridge which runs approximately in a S.W.-N.E. direction just about parallel to the base of the Pasquia Hills.

The drainage in a considerable part of the investigated area is poor. Only in the more elevated parts and on higher banks of creeks the water level could not be reached by a 3-foot hole. This seems to be caused by several factors: location close to the foothills of the Pasquia; considerable impermeability of the subsoil; obstructions in creeks caused by beaver; comparatively level relief and, for the summer of 1952, increased amount of precipitation. (On 27 per cent of plots the water table was not more than 2 inches from the surface.)

The main characteristics of the soil are as follows:

No visible reaction to HCl in Ao to B horizons.

Ao—2 to 7 inches; the thinner Ao usually found on dry elevations, thicker—in lower spots with moss as main ground vegetation; pH up to 8 on higher ground and down to 4.5 in lower places. Decomposition better on higher ground but retarded in lower areas where it is of quite tough peat-forming consistence.

A1—Hardly noticeable in lower areas where Ao lies on A2 like an easy separable mat; traces of A1 usually on higher ground; in a few places A1 appears about 0.25 inches thick; pH values not measured.

A2—Appears in a layer of 7 to 18 inches; leaching not very pronounced; in many places impossible to distinguish from B, sandy loam to clay with a few gravel in places. Color—different shades of grayish brown. Compact; pH 5.5 to 7.5.

B —Parent material and structure the same as in A2; in places brown color more pronounced than in A2; brown spots and streaks observed in some pits; in several places the horizon hard to distinguish from A2; pH. 5.0 to 7.0.

Professor J. Mitchell has found an average PH of 7.9 for recently broken areas in the Carrot River lowland, west of this investigated area².

The average contents of total nitrogen, phosphorus and potassium, found in the broken Carrot River lowland is: N-0.45%, P-0.06%, K-1.13%.³ These figures, the same as the above mentioned average figure for pH, might be somewhat influenced by the process of breaking when the slash and a considerable portion of the Ao horizon was burnt.

The predominant shrub in most areas is dogwood, *Cornus (Svida) stolonifera*, Michx., hazel, *Corylus rostrata*, Ait., mixed with roses, mainly *Rosa acicularia*, Lindl., and other less frequent shrubs are abundant on dry ground. Hazel, as observed in numerous other places too, is at its best in such areas where the density of the stand has been reduced to about .3 (stand density index under 100), not in clearcut areas. In such semi-open stands even the regeneration of trembling aspen is seriously handicapped.

The main shrubs and constituents of ground vegetation are given in a separate list. An attempt has been made to classify them in accordance with Brown-Blanquet's system.

A diameter limit of 12 inches breast height was imposed on the operator when the area was cut. This has been more or less observed. (See Table No. 1).

As we see from Table No. 1, the total volume of wS cut per acre is $965.2 \times 2 = 1930.4$ cubic feet, which means that $965.2 \div (439.0 + 51.9 + 93.3 + 965.2) \times 100 = 62$ per cent of the volume of wS has been cut. The transformation of the stand by this cut can possibly be illustrated by establishing the respective stand density index before and after cut. (See Table No. 2).

Before the stand was cut over, the total stand density index was approximately between 260 and 270, for white spruce alone somewhere between 190 and 200 ($102.1 + 5.8 + 14 + 76.9 = 198.9$). By the cutting it was reduced by about 57 per cent— $102.1 \div (102.1 + 5.8 + 14.0 + 76.9)$

² Soil Survey of Saskatchewan, By J. Mitchell, H. C. Moss and J. S. Clayton. Report No. 18, 1950, p. 174.

³ Op. cit., p. 174.

$\times 100 = 51$ — and another 10 per cent went into the wS which died and was thrown by wind.

We see that the total density for the stand was not very high before cutting. In addition to that the great majority of the tA is, and also was 12 years ago over-mature and deteriorating. Furthermore, the density is not and has not been uniform over the whole area; bluffs of pure spruce with a density index over 300 were mixed with areas of a considerably lower density and higher percentage of tA.

But this does not convey a complete picture as to the manner of cutting applied in this area; possibly more insight could be gained by establishing the age of the white spruce at the time of cutting. In Table No. 3 we see that the great majority of those spruce trees which have been found standing and alive on the 250 sample plots was, at the time of cutting, in the age group of 71-100 years with a pronounced peak of representation in the age group of 91-100 years; the age group of 71-100 years comprises $14 + 46 + 24 = 84$ per cent of all these trees and there are 46 per cent in the age group of 81-90 years. A similar picture is conveyed for the age group of 71-100 years by trees tallied at random outside the plots: $29.3 + 36.0 + 17.8 = 82.1$ per cent. Although the peak in the group of 81-90 is not so strongly pronounced, there is 36.0 per cent. If we reconstruct the whole stand of white spruce in accordance with the data of the sample plots, including dead standing trees, windfall and cut trees, we find two predominant age groups: $12.9 + 38.8 + 17.6 = 69.3$ per cent in the age group of 71-100 years; $3.5 + 5.9 = 9.4$ per cent in the age group of 131-150 years. (See Table No. 3).

The six trees which have been cut in this age group, plus one tree in the age group of 121-130 and one in the group of 151-160 have yielded $[(60.6 + 209.4 + 75.7 + 130.0 + 133.4) \div 965.2] \times 100 = 63.1$ per cent of the total cut volume. One tree of 33.9 cubic feet has been cut in the 111-120 age group and two of 38.6 cubic feet each were cut in the 101-110 age group. The rest, in trees with a total volume of $965.2 - (609 + 33.9 + 77.2) = 245.0$ cubic feet or $(245.0 \div 965.2) \times 100 = 25.4$ per cent, have been taken from the age group of 71-100 years, the majority—six trees—coming from the age group of 84-90 years.

