SOME PROBLEMS OF MIXEDWOOD STANDS

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The writer would like to state at the very beginning that he does not intend to give final answers to any of the numerous problems which arise in the complicated biological features of our forests called mixedwood stands. It would require much more time and means than there is at the disposal of the writer to come to conclusions which in every detail could withstand scientific criticism. The main purpose of this article is to show the existence of some grave problems in our spruce-popular stands and to make an attempt to show the character of these problems.

During the last three years the writer has worked on the preparation of management plans in the province of Saskatchewan. This work has presented hundreds of questions, a large part of which have come from mixedwood stands. The very fact that about three-quarters of all productive forest area in the district of the management plans belongs to the mixedwood, is of great importance. (For exact figures see Tables No. 1 and No. 2). It is of some significance that these data came from the northern part of the mixedwood belt. These figures are based in Table No. 1 on a productive forest area of 80,913 acres and in Table No. 2 on 143,480 acres. This acreage constitutes 67.5 per cent of the total area of the forest in the first case and 49.8 per cent in the second case. Both these areas are located in the Dore-Smoothstone-Sled-Clark Lake district between 54 degrees, 20 minutes and 54 degrees, 55 minutes Northern Latitude.

It seems that this area could be considered a big enough sample plot to show the general character of the forest in the northern part of the mixedwood belt. In the southern part this belt appears to be of a somewhat different character. In the Armit area, at the provincial boundary of Manitoba and Saskatchewan close to Hudson Bay Junction, the percentage of pure or practically pure stands of trembling aspen (At) is 31.5 per cent of the productive area, although together with mixed stands of white spruce (Sw) and trembling aspen (At) the per cent is as high as 77.0. (Figures based on a total productive area of 65,081 acres). It is true that in the Sled-Clark area this category of stands (pure poplar) gives a percentage of 21.7 (Table No. 2), but if we look at the table, we see that the major part of it (86.0 per cent), is in the first age class (1-20 years). This situation was caused by a large recent burn, and only young trembling aspen has managed to come in on the major part of it at present. Normally in this area trembling aspen of the first age class, together with balsam fir and some white spruce, is young growth under older stands, thus not taking up productive area for this age of low increment.

The situation is quite different in the Armit area where 55.0 per cent of all stands of pure poplar are in the third age class and 19.3 per cent in the fifth age class. However, the most important feature showing the difference between the southern and the northern areas from this point of view seems to be

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the fact that in the south-east of the mixedwood belt in the Armit district, 21.2 per cent of the area covered by pure poplar is under old, deteriorating semi-open stands, density under 0.3 of normal with heavy underbrush of hazel or mountain maple, presenting a serious problem to management. This situation has not been caused by man as practically no cutting has been done in such stands in the Armit area. There were no such stands in the Dore area and only 0.8 per cent of the total acreage covered by stands of pure trembling aspen (At) is semi-open in the Sled-Clark area (Table No. 2). But they have been caused by recent cutting.

Taking into consideration the high percentage of the productive area covered by these mixedwood stands and the fact that they are the source of spruce timber, we have to inspect more closely the data about these stands as shown in Tables No. 1 and No. 2 (in per cent) and in graphs No. 1 and No. 2 (in acres). We see that in the area covered by stands of 4-10 white spruce +0-6 trembling aspen and likewise in stands of 7-9 trembling aspen +1-3 white spruce there is a gap comprising the fifth and sixth age classes (80-100 years and 100-120 years) with a counterpart in the second age class, the first age class being represented to a large extent by young growth under older stands, and thus not fully appearing in the tables and graphs. The large acreage of the third age class and the remoteness in time when the present second age class will be harvested, entitles us to disregard this gap at the present. Unfortunately we cannot say the same about the other gap which seriously influences our attitude in planning a sustained yield of white spruce timber. The necessity of bridging this gap causes quite a headache to people who prepare management plans. There are not many possibilities in building this bridge. Some help could be obtained from the present sixth age class if we do not include healthier stands of this age class into our next ten or fifteen year cutting period, and cut not much more than the seventh age class, the area of which is out of proportion, too, forcing us to cut more than we would like. However, there is such a small amount of the sixth age class that it would not help very much. Another way is to mark all trees to be cut yearly, leaving behind all promising white spruce of the fifth and lower age classes for the next crop, if in the stands to be cut there is a certain amount of such trees. This practice appeared to be quite helpful in the Armit area where there is a large amount of uneven-aged stands, but it would be of very little help in the Dore and Sled areas because the stands there are mostly even-aged.

