EFFECT OF STRIP WIDTH ON THE REGENERATION OF WHITE SPRUCE IN THE MIXEDWOOD FOREST SECTION OF ALBERTA

BY

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ABSTRACT

Logged strips and patches of white spruce in the Footner Lake, Peace River, and Slave Lake Forests of Alberta were sampled to determine the relationship between distance from nearest stand edge and amount of regeneration. This information is required to assist in setting policy concerning maximum allowable strip width in these forest districts.

Logging had been done to a merchantable diameter limit of 15-20 cm and was not clear-cutting in the true sense. Residual seed-bearing conifers occupied many of the cut strips and patches.

Results of the survey indicate that within the block size limitation of approximately 16-24 hectares the percent stocking probably will not differ appreciably regardless of the cut dimensions. Numbers of seedlings per unit area will be greater on narrow strips, but percent stocking is dependent on the distribution of suitable seedbeds, which can be controlled by scarification. Larger numbers of seedlings may not be an advantage because subsequent stand treatment may be required to reduce stocking levels.

RESUME

On a échantillonné des bandes et étendues coupées d'Epinette blanche dans les forêts du lac Footner, de Rivière La Paix et du lac des Esclaves en Alberta, pour déterminer la co-rélation entre la distance

à la bordure du peuplement le plus proche et le degré de régénération. Ce renseignement était nécessaire à l'établissement d'une norme établissant la largeur maximale des bandes dans ces districts forestiers.

L'abattage avait été effectué en se limitant à un diamètre marchand minimal de 15-20 cm; il ne s'agissait pas d'une véritable coupe rase. Des Conifères semenciers résiduels occupaient plusieurs des bandes et étendues coupées.

Les résultats de cette étude démontrent qu'à l'intérieur des limites de blocs d'approximativement 16-24 hectares, le pourcentage de matériel relatif ne différera probablement pas beaucoup, peu importe les dimensions de coupe. Le nombre de semis par unité de surface sera plus élevé dans les bandes étroites mais le pourcentage de matériel relatif dépendra de la répartition des lits de germination qui peuvent être contrôlés au moyen du scarifiage. Il est possible qu'un plus brand nombre de semis ne soit pas avantageux car un traitement ultérieur du peuplement sera peut-être nécessaire pour diminuer la densité du matériél relatif.

CONTENTS

INTRODUCTION

For the past 10 years most sawtimber quota holders in the Mixedwood Section of the Boreal Forest of Alberta (Rowe 1972) have logged by the merchantable clear-cut strip system. Narrow strips, usually 151 or 201 m wide and seldom exceeding 24 ha in size, have comprised the logging pattern. Recently this practice has been questioned by logging operators from the standpoint of strip width. There is little opposition to the size of the cuts, but most quota holders would prefer to log a wide block rather than a narrow strip due to the efficiency of the former in tree-length logging.

In formulating a policy for maximum allowable strip width it is necessary to know the relationship between distance from the nearest stand edge (seed source) and the amount of established regeneration. The Canadian Forestry Service was requested to examine cutovers in the Mixedwood Forest Section of Alberta to determine this relationship.

DESCRIPTION OF THE AREA

The population sampled consisted of strip and patch logged white spruce and white spruce-poplar stands in the Slave Lake, Footner Lake, and Peace River Forests. As a check on larger clear-cuts, sampling was also done in the Edson Forest.

Logging had been done to merchantable diameter limit of 15-20 cm. Therefore, on most cuts residual cone-producing spruce were present in varying amounts within the cut blocks. Poplar was not logged. All logging was done in stands of sawtimber size on fresh and moist sites. Plates 1-4 show conditions after logging.

1. Aerial view of cut strip showing residuals.

2. Strip edge showing residual spruce.

3. Helicopter access to survey areas.

4. Strip edge showing residual poplar.

Most of the areas sampled had been logged in the winter because of the terrain, which for the most part consists of good spruce sites interspersed with muskegs and bogs. Summer access is usually too difficult and expensive under present utilization practice.

METHODS

It was recognized that the area to be sampled is huge and that variation is considerable. An experiment designed to determine the relationship would take several years, and forest managers were anxious to obtain early leads. Therefore, a survey approach was considered essential. Furthermore, it was necessary to restrict field work to one season.