The question whether the age could be disregarded during this cutting operation leads to the following thoughts. First of all we have to remember that the stand density index for wS was reduced from $102.1 + 5.8 + 14.0 + 76.9 = 198.8$ to $198.8 - 102.1 = 96.7$. (See Table No. 2). Second, apparently no wS with poor or crippled crowns (see below) was removed. Third, the trees cut in the .5 acres of the 250 plots in the age group of 131-160 years would have yielded $(60.6 + 209.4 + 75.7 + 130.0 + 133.4) \times 2 = 1218.2$ cubic feet, or over 6,000 F.B.M. per acre. If the $3 \times 2 = 6$ trees per acre from the age groups of 101-120 had been added, the volume to be cut would have been $1218.2 + (33.9 + 77.2) \times 2 = 1430.4$ cubic feet or

about 8,000 F.B.M. per acre. To obtain another $245.0 \times 2 = 490$ cubic feet, or about 2,000 F.B.M. per acre, the number of the cut trees was about doubled and this additional volume was obtained by cutting trees in the age groups of 71-100 years. These trees, if left standing, would have increased the stand density index of the remaining wS by 30.1; it would have been $96.7 + 30.1 = 126.8$. The dying of the wS, which was released by cutting, possibly could to a large extent have been avoided by cutting those trees which had poor crowns. (See below discussion of increment).

The larger number of wS left behind would possibly not have caused a larger number of windfall; even the contrary is not excluded due to better spacing and existence of more dominant trees. Unfortunately there is no material to substantiate these conjectures. Furthermore, it is not excluded that the presence of about 20 spruce trees more per acre would have hampered

Graph No. 1
Number of Trees-in-percent in different Age groups
From Table No. 3

the development of hazel and dogwood and thus provided a better chance for wS regeneration and, last but not least, the volume of the living wS which is found at the present on the area would be about 50% higher; instead of $538.8 \times 2 = 1077.6$ cubic feet per acre, with a considerable number of trees in low diameter groups (See Table No. 1), we would possibly have over 1,600 cubic feet with lumber prevailing. This would make a fairly good combined operation possible.

These thoughts inevitably lead to the conclusion that in this case from the discussed points of view the cutting by diameter limit has been harmful and that cutting by age and taking into consideration crown quality (see discussion of increment) would have led to considerable better results.

It appears that from Table No. 3 and Graph No. 1 we can reconstruct the development of the stand with a considerable probability. We see that the oldest trees, cut on this area, have been of the age between 151 and 160 years. Indications have been found that the stand had originated after a fire as it is the case with a considerable portion of the forests in Saskatchewan. As far as could be ascertained, the oldest, dying tA which still could be found in this cut-over area were about 160 years or somewhat older at the time when wS was cut there. (It was impossible to establish the exact age because of rot). Thus it appears that tA has come in on the burn somewhat before the first wS as it usually happens.⁴

In about 10 years from that time when the first wS appeared in this stand, the largest number of wS came in and, so to speak, the crest of the *first* wave of wS was formed. A trough appeared after that and, about 60 years after the first crest, another peak, a much more pronounced one, shows up. (See Graph No. 1) This means that at the time when this *second* crest of the incoming wave of wS formed itself, the original stand of tA was about 70 years old or somewhat older. In other words,—this second crest moved in at that time when the natural thinning out of the tA stand was accelerated by increased heart rot.⁵

After this the number of trees in each ten-year age group started to decrease again until another low was reached with 1.2 per cent in the age group of 31-40 years, the same percentage as in the age group of 121-130 years.

Quite naturally, the question arose as to whether such a course of development is a particular feature only of this investigated area, or a similar genesis can be found in other parts of the mixedwood belt. The most reliable way to find this out, of course, would have been the analysis of stands on sample plots of different areas but, owing to shortage of time, a shortcut by

⁴ Descriptions of mixed stands show that usually tA is about 10 years, or somewhat more, older than the oldest wS.

⁵ This feature is in line with the findings of Dr. C. G. Riley and observations of the author. (See "Some Problems of Mixedwood Stands" by the writer, Forestry Chronicle, June, 1952.)

means of a statistical method was taken by using the age indications for wS on the management-plan stand descriptions. The results of this investigation for three different locations are shown in Table No. 4.

Stands, containing wS, were first of all split into three groups: (a) pure or practically pure stands, with 9- to 10-tenths of wS; (b) stands with 4- to 8-tenths of wS, for practical purposes called stands with dominant wS and (c) stands of dominant tA with 1- to 3-tenths of wS. (Heading 2). Taking into consideration the age of wS, the area of the stands was split into three groups: (1) Stands with even-aged wS, i.e., age limits within a 20-year age class plus stands within the limits of two adjacent age classes. (Heading 3). (2) Stands with two major groups of wS with one 20-year age class between these groups; (3) Stands of three age groups with one 20-year age class between them.

It is evident that this does not give the complete picture, because there cannot be several age groups in stands of the 1st and 2nd and even 3rd age classes, and therefore, in areas where these younger stands are represented with a higher percentage like in Montreal area (9-10 wS—80.9% in 3rd age class; 4-8 wS in first three age classes: together 61.9%; tA plus 1-3 wS in first three age classes 60.2%, the percentage of stands with practically even-aged wS is higher. The percentage of stands with young wS is lower in Torch area, resulting in a lower per cent of stands with even-aged wS. Both these percentages are lower still in the Pasquia area. In addition to this it seems that in more northerly parts of the mixedwood belt there is a more pronounced tendency for even-aged wS than in the southern part.

But to follow up these issues in a more conclusive detail would take us beyond the scope of this article. The main question was whether the development of the investigated cut-over area was exceptional or it fits into a pattern which shows up in considerable portion in stands with wS in the mixedwood belt. It appears that Table No. 4 supports the latter possibility. Formally the age of wS under Heading 4 does not exceed the limits of three age classes, 60 years, but in fact the limits extend themselves over an additional period of close to 20 years because the split of the 20-year age classes is not done exactly on the limit-year of the age class (which shows the value of 10 year age classes). Thus the areas listed under Heading 4 appear to fit in quite well with the pattern of development shown in Graph No. 1. The same refers to the areas under Heading 5 of Table No. 4 with the exception that the development of the stands has reached a more advanced stage: the first wave of wS is starting to deteriorate and the remaining old tA has died out giving the spruce a chance to form a third age group.