Therefore, we are forced to have a closer look at the third and the fourth age classes, and we have to find out if in these age classes there is not some possibility of filling the gap. The writer tried to do this and one of the results of this examination is Table No. 3.

All the sample plots of this table were taken at random in stands of the second half of the third age class (50-60 years), except Plot No. 10 which is in the first half of the third age class. The soil was moist to dry during the period of June to August. The A₀ layer, not too well decomposed, with quite an amount of roots of living ground cover and hyphae of fungi, is 0.5 to 2 inches thick. The A₁ layer is poorly developed, usually not over 1 inch; A₂ layer from

3 to 6 inches, not too badly leached, with a number of roots ending in this layer. The B layer is in no place developed into a real hardpan; often it is indicated mainly by a slight brown stain or by brown patches. The soil is mainly sandy loam or gravel with some clay usually with a C horizon of sandy clay, often quite hard. The reaction, as far as it could be established in the field, was not far from 6 pH. in either direction, in a few places showing around 7 pH. or slightly more. No visible reaction to HCl.

The main shrubs are low brush cranberry—*Viburnum edule* Raf. (*V. eradicatum*), high bush cranberry—*V. trilobium* Marsh., in depressions Rosebush—*Rosa* sp., Alder—*Alnus rugosa* (Du Roi) Spring., (*A. incana*), Dogwood—*Cornus stolonifera* Michx. (*Svida stolonifera* Rydb.). In some places hazel—*Corylus cornuta* Marsh. (*C. rostrata* Ait). In a few dry, sandy spots Saskatoons—*Amelanchier alnifolia* Nutt., *Cyanococcus Canadensis* Rydb. and *C. pennsylvanicus* Rydb.

Main herbs are *Aralia nudicaulis* L., *Cornus canadensis* L., *Pirola* sp., *Linea borealis* L., *Fragaria canadensis* Michx., *Maianthemum Canadense* Desf., *Geranium* sp., *Vicia* and *Latyrus* sp. in more moist spots. *Asarum Canadense* L., *Anemone Canadensis* L., *Rubus idaeus* together with some grasses (*Calamagrostis* and others) appear in places which have been cut over. Mosses—*Hypnum*, *Hylocomium* and *Diacranum* sp.; *Lycopodium* and *Equisetum* sp. scarce. Few *Polypodiaceae* in creek valleys.

NOTE TO TABLES OF AGE CLASSES (TABLES NO. 1 and 2)

These tables are slightly modified parts of tables used in the management plan for the areas concerned. The composition is listed in tenths of basal area. Ten tenths would mean a pure stand of a given species, and other combinations indicate the proportion of different species. In several of the stands which have served as a basis for these tables, a certain amount of black spruce, balsam fir and white birch up to three-tenths is present in a few instances. But the stands have been classified by dominant species. Thus, those stands are represented in these tables in which either white spruce or trembling aspen is dominant, and the other major component is either white spruce or trembling aspen. Stands with dominant black spruce, jack pine and other species have been grouped separately. Twenty-year age classes have been used both for hardwoods and softwoods. Thus, under the first age class come all stands 1-20 years old; all stands 20-40 years old come under the second age class, and so on. The seventh age class comprises stands 120-140 years old and older. This distribution of age classes was established for practical purposes; therefore, there was no need for further classes for older stands. The preference for cutting was based on the description of each stand. The figure in the column for each age class indicates what per cent of stands of a given composition group is in this age class. All areas with a density over 0.3 were considered covered, taking the figure 1 for normal. Semi-open were classified stands of 0.1-0.3 density, except for the first two age classes where all areas with less than a density of 0.2 were considered as non-forested. Areas with older trees were classified as non-forested when density was under 0.1.