A representative sample of logged strips and patches 5-10 years old (1966-70 inclusive) was obtained. Sampling was restricted to cuts of this age-class, as it was believed that well-established seedlings would be present and that likely a reasonable seed year had occurred in that time period.

Ideally about 6-10 replications of each existing combination of variables used to describe sampling units would have been desirable. Practically this was impossible because most access was by helicopter. As much prestratification as possible was done from aerial photographs, project maps, and the knowledge of local field staff. A helicopter flight was usually required, and only occasionally was road access possible (Plate 3). Therefore, problems of access resulted in oversampling of some strata and undersampling of others, but it is believed that all or most existing strata were sampled.

The sampling unit was a line of 20 contiguous milacre plots oriented parallel to the uncut edge of the strip or block. These were located at 10, 20, 40, and 80 m from the stand edge to the middle of the cut depending on the strip or block width. Each unit was established on the basis of the following variables and classes:

1. Distance from stand edge: 10, 20, 40, 80 m
2. Site: normal spruce site, wet spruce site
   0-10 cm organic, over 10 cm organic
3. Vegetative competition: grasses - light, heavy
   herbs - light, heavy
   shrubs - light, heavy
4. Degree of scarification: 0-10%, 11-30%, 31-50%, 51%+ on quadrats
5. Aspect of uncut edge: northerly, southerly, easterly, or westerly

On each sampling unit the following data were collected:

1. A total seedling count on each quadrat separated on the basis of white spruce, poplar (both trembling aspen and balsam poplar), pine, balsam fir, and coniferous advance growth
2. The percentage of scarification on each plot
3. The height of the tallest seedling on each plot
4. The number of residual conifers within 20 m of the sampling unit

A total of 320 sampling units or 6400 plots was examined during the field season of 1976.

Seeded and unseeded strips and patches were combined for analyses. The majority of logged areas examined were scarified but not seeded; the small amount of seed used on projects seemed to have had little influence on the stocking levels.

Statistical analyses of the data were not warranted because of the gaps in sampling. However, it was decided to consider distance from nearest stand edge (main seed source) as the most important factor and to examine first-order interactions on this basis.

Averages were plotted for the various classes of variables with percentage stocking and numbers of stems per hectare as dependent variables (Y) and distance from the nearest stand edge as independent (X). Averages were joined by lines to indicate trends from nearest stand edge to various distances to strip or block midpoint.

RESULTS AND DISCUSSION

NUMBER OF SEEDLINGS PER HECTARE

Figure 1 shows the trend between distance from nearest stand edge and number of white spruce seedlings per hectare based on all samples. Figures 2-5 show this trend stratified on the basis of vegetative competition, aspect of nearest stand edge, degree of scarification, and number of coniferous residual trees. All figures show the same general trend of decreased numbers of seedlings with increased distance from stand edge.

In Fig. 1 the standard error of the mean is shown for the mean number of seedlings at 10, 20, 40, and 80 m from the nearest stand edge. Although these standard errors ($S\bar{x}$) are large, as would be expected from a diverse population, the trend from 10 to 80 m is considered meaningful. The average number of seedlings at these distances decreases from 16 060 near the stand edge to 8400 at 80 m. At the 80-m point, which is the limit of sampling for the Mixedwood Section, the number of seedlings per