To avoid misunderstanding, the writer feels the necessity to underline one important remark: This pattern of development should be regarded rather as a governing tendency in a considerable part of stands containing wS. (Table No. 4 gives an average of 52.2 per cent for Headings 4 and 5 together for the listed areas. This percent would be considerably higher

if young stands were omitted). It should *not* be regarded as an iron rule, because variations in soil, in drainage, in presence or absence of certain shrubs and ground vegetation, presence or absence of seed source, etc., would cause considerable variations not only in the "size" of the invasion waves of wS, but also in the general pattern itself. But, nevertheless, this general tendency or pattern seems to be of some value for the establishment of some management practices in stands which fit into this pattern of development. The main practical conclusion appears to be *that these stands can be managed on the basis of so-called permanent forest. (Dauerwald).*

It seems that the trough after the crest of the first wave of wS could be more or less filled in by releasing the wS from tA at the time when tA has reached about 30 years of age or somewhat more, depending on the individual stand. This would probably also lower the crest of the second wave, which could be made broader by removing a considerable amount of tA and of such wS which has no future, at the time when the tA has reached the age about 70 to 75 years.⁶

This would lead to less pronounced age peaks of wS and would make the taking out of smaller portions of the stand at a time in shorter intervals possible which, in turn, might make it possible to present the appearance of harmful shrubs and ground vegetation. Thus the sore spot of wS regeneration and of reduced production over considerable periods could on suitable areas possibly be mitigated if not avoided. It is readily admitted that this practice of management would have a few practical drawbacks. First of all the person who goes into such stand for cutting would by no means get everything he would like to take out which could be against the creed of a "real" timber operator. Second, the marking of trees for cutting would have to be done by an experienced forester who has a clear picture of the paramount significance of this work. His attention should not be distracted by any other activity except making a mark on the tree to be cut.

During the investigation of this cut-over, it appeared that the information which was collected there might yield some points of guidance for marking the trees. Therefore, also the increment of the residual stand was subject to a somewhat detailed scrutiny. In Table No. 5 we see that the total increment for the last 10 years on wS which is standing and alive is 99.8 cubic feet on .5 acres or $99.8 \times 2 = 198.6$ cubic feet per acre, or 19.9 cubic feet per acre per year. On the other hand from Table No. 1 we see that during the twelve years after cutting, $51.9 \times 2 = 103.8$ cubic feet of wS per acre have died, or an average of $103.8 \div 12 = 8.7$ cubic feet a year. The same Table No. 1 shows that $93.3 \times 2 = 186.6$ cubic feet of wS windfall has occurred, giving an average of $186.6 \div 12 = 15.6$ cubic feet a year. Thus we have an average

⁶ It might be worth mentioning that this course of action was found to be of some possible value from the point of view of increment in mixed tA and wS stands in general. See "Some Problems of Mixedwood Stands" by the writer, Forestry Chronicle, June, 1952.

net loss of $(15.6 + 8.7) - 19.9 = 4.4$ cubic feet per acre a year. The picture would not be so displeasing if the windfall could be utilized, which is quite possible, the trees being of 8 to 12 inches D.B.H. In such case we would have an average net gain of $19.9 - 8.7 = 11.2$ cubic feet per acre a year. But the 4.4 cubic feet net loss prevents us from calling the picture satisfactory from the point of view of increment.

It was noticed on the spot that the death rate and the rate of windfall is on the decrease which will improve the situation during the next decade. V. H. Phelps of the Dominion Forest Service has found in the Porcupine Hills that the total mortality is steadily diminishing after the first decade after cutting.⁷

Quite naturally the question arises if in this case another course of action would not have led to better results from the point of view of *increment*. It was noticed after the first few borings that a very large difference exists regarding the increase of increment on individual trees after full release.⁸ Some trees were found on which the increment of volume had increased to 5-fold in comparison with the increment before release; others showed a decrease of volume increment up to 60%. A relationship between these features and crown *classes* alone (Kraft's classes), based on the place of the crown in the canopy, could not be established. After some calculation and repeated observation it appeared that another factor, crown *quality* has more pronounced influence on the increment after release and that this influence could possibly be shown in some kind of a classification. Therefore, the crown *class* and crown *quality* of each tree were noted. Although a more detailed classification on the ground of crown quality appeared possible, to simplify tabulation only three quality categories were used: good, medium and poor.⁹

⁷ V. H. Phelps — "Forest Conditions in Cut-over Spruce Lands in Porcupine Hills, 1938". (Typewritten). p. 33-34.

⁸ It was established by a considerable number of borings on the spot that 20 feet can practically be considered the limit of distance up to which the increment of one tree is influenced by another. An attempt to find a formula which would express the relationship between distance, crown classes and increment, failed; the amount of material seemed insufficient.

⁹ It cannot be denied that some lack of objectivity is present in this classification, although such features as size of crown:—at least 1/3 of tree length and well developed branches for good crown; at least 1/4 with well developed branches—medium; shorter crowns—poor regardless of width of crown and healthiness of branches. The personal element entered more into play when the factor of the length of the crown was counterbalanced by its narrowness, resulting in a smaller volume of the crown. A third factor, which might be called healthiness or general aspect, was also considered; it was taken into consideration how many dead or dying twigs there are in the crown and if there was any growth on the ends of the twigs. After weighing the volume of the crown against its soundness or, in other words, by trying to estimate and to compare the living and active volume of the crown, the trees were classified as having a good, medium, or poor crown. To establish some uniformity in the classification, this work was done by one person, the writer, throughout the investigation.

It appears that this discrepancy between crown class and crown quality is considerably less conspicuous in an even-aged, pure stand of high density, but in mixed WS and TA stands, crown quality appears to have a more pronounced practical importance.

It was evident that the 50 wS trees, found on the 250 sample plots, would not yield enough material to make a comparison of increment in different crown quality groups possible. Therefore, trees of different crown qualities and crown classes outside the plots were added. After the increment for each individual tree for the last 10 years and for the previous 10 years was established the results were grouped into Table No. 6 which shows that there is quite a marked difference between the increment on trees of different crown quality, especially after the area has been cut over and a considerable number of trees have been released. (See Table No. 6).

Graph No. 2
Percent of Increment—simple interest
From Table No. 6

If we look at Graph No. 2 and Table No. 6, showing the per cent of increment in simple interest over the last 10 years and for the previous 10 years for trees of different crown quality, we see two quite noteworthy features.