The percentage of the productive forest area covered by the given category of stands is shown in the last column.

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TABLE No. 1
Dore Lake Area
Table of Age Classes (In Per cent)

Composition	1	2	Age Classes				7	Total Cover- ed	Semi- Open	Non For- ested	Percent of Total Productive Area
9-10 Sw +											
0-1 At	—	—	—	—	—	—	100	100.0	—	—	.9
4-8 Sw +											
2-6 At	6.5	10.6	24.2	4.9	8.5	.5	44.8	99.9	—	.1	24.9
7-9 At +											
1-3 Sw	5.7	3.4	38.8	30.0	11.7	.9	9.5	100.0	—	—	51.7
10 At or + less than 1 Sw ..	—	82.8	5.7	11.5	—	—	—	100.0	—	—	.2
Total											77.7

TABLE No. 2
Sled — Clark Lake Area
Table of Age Classes (In Per cent)

Composition	1	2	Age Classes				7	Total Cover- ed	Semi- Open	Non For- ested	Percent of Total Productive Area
9-10 Sw +											
0-1 At	—	—	—	22.1	—	55.7	22.2	100	—	—	.3
4-8 Sw +											
2-6 At	.6	.8	44.1	14.8	2.6	5.0	30.1	98.0	2.0	—	13.0
7-9 At +											
1-3 Sw	1.3	4.2	55.5	20.6	7.6	4.7	4.5	98.4	1.6	—	39.1
10 At or + less than 1 Sw	86.0	2.0	1.1	4.5	5.5	—	—	99.1	.8	.1	21.7
Total											74.1

The area of the plots for Table No. 3 was not established because it was considered that the percentage of each group of trees would largely convey the picture sought for. Spruce trees of the first three Kraft classes only—dominants, codominants and intermediates—were taken into consideration as those which eventually would be participating in forming the future mature stand. In doing this classification, the stand was considered to consist of 10 white spruce. In the column "Remarks on the Stand" the composition and density is indicated. If some trees of white spruce were not overtopped by trembling aspen it is indicated under this heading.