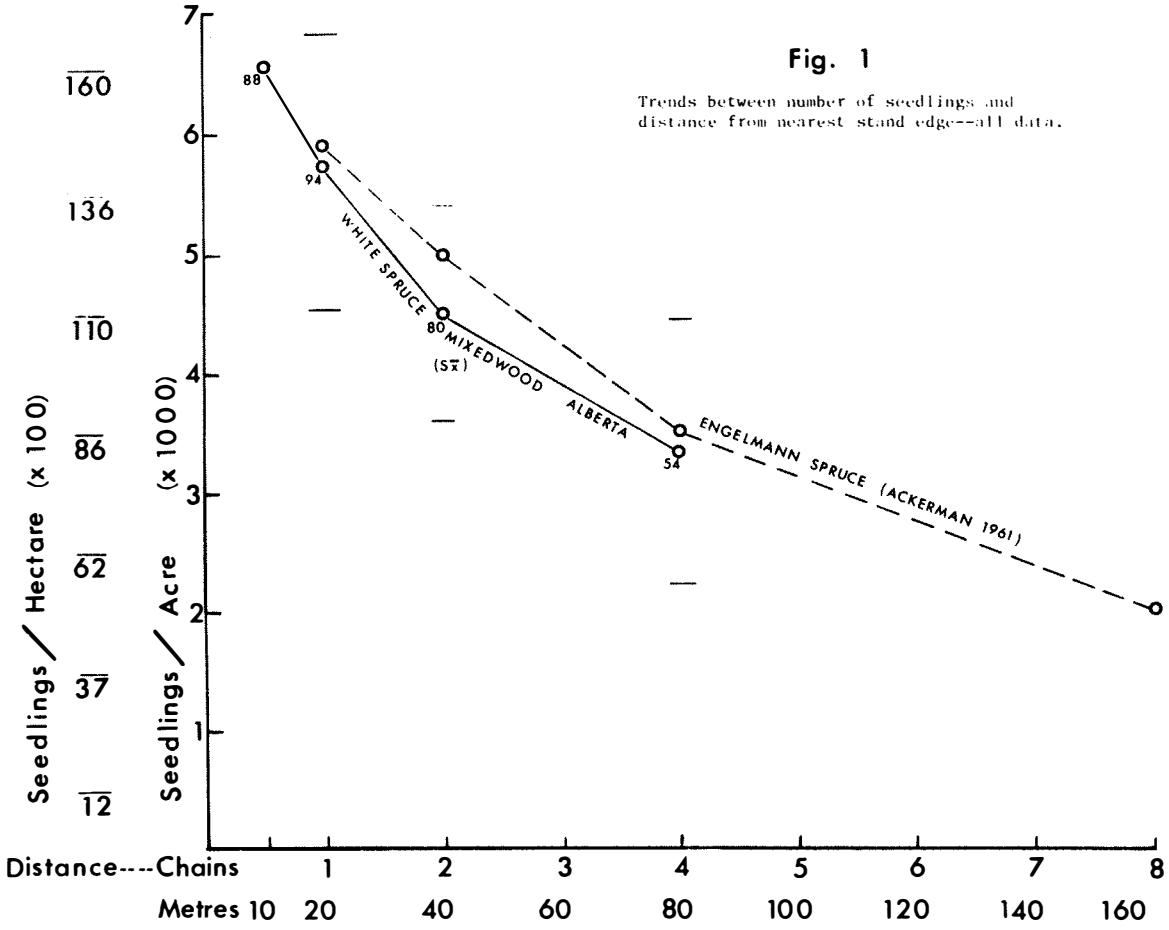


Fig. 1

Trends between number of seedlings and distance from nearest stand edge--all data.

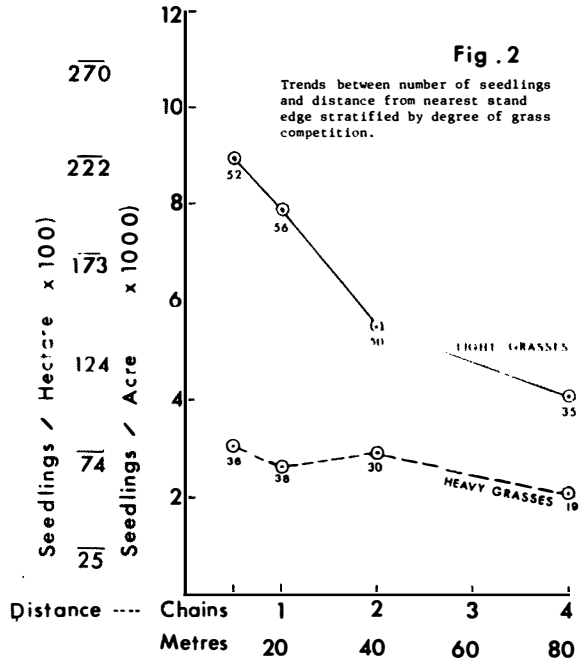


Fig. 2

Trends between number of seedlings and distance from nearest stand edge stratified by degree of grass competition.