(1) Trees with bad crown within all crown classes have either practically not improved their percent of increment or this per cent has dropped in comparison with the increment of the previous decade. This last feature shows itself even more conspicuously on Graph 3 which shows the increase (decrease) of increment after cutting. On this graph we see that the increment has decreased by close to one half (46.1%) on oppressed trees with poor crowns and by 13.3% on dominants with poor crowns. Intermediates with poor crowns have held approximately their own while co-dominants had an increase of increment by 14.8 per cent.

Graph No. 3
Increase of Increment after release
Percent - simple interest

(2) There is a very marked increase of increment on all trees with good crowns during the last 10 year period.¹⁰

There is one peculiar feature in Graph No. 2: the curves for the per cent of increment for dominants before and after cut are quite flat and before cutting the dominants with poor crowns had a better increment rate than those

¹⁰ More detailed analysis of the behaviour of the increment within the last 10-year period was not made because it appeared that the diameter increment was quite stable after the first 1 to 3 "shock" years. This "shock" manifested itself in reduced increment, but it was hardly noticeable on trees with good crowns, and on many trees with very good crowns the increased increment appeared right after the year of cutting. On trees with bad crowns this "shock" persisted and resulted in decreased increment. The death of many standing trees might be a result of this "shock", and they possibly were mainly oppressed trees with bad crowns, which is supported by their small diameter. (See Table No. 1).

with good or medium crowns. We have to admit that the number of dominants with poor crowns is not large—only four trees (See Table No. 6) which is not a sufficient basis for any conclusions. On the other hand, however, it seems that these trees possibly "took their chance" after the dominants with good crowns had reached their size limit and their increment started to decline. We see in Table No. 7 that with higher age the per cent of the dominants is higher which means that the decrease of increment in connection with age might have some influence on the result in Graph No. 2 regarding increment before cutting.

In general, from Table No. 6 and from Graphs Nos. 2 and 3 the impression is obtained that *the lower the crown class of the trees the more influence is exercised by crown quality on the increment after release.*

To gain more insight into the question of increment both before and after release Graph No. 4 was prepared showing the average increment per tree in cubic feet depending on crown class and crown quality, both for the last 10-year period and for the previous one. This has been done to obtain an additional criterion as to which trees should be cut and which should be left behind while carrying out a selective cutting. All three graphs give a unanimous verdict about suppressed trees with poor crowns: increment rate after cut-over low; increase of increment minus 46.1%; average increment per tree in 10 years after cut-over about .3 cubic feet. The next category to go seemed to be intermediates with bad crowns; practically no increase of increment—1.2 cubic feet per tree in 10 years after release. It appears that the third category to go is the dominants with poor crowns; even their increment in cubic feet per tree after cutting is below that of co-dominants and intermediates with good crowns. Their increase of per cent of increment is with

a minus sign and their per cent rate of increment is just about the same as for intermediates with bad crown and co-dominants with bad crowns which possibly would be the next group to go if necessary. In addition to everything else, dominants and co-dominants with poor crowns would often interfere with intermediates and oppressed having good crowns, the value of which for the residual stand could be shown even more conspicuously by calculating their volume after the next couple of decades by means of their per cent of increment. But it seems, that all in all, in this area of investigation all trees with poor crowns did not justify their being left behind, which possibly applies to similar area elsewhere.

It seems quite apparent that our attitude towards trees of medium crown quality should be governed by the density of the residual stand. If, like in the area of this investigation, the percentage of the older group is fairly high, a going beyond the trees of poor crowns in the younger age group would be hardly justified. It appears even that the removal of about twenty dominants with good crowns per acre in the younger age group (see beginning of this article) has had quite a considerable influence on the amount of windthrow. The leaving behind of trees with poor crowns, especially oppressed ones, possibly has increased the quantity of dead standing trees.

The next outstanding question is about the relationship between age and response to release in those age groups which are represented in the residual stand. In connection with this question it appears that the age limits within which there is a sufficient number of trees to warrant any conclusion is 71 to 120 years (present age), respectively, 51-100 years twenty years ago. There was one tree in the age group of 41-50 years and one in the group 61-70 years, giving two trees in the combined group of 41-70. years. (See Table No. 8). Likewise it appeared that there were not enough trees in the age groups comprising 121-130 years to warrant any conclusion.

The percents of increment before and after cut are shown in Table No. 8 and Graph No. 5 for all crown classes and crown quality groups together.¹¹

As it can be seen on Graph No. 5, the lines for the per cent of increment before and after cut run quite parallel. There is a marked digression only at both ends of the line, a decrease of the per cent showing up in *both* lines on trees which are at the present over 91 years old; in other words—it has set in after 71 years. A little puzzling appears to be the behavior of these lines after 101 years. After 81 years the per cent of increment rises, although the response to release appears to be less pronounced. Some explanation to this might be found in Table No. 9. In this table we see that the percentage of trees with good crown increases from the age group of 71-80 years to 111-120 years from 16 to 79, making a spectacular jump in the latter age group. The facts that trees with good crowns have a better per cent of increment, and that they respond readily to release (see above), might explain the right

¹¹ Ten-year periods instead of actual time after cutting, which with the expectation of a small area was 12 years, was used for convenience in calculation, as elsewhere in this article, anticipating that this would not influence the results to an unacceptable degree. The number of trees seemed to be insufficient for the establishment of relation between age and increment in each crown class and crown quality group.

hand end of the curves on Graph No. 5, although the increase of increment after cut is smaller. (See also Table No. 8). For the opposite reason, that is—high percentage of trees with poor crowns in the lower age groups—we

Graph No. 5
Per cent of Increment in Different Age Groups
From Table No. 8

might be justified to suppose that the upper curve at least for the age group of 71-80 years is somewhat low and the doubted figure for the combined age group of 41-70 years might be in accordance with the actual situation. But, even with these possible corrections, we see that the general tendency to respond to release does not change much within the age limits of the present age groups of 71-100 years and even to 110 years, although *both* lines of the graph descend for the last decade. The general conclusion, possibly warranted by this material, appears to be that up to the age of about 90 years (the present age group of 91-100 years we can expect good response to release and a not lowered per cent of increment.