TABLE NO. 3
Percent of Damaged White Spruce

No. of Plots	DOMINANT						INTERMEDIATE						Total No. of Trees Counted	Remarks on the Stand
	No. of trees and per cent of total			No. of trees and per cent of total			No. of trees and per cent of total			No. of trees and per cent of total				
	Top	Limb	Damage	Top	Limb	Damage	Top	Limb	Damage	Top	Limb	Damage		
1	5	1	3	6	1	4	4	—	—	2	2	26	6 At, 4 Sw; density 0.9; 2 of dominant Sw not overtopped	
	19.2	3.8	11.6	23.1	3.8	15.4	15.4	—	—	7.7	7.7	100		
2	6	1	4	10	—	2	5	2	2	4	4	34	6 At, 4 Sw; density 0.8; dominant Sw reach level of At.	
	17.6	2.9	11.8	29.4	—	5.9	14.7	6.9	6.9	11.8	11.8	100		
3	—	—	8	12	2	—	2	—	—	2	2	26	7 At, 8 Sw; density 0.8; dominant Sw 5-15 years older than At, not overtopped.	
	—	—	30.8	46.1	7.7	—	7.7	—	—	7.7	7.7	100		
4	—	—	14	17	—	1	8	—	—	2	2	42	6 At, 4 Sw; density 0.8; dominant Sw 10-15 years older than At, not overtopped.	
	—	—	33.3	40.5	—	2.4	19.0	—	—	4.8	4.8	100		
5	8	1	1	7	1	1	1	—	—	5	5	25	7 At, 3 Sw; density 0.8; all Sw overtopped by At.	
	32.0	4.0	4.0	28.0	4.0	4.0	4.0	—	—	20.0	20.0	100		
6	2	—	5	4	2	—	2	1	1	—	—	16	7 At, 3 Sw; density 0.9; 2 of dominant Sw overtopped.	
	12.5	—	31.2	25.0	12.5	—	12.5	6.3	6.3	—	—	100		
7	2	—	6	10	1	2	—	—	—	8	8	28	7 At, 3 Sw; density 0.9; 3 dominant Sw overtop At.	
	7.1	—	17.9	35.7	8.6	7.1	—	—	—	28.6	28.6	100		
8	7	2	—	1	1	1	—	—	—	10	10	28	9 At, 1 Sw; density 0.9; All Sw overtopped by At.	
	80.4	8.7	—	4.8	3.4	8.7	—	—	—	43.6	43.6	100		
9	7	2	4	1	1	6	—	—	—	8	8	23	7 At, 3 Sw; density 0.8; All Sw overtopped by At.	
	80.4	8.7	17.4	4.3	4.3	21.8	—	—	—	13.1	13.1	100		
10	1	—	10	9	1	8	2	—	—	7	7	38	8 Sw, 2 At; density 1.0; 5 dominant Sw overtop At.	
	2.6	—	26.8	23.7	2.6	21.1	5.8	—	—	18.4	18.4	100		
11	1	2	14	2	—	2	8	1	—	8	8	38	6 At, 4 Sw; density 0.7; Dominant Sw 5-15 years older than At; 4 of dominant Sw overtop At.	
	2.6	5.3	36.8	5.8	—	5.3	21.0	2.6	2.6	21.1	21.1	100		
12	8	6	—	9	2	—	3	1	—	2	2	32	7 At, 3 Sw; density 1.0; All Sw overtopped by At.	
	25.0	18.7	—	28.1	9.4	—	9.4	3.1	3.1	6.8	6.8	100		
Totals	47	15	68	88	13	27	85	6	6	53	53	861		
	13.4	4.3	19.3	25.0	3.7	7.7	10.0	1.5	1.5	15.1	15.1	100		

Trees with top damage were listed as those which had at least the last year's leader destroyed. The writer recognizes that two sub-groups might have been of some value—one year's terminal destroyed and terminal destroyed repeatedly, but this would have involved a considerably larger amount of work and, on the other hand, it was noticed that practically all trees which have one year's leader destroyed will suffer the same destruction during the ensuing years. Trees with limb damage were listed as those which had limbs whipped off or crippled, including trees with visible bruises on the bark. In general the purpose of this checking was to find out how much mechanical damage is done by trembling aspen to white spruce in this kind of a stand 50-60 years old. This age was chosen because it appeared that in the bulk of these mixed stands at this age the damage manifests itself clearly. The age class corresponds to the average age of the stands. The bulk of the white spruce is 5-15 years younger than the trembling aspen with the exception of some trees which overtop the trembling aspen. These apparently have originated from seedlings which had established themselves under the previous stands and are 5-15 years older than the trembling aspen. Such, for instance, is the case in plots No. 3 and 4, where all dominant white spruce is older than trembling aspen.

The main result shown by Table No. 3 is that the percentage of white spruce with damaged tops is $13.4+25.0+10.0=48.4$; trees with limb damage give a percentage of $4.3+3.7+1.5=9.5$. Thus the total per cent of damaged trees appears to be $48.4+9.5=57.9$. More than double the number of plots recorded in Table No. 3 were examined with the same overall result. They were all in the same Dore-Sled-Clark Lake area. Maybe the picture would be somewhat different in another area, but the general impression is that these figures are close to the average. It might be of interest to note that the percentage of trees with top damage goes as high as 62 (Plots No. 12 and 2) and might be as low as 29 or 32 (Plots No. 10 and 11).