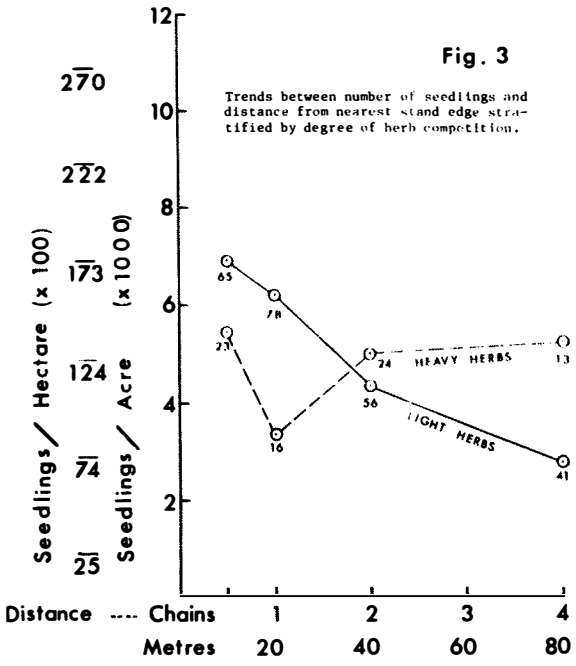


Fig. 3

Trends between number of seedlings and distance from nearest stand edge stratified by degree of herb competition.

hectare averages 7400. The dotted line in Fig. 1 represents data for Engelmann spruce obtained from the Crowsnest Area of Alberta (Ackerman 1961). The similarity of this relationship to the one for white spruce in the Mixedwood Forest Section strengthens the credibility of the latter.

Figure 2 shows the trend of number of white spruce seedlings per hectare and distance from the nearest stand edge with the data grouped on the basis of light and heavy grasses. Similar trends are shown in Figs. 3 and 4 for herbs and grasses. Heavy grasses are detrimental to white spruce seedling establishment, whereas shrubs and herbs seem to favor establishment. It is well documented that white spruce is shade-tolerant and will thrive under herbs and shrubs, but severe grass competition is fatal to young seedlings.

Figure 5 shows the importance of degree of scarification to the number of established seedlings. Sampling units with 0-10% coverage had from approximately 11 100 to 2000 seedlings/ha depending on distance from stand edge. Those with over 50% scarification had over 19 800 seedlings/ha.

The contribution of seed-bearing coniferous residuals on the logged strips and patches is illustrated in Fig. 6. Those strips with residuals within 20 m of the sampling units averaged 22 200-14 800 seedlings/ha from 10 to 80 m from the nearest stand edge. Strips and patches with no recorded residuals averaged 11 000-4500 seedlings/ha for the same distances from the nearest stand edge.

Figure 7 shows the importance of aspect of the uncut edge. More white spruce seedlings became established when the nearest stand

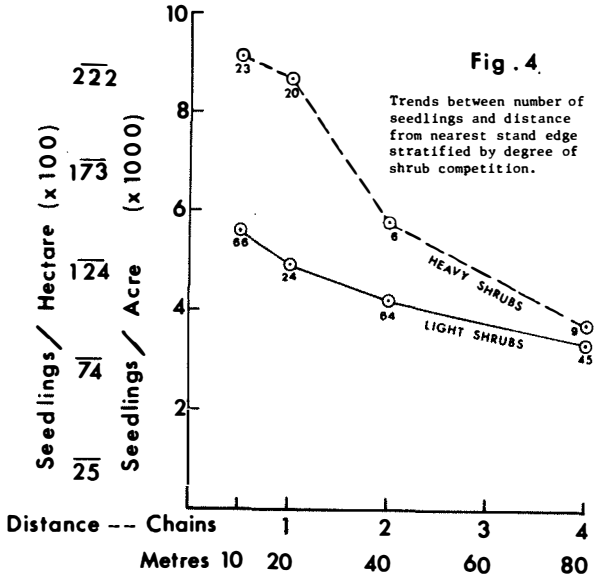


Fig . 4
Trends between number of seedlings and distance from nearest stand edge stratified by degree of shrub competition.
Seedlings / Hectare (x 100)
Seedlings / Acre (x 1000)
222
173
124
74
25
HEAVY SHRUBS
LIGHT SHRUBS
Distance -- Chains 1 2 3 4
Metres 10 20 40 60 80