Before any further discussion of the regeneration, one feature of it which is in line with the pattern of coming in of wS discussed above, deserves being mentioned. On the 250 plots, nine wS saplings from 14 to 19 years old

were found. (They are included in the total number of wS shown in Tables Nos. 10 and 11). This means that at least $9 \times 2 = 18$ seedlings per acre were present before cutting. It seems to be quite safe to say that this number was higher because a considerable portion of the seedlings must have been destroyed by mechanical logging equipment. This shows that the third wave of wS, which was mentioned before, was about to start its appearance when the cutting was done.

As shown in Table No. 11, 416 wS seedlings were found on an acre, the great majority of which ($416 - 18 = 398$) had appeared after cutting. At first glance this figure does not seem to be very discouraging. Unfortunately, there are a couple of features which make this first impression less pleasing. First—when the seedlings were counted they were divided into two groups: poor and fair or better¹².) From Table No. 10 we see that $(33 + 3) \times 2 = 72$ seedlings per acre are classified as poor which leaves $416 - 72 = 344$ fair or better wS seedlings per acre, which is not a large number. Second—out of 250 plots we have wS seedlings only on 61 plots, that is on 24.4 per cent of all plots, which means that the distribution of seedlings on the area is not even. We come to the same impression when we take into consideration the number of seedlings found on decaying logs and old stumps: out of 344 wS seedlings per acre which were found to be of a fair or better shape, 222 or 64.5 per cent grow on rotten debris, mostly in clumps or strings.

In addition to this lack of uniformity of distribution of wS, there are $802 + 140 + 40 = 982$ suckers of hardwoods, that is more than double the number of wS. Of these hardwood suckers $414 + 124 + 32 = 570$ are fair or better against 344 wS. Thus it has the appearance as if the above mentioned re-appearance of wS in waves might repeat itself, although the first wave seems to be of somewhat more considerable proportion.

It is evident that the comparatively small number of wS seedlings has not been caused by lack of seed. All 144 wS seedlings growing on debris of the 250 plots were found on 9 plots, representing 288 seedlings on 18 two milli-acre plots per acre. These 18 plots carry $(288 \div 416) \times 100 = 69.2$ per cent of all wS seedlings. The debris, rotten stumps and trunks on which these seedlings are growing occupy less than five per cent of the area of these plots or about 180 square links per acre, that is, about 0.18 per cent of the area. If we accept that every individual seed that has fallen on the debris has germinated, which, of course, is not the case, an acre would have received $(288 \div 0.18) \times 100 = 160,000$ viable seeds, or about a pound of seed. If we accept that the germination was about 25 per cent, which could have hardly been exceeded under the existing circumstances, we arrive at about four pounds of seed received per acre.

¹² For this classification the general appearance was taken into consideration; those seedlings which looked unhealthy and hardly had a chance to survive, were considered poor. This was applied to seedlings and suckers alike.

Therefore, the conclusion that the small amount of seedlings found per acre *not on debris* is due to the unfavorable seedbed and appears to be unavoidable.¹³

This in turn once more puts the emphasis on the necessity to avoid cutting practices which foster the coming in of shrubs and extensive vegetation on the ground. In other words, it leads us back to the desirability of permanent forest (Dauerwald) for mixedwood stands. (See above). The high percentage of seedlings on debris and also in places where mineral soil has been exposed, (only two small patches of denuded mineral soil were found on the sample plots; one of them had one wS seedling, on the other there were two; a large number of wS seedlings had established themselves along a permanent road) points towards a comparatively cheap way of giving some assistance to wS regeneration in such places where there is lack of seed, like on large burns. On such burns there often is a very thick ground vegetation and plenty of shrubs, but there are also rotten stumps and fallen, rotten trees. Also spots of mineral soil exposed by animals can be found. Bringing in of wS seed in such places as they are found by a seeding crew going more or less in line seems to be quite practicable.¹⁴

The writer wishes to express thanks to Mr. A. M. Howland, who did a considerable amount of the measurements in the field and to Mr. S. C. Pocock, who helped with the calculations.

¹³ Rodents would hardly have preference for seed which is not on debris. Furthermore, the existence of a considerable amount of seedlings on debris leads to the thought that the role of the rodents in this area is often exaggerated.

¹⁴ This cheap palliative has been proposed for burns in several management plans in the province of Saskatchewan.

MAIN SHRUBS AND GROUND VEGETATION
(ABUNDANCE*) AND SOCIABILITY BY
BROWN-BLANQUET'S SYSTEM

*Abundance refers to the whole area investigated, not only to those plots where the particular plants were found.

Name of Plant	Abundance & Sociability	Remarks
SHRUBS		
Dogwood, <i>Cornus stolonifera</i> , Michx.	3, E	Main brush in moist places; on 107 plots.
Hazel, <i>Corylus rostrata</i> , Ait.	3, E	Main brush in dry places; on 105 plots.
Roses, mainly <i>Rosa acicularis</i> , Lindl.	1, A	Usually together with hazel; on 116 plots.
Highbush cranberry, <i>Viburnum trilobum</i> , Marsh.	1, C	Together with dogwood or main shrub on plot; on 17 plots.
Alder, <i>Alnus rugosa</i> , (Du Roi) Spreng.	2, B	In moist and wet places; on 36 plots.
Gooseberry, <i>Ribes oxycanthoides</i> , L.	1, A	Usually with dogwood and highbush cranberry; on 37 plots.
Lowbush cranberry, <i>Viburnum edule</i> , Raf.	1, A	Usually amongst hazel or together with saskatoons; on 24 plots.
Red currants, <i>Ribes glandulosum</i> , Grauer.	X, B	In moist places; on 21 plots.
Black currants, <i>Ribes hudsonianum</i> , Richards.	X, A	In moist places; on 4 plots.
Saskatoon, <i>Amelanchier alnifolia</i> , Nutt.	X, A	In dry places, scattered together with lowbush cranberry and roses; on 18 plots.
Willow, <i>Salix</i> spp.	X, B	In depressions; on 8 plots.
Snowberry, <i>Symphoricarpos albus</i> , (L.) Blake.	X, A	Together with hazel and roses; on 9 plots.
Pinchberry, <i>Prunus pensylvanica</i> , L.f.	X, A	On dry ground; on 7 plots