To gain some insight as to what the result is at the cutting age, several areas of such mixedwood stands, cut over for white spruce timber were examined. It was found that five to eighty per cent of white spruce trees (by number, not by volume) had been left behind because their tops had been constantly whipped off by trembling aspen and they had not reached ten inches D.B.H., being of the same age as those trees which had been cut, over 120 years old.

It is a question if under such circumstances we are not entitled to think that at least about one-third of the possible volume of white spruce has been lost because of the mechanical action of trembling aspen and because of competition. If we take into consideration the additional damage sustained because some amount of lower grade lumber results in crooked trees and because of increased rot, the financial damage might show a considerably higher per cent.

There is one more fact which throws some light on the question of the total increment in these mixed trembling aspen and white spruce stands. Mr. A. Kabzems of the Saskatchewan Forest Service, while working on data for yield tables, has found that on the average the curves for the

current annual increment and the mean annual increment are crossing at the following ages: In stands of 10 Sw at 57 years, in 10 At between 41 and 42 years, in mixed At + Sw stands between 38 and 39 years. The last figure made Mr. Kabzems a little puzzled because theoretically the figure for mixed poplar — white spruce should be somewhere between the figure for At and Sw, in this case between 57 and 41 or 42, say, around 50 years, depending on the composition of the stand. In other words, the highest production of volume over several rotation periods should theoretically be reached with a rotation of about 50 years.

Some light is thrown on this "mystery" by the results of Table No. 3 when we take into consideration that 48.4 percent of all white spruce has suffered top damage and that the total percentage of damaged trees is 57.9, we could expect that this would slow down the increment. The graph No. 5 shows that the current annual increment in mixed At+Sw stands starts to drop sharply at about thirty years. This is the age when the tops of the spruce usually start to grow into the crowns of the trembling aspen as it has been established in several stands of this age. It might be wrong to attribute this to the mechanical damage only, but the fact that in pure trembling aspen stands this sharp decline of the curve of current annual increment sets in later (see Graph No. 4) shows that the

reason is to be looked for in unfavourable circumstances of development in the At + Sw stands, especially when we take into consideration that for pure white spruce stands the **current** annual increment reaches its peak at about forty years and a sharper decline of this increment starts only at an age close to fifty years.

Another important feature of the curve for the **current** annual increment in At + Sw stands seems to be the behaviour of the curve of this increment at the age of sixty years. First of all the **current** annual increment at this age in the At + Sw stands is considerably lower than in pure stands of trembling aspen and in pure stands of white spruce. In the At + Sw stands it is over eleven cubic feet per acre for stand density index 100; in pure white spruce and pure trembling aspen stands, it is about the same — about fifteen cubic feet per acre for stand density index 100. Furthermore, the curves for this increment in pure trembling aspen and pure white spruce stands continue to drop after this age at a nearly constant rate. The curve for the At + Sw stands starts to flatten out. This seems to indicate that at an age between fifty and sixty years some spruce trees have succeeded in struggling out of the canopy of trembling aspen and start to grow under more favourable circumstances. In other words, the period of maximum damage is finished and a relative improvement starts to set in.

The course of this improvement merits some attention. In the graphs No. 1 and No. 2, showing the distribution of age classes in stands of 4-10 Sw + 0-6 At and 7-9 At + 1-3 Sw we see that, with the fifth age class, the stands of 4-10 Sw + 0-6 At are starting to cover a somewhat larger proportion of the area covered by both these kinds of stands. This appears in Graph No. 2 more clearly in the sixth age class but shows up definitely in the fifth age class in Graph No. 1. This could be interpreted as an indication of the age at which the trembling aspen starts to fall, leaving a larger proportion of the basal area to white spruce, so that the stands start to go over from a composition group of 7-9 At + 1-3 Sw into the composition group of 4-10 Sw + 0-6 At, which for practical purposes in the management plans, have been called stands with dominant Sw. This elimination of trembling aspen seems to improve the increment on the Sw in the mixedwood stands to such an extent that the curve of the current annual increment in these stands between eighty and ninety years becomes flatter than in pure white spruce stands (See Graph No. 3 and No. 5).