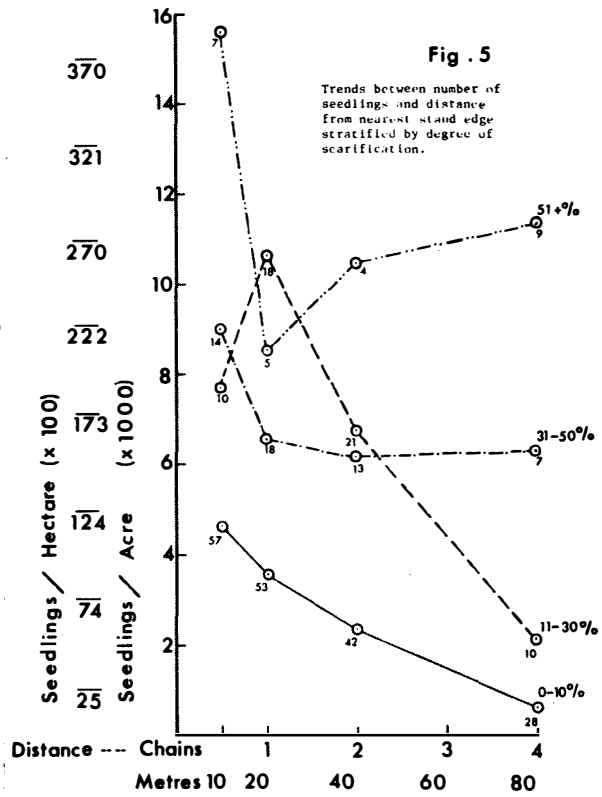
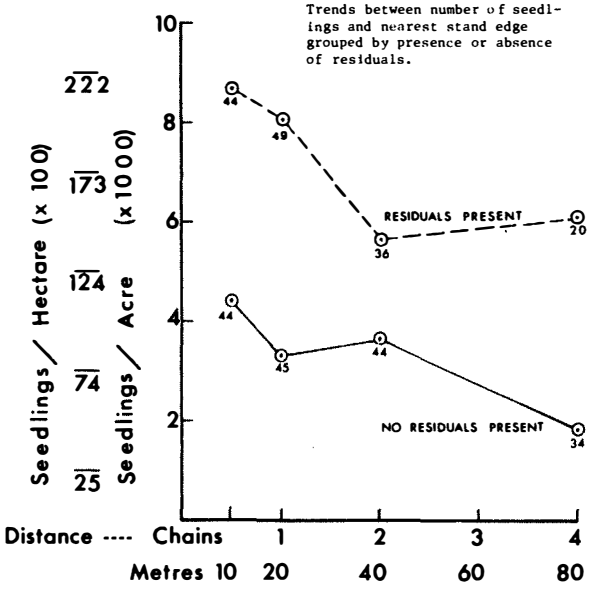


Fig . 5
Trends between number of seedlings and distance from nearest stand edge stratified by degree of scarification.
370
321
270
222
173
124
74
25
Seedlings / Hectare (x 100)
Seedlings / Acre (x 1000)
51+%
31-50%
11-30%
0-10%
Distance --- Chains 1 2 3 4
Metres 10 20 40 60 80

Fig . 6


Trends between number of seedlings and nearest stand edge grouped by presence or absence of residuals.
222
173
124
74
25
Seedlings / Hectare (x 100)
Seedlings / Acre (x 1000)
RESIDUALS PRESENT
NO RESIDUALS PRESENT
Distance ---- Chains 1 2 3 4
Metres 10 20 40 60 80

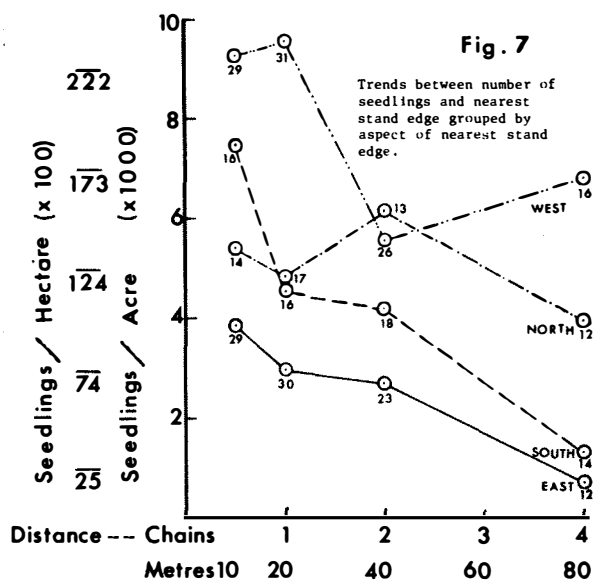


Fig . 7
Trends between number of seedlings and nearest stand edge grouped by aspect of nearest stand edge.
222
173
124
74
25
Seedlings / Hectare (x 100)
Seedlings / Acre (x 1000)
WEST
NORTH
SOUTH
EAST
Distance --- Chains 1 2 3 4
Metres 10 20 40 60 80