Chokecherry, <i>Prunus virginiana</i> , L.	X, A	Mainly on banks of creeks; on 6 plots.
Labrador tea, <i>Ledum groenlandicum</i> , Oeder.	X, B	In patches of muskeg; on 4 plots.
Kalmia, <i>Kalmia polifolia</i> , Wang.	X, A	In patches of muskeg; on 3 plots.
HALF SHRUBS		
Raspberry, <i>Rubus strigosus</i> , Michx.	2, B	Mainly in places where soil disturbed; on 46 plots.
Blackberry spp. of prostrate <i>Rubus</i> .	X, B	Mainly on disturbed soil; on 7 plots.
GROUND VEGETATION (Herbs, grasses and others)		
Grasses, <i>Calamagrostis</i> , spp. and others.	2, A	Mainly in places where shrubs not dense; on 120 plots.
Moss, <i>Hypnum</i> , <i>Hylocomium</i> , and <i>Dicranum</i> spp.	2, D	<i>Hypnum</i> in some depressions; <i>Polytrichum</i> mainly in burnt places; on 137 plots.
<i>Polytrichum</i> spp.		
Bunchberry, <i>Cornus canadensis</i> , L.	1, C	With other broad leaves; on 102 plots.
Sarsaparilla, <i>Aralia nudicaulis</i> , L.	2, A	Not of vigorous growth; on 79 plots.
Horsetail, <i>Equisetum</i> spp.	1, A	On 95 plots.
Twinflower, <i>Linnaea borealis</i> , L.	1, B	On 68 plots.
Strawberry, <i>Fragaria canadensis</i> , Michx.	1, A	On 56 plots.
Bedstraw, <i>Galium Aparine</i> (?) L.	1, A	On 47 plots.
Fireweed, <i>Epilobium angustifolium</i> , L.	2, A & B	Mainly on disturbed soil; on 62 plots.
Wintergreen, <i>Pyrola</i> , spp.	1, A & B	On 37 plots.
Windflower, <i>Anemone canadensis</i> , L.	1, A	On 33 plots.
Crane's Bill, <i>Geranium</i> spp.	1, A	On 23 plots.
Aster, <i>Aster</i> spp.	1, A	In 16 plots.
Wild Pea, <i>Lathyrus palustris</i> , (var. <i>macranthus</i> (?) (Fern).	1, A	On 13 plots.
Cranberry, <i>Vaccinium vitis-idea</i> var. <i>minus</i> , L.	X, B	On 13 plots.
Vetch, <i>Vicia Craca</i> , L.	X, A	On 9 plots.
Plantain, <i>Plantago</i> spp.	X, A	On 11 plots.
Fern, <i>Polypodiaceae</i>	X, A	Of poor growth; on 15 plots.
Sedges, <i>Carex</i> spp.	X, A	On 9 plots.

APPENDIX

TABLE NO. 1

STAND TABLE

(For 250 plots of 2 milliacres each)

White Spruce										Trembling		Black	
Standing				Standing		Windfall		Cut *)		Aspen		Spruce	
(Alive)				(Dead)						(Standing)		(Standing)	
D.B.H.	No. of: Volume:	No. of: Volume:	No. of: Volume:	No. of: Volume:	No. of: Volume:	No. of: Volume:	No. of: Volume:	No. of: Volume:	No. of: Volume:	No. of: Volume:	No. of: Volume:	No. of: Volume:	D.B.H.
(Inches)	Trees: cu. ft.	Trees: cu. ft.	Trees: cu. ft.	Trees: cu. ft.	Trees: cu. ft.	Trees: cu. ft.	Trees: cu. ft.	Trees: cu. ft.	Trees: cu. ft.	Trees: cu. ft.	Trees: cu. ft.	(Inches)	
3	3												3
4	3								1	.8			4
5	2	2	4.2										5
6	4	1	3.1										6
7	6	2	10.8						2	6.4	1	3.4	7
8	6			2	15.0								8
9	11			1	10.2				1	8.4	1	6.8	9
10	5			1	13.4	1	13.4				3	38.4	10
11	3	2	33.8	2	38.8	2	33.8	2	24.4				11
12	4			1	20.9	2	41.8	5	73.0				12
13	1					1	25.0	5	85.0				13
14	2					1	29.3	4	78.0				14
15						4	135.6	1	21.8				15
16						2	77.2	1	38.2				16
17								1	42.0				17
18													18
19													19
20						1	60.6						20
21						3	209.4						21
22						1	75.7						22
23						2	130.0						23
31						1	133.4						31
**)													
Total	50	538.8	7	51.9	7	93.3	21	965.2	23	378.0	5	48.6	

*) The D.B.H. of these trees was computed from the diameter of the stumps.

**) This volume is taken from Table No. 5 which is the result of calculating the volume and increment for each tree separately.

TABLE NO. 2
STAND DENSITY INDEX

<u>For the present stand</u>		<u>For the stand before Cutting</u>	
wS	 87.4	wS: Cut	 102.1
tA	 68.3	At present dead, standing	5.8
bS	 10.0	Present windfall	 14.0
Total	 165.7	Present wS stand 10 years ago	 76.9
		tA	 68.3
		bS	 10.0
		Total	 277.1 *)

*) No attempt was made to establish the average D.B.H. for the present dead wS and wS windfall before the cutting. Also the present average D.B.H. was used for tA and bS. The stand density index for the present living wS has increased by 12% of the present S.D.I. if we apply this per cent to wS windfall tA, and we arrive at a S.D.I. of 277.1 — [(14.0 + 68.3 + 10) x 0.12] = 266.0.