The writer is pleased to mention that the age at which the trembling aspen starts to eliminate itself from the mixedwood stands, found by a statistical method, largely coincides with the results obtained by Dr. C. G. Riley of the Dominion Laboratory of Forest Pathology. Dr. Riley, in an

account of his research on heart rot of trembling aspen, which at this time is in the process of publication, comes to the conclusion that the heart rot in trembling aspen starts to increase considerably at the age of seventy. This would mean that results of this increased rot could show up some years later, that an increased falling down of poplar would start at an age close to eighty years, which was mentioned above.

This short analysis appears to entitle us to underline two conclusions which are important for the question about our gap in the age classes:

1. The current annual increment starts to decline prematurely in mixed At + Sw stands and this decline is very rapid.
2. Even at the age of eighty years white spruce responds to release. Of course this response would occur only in trees which are not damaged beyond repair.

If this is so, our action is determined by these conclusions, especially on better sites where an average D.B.H. of nine inches for white spruce was often found already in the first half of the fourth age class in stands where the trembling aspen was not doing too much damage because of a low percentage of it. Under such circumstances and taking into consideration the fact that at this age on better sites the white spruce adds often over two inches of D.B.H. in ten years, we apparently can expect that proper release cuttings would make the present stands of the third and fourth age classes ready for harvest when they are in the fifth age class. In connection with this it should be remembered that under the existing circumstances practically no stand of the fifth age class is ready for cutting of white spruce timber.

Thus we see that in areas like those which have been analyzed in this article, where the timber comes mainly from even aged mixedwood stands, the only way to bridge the gap in the age classes, to insure a sustained yield and to avoid a desperate shortage of white spruce lumber after about fifteen to twenty years, is to help the white spruce of the present third and fourth age classes by appropriate release cuttings. Of course, the damage that is done to the white spruce in these stands cannot be repaired completely and the lost increment cannot be replaced, but we can help to even out the cutting rate in our mixedwood stands.

A proper method of treatment for such stands would firstly involve action to prevent the heavy top damage shown above and thus to avoid the premature steep descent of the curve of the current annual increment. This would mean a release cutting around the age of thirty, somewhat earlier in some stands and maybe a little later in others, depending on the time when the white spruce has come in. A second release cutting, combined with taking out of some undesirable white spruce, would be necessary when the trembling aspen is about seventy years old, to avoid loss of the trembling aspen because of heart rot and to give the white spruce of the final harvest a good chance for development. The trembling aspen of these stands, if they have had

a release cutting at an earlier age, would have a D.B.H. sufficient for plywood to a large extent, at seventy years.

Of course on the grounds of the material presented in this article it is not possible to make any exact calculations on the financial loss sustained in such stands. Still there are some figures which cast some light on this question. The average volume per acre of white spruce trees over twelve inches D.B.H. in the stands of the seventh age class in the area on which this paper is mainly based, is a little higher than 5,000 F.B.M. It seems that the figures on damaged trees in the mixedwood stands of the third age class and figures on the percentage of white spruce trees left behind by timber operators entitles us to say that we have lost at least thirty-five per cent of the white spruce volume in these stands. Let us say that the reduced quality of the lumber because of crooked logs and for additional decay is not more than five per cent of the potential value. Even if we disregard the reduction of the rotation period by proper release cutting, which would mean a gained volume close to the volume of fifteen to twenty years of the mean annual increment at the age between eighty and a hundred years, it seems to be fair to say that our loss is at least forty per cent of the potential value of the white spruce of these stands, and we are harvesting something around sixty per cent of this potential value. If we take into consideration the possibility of reducing the cutting age our gross loss which occurred because release cuttings are not carried out, would be at least equal to the financial result of the present harvest of five thousand F.B.M.