TABLE NO. 3
TREES IN DIFFERENT AGE GROUPS: NO. AND PER CENT

		31-40		41-50		51-60		61-70		71-80		81-90		91-100	
		No.of:	Per	No.of:	Per	No.of:	Per	No.of:	Per	No.of:	Per	No.of:	Per	No.of:	Per
		Trees:	Cent:	Trees:	Cent:	Trees:	Cent:	Trees:	Cent:	Trees:	Cent:	Trees:	Cent:	Trees:	Cent:
On 250 Plots	Standing, alive	1	2	-	-	1	2	3	6	7	14	26	46	12	24
	Standing, dry	-	-	2	28.6	3	42.8	2	28.6	-	-	-	-	-	-
	Windfall	-	-	-	-	-	-	1	14.3	3	42.9	1	14.3	-	-
	Cut	-	-	-	-	-	-	-	-	1	4.8	6	28.5	3	14.5
	Total	1	1.2	2	2.4	4	4.7	6	7.0	11	12.9	33	38.8	15	17.6
Outside of Plots	Standing, alive	-	-	2	.7	10	3.6	16	5.7	82	29.3	101	36.0	50	17.8
	Added for dead	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	windfall and cut	-	-	11	5.7	16	8.4	16	8.4	33	17.5	28	14.8	22	11.6
	Total	-	-	13	2.7	26	5.5	32	6.8	115	24.6	129	27.5	72	15.4
Grand Total		1	-	15	2.7	30	5.4	38	6.8	126	22.8	162	29.3	87	15.8

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		101-110		111-120		121-130		131-140		141-150		151-160		Total	
		No.of:	Per	No.of:	Per	No.of:	Per	No.of:	Per	No.of:	Per	No.of:	Per	No.of:	Per
		Trees:	Cent:	Trees:	Cent:	Trees:	Cent:	Trees:	Cent:	Trees:	Cent:	Trees:	Cent:	Trees:	Cent:
On 250 Plots	Standing, alive	-	-	-	-	-	-	-	-	-	-	-	-	50	100
	Standing, dry	-	-	-	-	-	-	-	-	-	-	-	-	7	100
	Windfall	-	-	-	-	-	-	1	14.3	1	14.3	-	-	7	100
	Cut	2	9.5	1	4.8	1	4.8	2	9.5	4	19.0	1	4.8	21	100
	Total	2	2.4	1	1.2	1	1.2	3	3.5	5	5.9	1	1.2	85	100
Outside of Plots	Standing, alive	9	3.3	5	1.8	2	.7	1	.4	2	.7	-	-	280	100
	Added for dead	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	windfall and cut	11	5.8	5	2.6	5	2.6	16	8.4	22	11.6	5	2.6	190	100
	Total	20	4.2	10	2.1	7	1.5	17	3.6	24	5.1	5	1.0	470	100
Grand Total		22	4.0	11	2.0	8	1.4	20	3.6	29	5.2	6	1.0	555	100

TABLE NO. 4

a. Acres		AREA OF WHITE SPRUCE STANDS					
Location	Portion of WS in Stands (in tenths)	WS Even-aged (including those of two adjacent age classes)	WS in Two Age Groups with Difference of Two Age Classes	WS in Three Age Groups	Total of Headings 4 and 5	Total of Headings 3 and 6	
1	2	3	4	5	6	7	
Pasquia Area (Approx. centre: 53° 20' N, 102° 40' W)	9-10	1,233	1,758	2,691	4,449	5,682	
	4- 8	5,429	28,070	11,574	39,644	45,073	
	tA & 1-3 WS	11,512	4,390	--	4,390	15,902	
Torch Area (Approx. centre: 53° 45' N, 103° 30' W)	9-10	472	507	160	667	1,139	
	4- 8	21,708	12,190	2,396	14,586	36,294	
	tA & 1-3 WS	7,249	1,327	--	1,327	8,576	
Montreal Area (Approx. centre: 54° 15' N, 105° 45' W)	9-10	42	--	--	--	42	
	4- 8	10,115	3,814	--	3,814	13,929	
	tA & 1-3 WS	6,359	921	82	1,003	7,362	
b. Percentages							
Pasquia Area	9-10	21.7	31.0	47.3	78.3	100.0	
	4- 8	12.1	62.3	25.6	87.9	100.0	
	tA & 1-3 WS	72.4	27.6	--	27.6	100.0	
Torch Area	9-10	41.4	44.5	14.1	58.6	100.00	
	4- 8	59.8	33.6	6.6	40.2	100.0	
	tA & 1-3 WS	84.5	15.5	--	15.5	100.0	
Montreal Area	9-10	100.00	--	--	--	100.0	
	4-8	72.6	27.4	--	27.4	100.0	
	tA & 1-3 WS	86.4	12.5	1.1	13.6	100.0	
c. Totals							
Pasquia Area	Acres	18,174	34,218	14,265	48,483	66,657	
	Per Cent	27.3	51.3	21.4	72.7	100.0	
Torch Area	Acres	29,429	14,024	2,556	16,580	46,009	
	Per Cent	64.0	30.5	5.5	36.0	100.0	
Montreal Area	Acres	16,516	4,735	82	4,817	21,333	
	Per Cent	77.4	22.2	.4	22.6	100.0	
GRAND TOTALS	Acres	64,119	52,977	16,903	69,880	133,999	
	Per Cent	47.8	39.5	12.7	52.2	100.0	

TABLE NO. 5
INCREMENT ON SAMPLE PLOTS
(Total Area .5 Acres)

No. of Trees	Total Volume 20 yrs. Ago	Total Volume 10 yrs. Ago	Total Volume at Present	Increment from 20-10 Years		Increment from 10 Yrs. to Present		Increase of Increment	
				(3-2)		(4-3)		(7-5)	
				Volume	%	Volume	%	Volume	%
1	2	3	4	5	6	7	8	9	10
50	371.1	439.0	538.8	67.9	18.3	99.8	22.7	31.8	46.1