However, let us go by forty and sixty per cent. This means that we have lost on each acre of our cutting area in the mixedwood stand, the stumpage value of about 3,500 F.B.M. of lumber. A multiplication of this figure by the stumpage offered on the market, which is generally over fifteen dollars per thousand F.B.M., would give us a loss of about forty dollars per acre. For a rotation period of one hundred years this would mean an average loss of forty cents per acre per year. If we refer this loss to the age in which it is actually caused, that is to the age between thirty and sixty years, the average loss per year per acre of this period would be $\$40 \div 30 = \$1.33$. Taking the figures from tables on which Graphs No. 1 and No. 2 are based we see that in the whole Dore - Sled - Clark area there are $22,859 + 40,563 = 63,422$ acres of such stands or in round figures 60,000 acres (half of the area of the second age class and the whole of the third age class of 4-10 Sw + 0-6 At and 7-9 At + 1-3 SW). If we drop the .33 dollars from the above figure of 1.33, we still have a loss of 60,000 dollars per year in this area.

To have an approximate estimate of the damage caused in the mixedwood belt of the province of Saskatchewan alone, we have to remember that all this mixedwood belt is estimated to cover an area of 30,000,000 acres. Even if we accept that fifty per cent of this whole area is under water and muskeg, we still have a productive forest area of 15,000,000 acres. The 63,422 acres mentioned above constitute 28.3 per cent of the total productive forest area of the Dore - Sled - Clark district which comes under the management plans. If we admit that the productive forest area of these plans, which is $80,913 +$

143,460 = 224,373 acres, can be considered as a big enough sample plot, we could say that about twenty-five per cent of the productive forest area of Saskatchewan falls into the group of mixedwood stands of the age from thirty to sixty years. Twenty-five per cent of 15,000,000 would be 3,750,000 acres. Taking the one dollar loss per year per acre of such stands, we have the loss of 3,750,000 dollars a year, which quite well stands comparison with the losses from fire.

The writer readily admits that this little financial excursion sounds somewhat rhetorical, but if a forester has to see during the whole summer every day what is going on in our mixedwood stands, he is almost bound to become a little emotionally influenced.

A number of valuable experiments have been conducted in different mixedwood stands in the east. Although the results of these experiments cannot be applied to the mixedwood belt of the prairie provinces, they nevertheless are indicating that results falling generally in line with what is said above have been obtained. Thus C. A. Mulloy of the Dominion Forest Service states that "an intolerant hardwood stand 30-40 years of age with an understory of conifers is an ideal condition for improvement cuttings". This age is largely in agreement with the desirable age found above by an analysis of the increment. W. M. Robertson (Forestry Chronicle, Vol. 6, No. 2, June 1930) comes to the conclusion that girdling mature hardwoods to release softwoods in a mixedwood stand makes "a good showing". B. M. Westveld (Forestry Chronicle, Vol. 12, No. 2, June 1936) on the ground of the figures obtained by a girdling experiment can make the statement that "red spruce stands, liberated by girdling, produce conifer pulpwood several times as rapidly as comparable stands not liberated". W. B. M. Clarke of the Dominion Forest Service (Experimental Girdling in Mixedwood Stands in New Brunswick, Silvicultural Research Note No. 62) has even found that in the specific circumstances of his experiment "the \$118 invested in girdling returned capital and compound interest at the rate of nine per cent".

As was stated at the beginning, the writer does not want to present final solutions for problems presented by the mixedwood stands. Some practical solutions have been adopted in the management plans for the above mentioned areas, but it seems that urgent research is required on the costs of release cuttings, and the actual increase of increment caused by these cuttings, on the influence of the release cuttings on the quality of material and heart rot, on the influence of release cuttings at an advanced age on regeneration. In a word, the whole problem of the mixedwood stands in the prairie provinces awaits an attentive approach by research people. This requirement is warranted by the large percentage of the productive forest area which they occupy, if not by anything else.

The writer wishes to express his gratitude to Dr. C. G. Riley and to Forester A. Kabzems for their permission to use some results of their work.