TABLE NO. 6
INCREMENT OF WS GROUPED BY CROWN CLASS AND CROWN QUALITY

		No. of Trees	Total Volume 20 yrs. Ago	Total Volume 10 yrs. Ago	Total Volume at Present	Increment from 20-10 Years (3-2)		Increment from 10 Yrs. to Present (4-3)		Increase of Increment (7-5)	
		1	2	3	4	Volume	%	Volume	%	Volume	%
Dominant	Poor Med. Good Crown Crown Crown	30	551.0	640.2	769.1	89.2	16.2	128.9	20.1	39.7	44.5
		13	230.3	272.7	320.7	42.4	18.4	48.0	17.5	5.6	13.0
		4	82.0	100.0	115.6	18.0	22.0	15.6	15.6	2.4	-13.3
Co-dominant	Poor Med. Good Crown Crown Crown	59	770.6	932.6	1229.0	162.0	21.0	296.4	31.8	134.4	83.0
		53	691.2	809.6	985.4	118.4	17.1	175.8	21.7	57.4	48.5
		15	191.6	220.0	252.6	28.4	14.8	32.6	14.8	4.2	14.8
Intermediate	Poor Med. Good Crown Crown Crown	23	157.9	204.8	307.3	46.9	29.6	102.5	50.0	55.6	140.1
		46	400.8	466.2	565.4	65.4	16.3	99.2	21.3	33.8	51.7
		25	185.3	215.2	245.7	29.9	16.1	30.5	14.2	.6	2.0
Oppressed	Poor Med. Good Crown Crown Crown	10	25.7	34.0	54.2	8.3	32.1	20.2	60.0	11.9	144.7
		23	75.2	95.6	134.7	20.4	27.3	39.1	40.7	18.7	91.2
		29	118.1	133.3	141.5	15.2	12.9	8.2	6.2	-7.0	-46.1
Totals and Average %		330	3479.7	4124.2	5121.2	644.5	18.5	997.0	24.2	352.5	54.7
All Crown Classes	Poor Med. Good Crown Crown Crown	122	1505.2	1811.6	2359.6	306.4	20.2	548.0	30.2	241.6	78.8
		135	1397.5	1644.1	2006.2	246.6	17.6	362.1	22.0	115.3	46.7
		73	577.0	668.5	755.4	91.5	15.9	86.9	13.0	-4.6	-5.0

TABLE NO. 7
TREES GROUPED BY AGE AND CROWN CLASSES

Age Group (Years)	Dominants		Co-dominants		Intermediate		Oppressed		In Age Group	
	No. of Trees	Per Cent	No. of Trees	Per Cent	No. of Trees	Per Cent	No. of Trees	Per Cent	No. of Trees	Per Cent
71 - 80	--	--	6	24	8	32	11	44	25	100
81 - 90	13	16	19	24	26	33	21	27	79	100
91 - 100	17	14	53	43	41	33	13	10	124	100
101 - 110	14	19	34	45	17	22	10	13	75	100
111 - 120	4	29	7	50	3	21	--	--	14	100
Total No. of Trees and Average Per Cent	48	15	119	37	95	30	55	17	317	100
121 - 160										
41 - 70	--	--	--	--	--	--	--	--	13	100
Total									330	100

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TABLE NO. 8
RELATION BETWEEN AGE AND INCREMENT

Age Group (Present)	No. of Trees	Volume 20 yrs. Ago	Volume 10 yrs. Ago	Volume at Present	Increment from 20-10 Years. (4 minus 3)		Increment from 10 Yrs. to Present (5 minus 4)		Increment Increase (8 minus 6)	
					Volume	Per Cent	Volume	Per Cent	Volume	Per Cent
41 - 70	2	15.6	19.0	25.6	3.4	21.8	6.6	34.8	3.2	94.1
71 - 80	25	108.9	130.6	163.6	21.7	19.9	33.0	25.3	11.3	52.1
81 - 90	79	771.1	924.8	1155.7	153.7	19.9	230.9	24.8	77.2	50.2
91 - 100	124	1357.7	1624.8	2040.8	267.1	19.6	416.0	25.6	148.9	55.7
101 - 110	75	914.1	1049.2	1269.3	135.1	14.7	220.1	20.9	85.0	62.9
111 - 120	14	193.5	229.1	286.5	35.6	18.4	57.4	21.8	21.8	61.3
121 - 130	5	118.8	146.7	179.7	27.9	--	33.0	--	5.1	--
131 - 140	2									
141 - 150	1									
151 - 160	3									
		3479.7	4124.2	5121.2	644.5	18.5	997.0	24.2	352.5	54.7

TABLE NO. 9
TREES GROUPED BY AGE AND CROWN QUALITY

Age Group (Years)	Good Crown		Medium Crown		Poor Crown		In Age Group	
	No. of Trees	Per Cent	No. of Trees	Per Cent	No. of Trees	Per Cent	No. of Trees	Per Cent
71 - 80	4	16	9	36	12	48	25	100
81 - 90	24	30	41	52	14	18	79	100
91 - 100	41	33	58	47	25	20	124	100
101 - 110	32	43	25	32	18	24	75	100
111 - 120	11	79	2	14	1	7	14	100
Total No. of Trees and Average Per Cent	112	35	135	43	70	22	317	100
121 - 160								
+ 41 - 70	--	--	--	--	--	--	13	100
							Total	330
								100

TABLE NO. 10
NO. OF SEEDLINGS AND SUCKERS ON 250 PLOTS (.5 ACRES) AND ON 1.0 ACRES

wS on Debris		wS on Ground		tA		wB		bPo.		bF	
Fair or Better	Poor	Fair or Better	Poor	Fair or Better	Poor	Fair or Better	Poor	Fair or Better	Poor	Fair or Better	Poor
111	33	61	3	207	194	62	8	16	4	5	20
---	---	---	---	---	---	---	---	---	---	---	---
222	66	122	6	414	388	124	16	32	8	10	40

TABLE NO. 11
DISTRIBUTION OF REGENERATION

Number of Plots with Indicated Number of Seedlings (Suckers)																		Total No. of Plots	No. of Plots Per Acre	Total No. of Seedlings (Suckers) Per Acre
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
wS	24	11	9	2	3	5	2	1	-	1	-	-	-	-	-	2	-	1	61	122
tA	38	24	20	11	8	10	3	4	-	1	2	1	-	1	-	-	-	-	123	246
wB	13	6	5	3	1	1	1	-	-	-	-	-	-	-	-	-	-	-	30	60
bPo	5	5	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	13	26
bF	8	1	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	13	26

Number of Plots without any kind of regeneration: 72