edge was westerly than for other directions; easterly edges resulted in the least number. The reason for this is that the prevailing winds in the Mixedwood Forest Section of Alberta are westerly. During good seed years more seed would be blown onto cut strips and patches from a westerly edge than from an easterly edge.

PERCENT STOCKING

The trend between distance from the nearest stand edge and percent stocking is not well defined (Fig. 8). There seems to be slightly higher stocking close to the stand edge but it is not appreciably higher than at a distance of 80 m. The reason for this is that percent stocking is greatly influenced by the distribution of suitable seedbeds, assuming that natural seeding has occurred. Therefore, although number of seedlings per hectare is greatly influenced by distance from stand edge, percent stocking is affected to a much lesser degree.

Figure 9 shows the trend between percent stocking and distance from nearest stand edge, stratified on the basis of degree of scarification. Within a given "degree of scarification" class, trends are not very meaningful, but between the lowest and highest degree of scarification there is an appreciable difference. Sampling units with the highest degree of scarification had the highest stocking.

The percent stocking of white spruce regeneration averaged about 40% for all logged areas examined. When other coniferous regeneration, including advance growth (mainly balsam fir) was added, average stocking of the population sampled was about 50%. Total stocking,

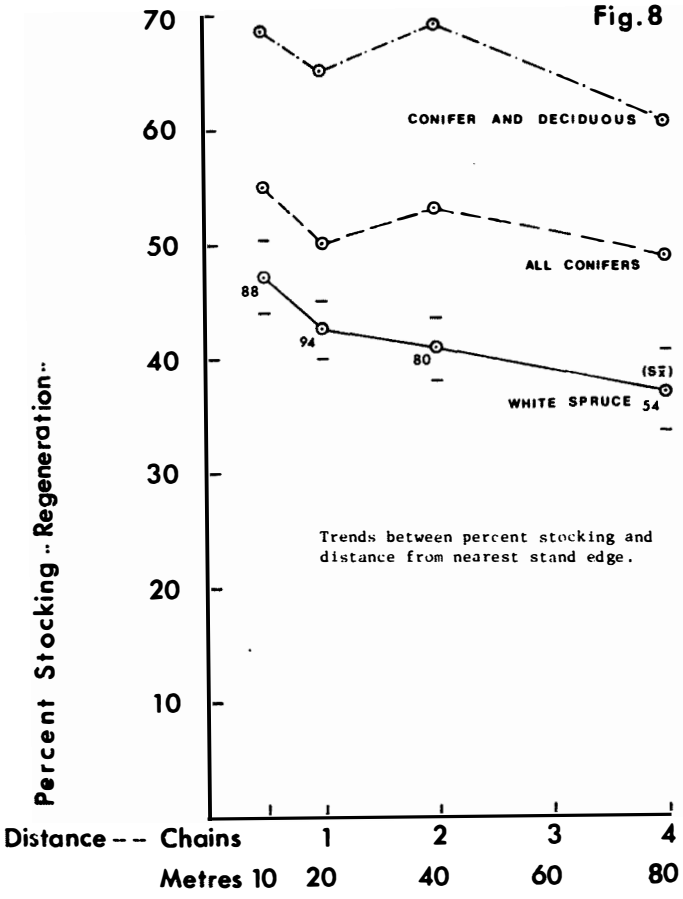


Fig.8
CONIFER AND DECIDUOUS
ALL CONIFERS
WHITE SPRUCE
88
94
80
54
Trends between percent stocking and distance from nearest stand edge.
Percent Stocking -- Regeneration
70
60
50
40
30
20
10
Distance -- Chains 1 2 3 4
Metres 10 20 40 60 80

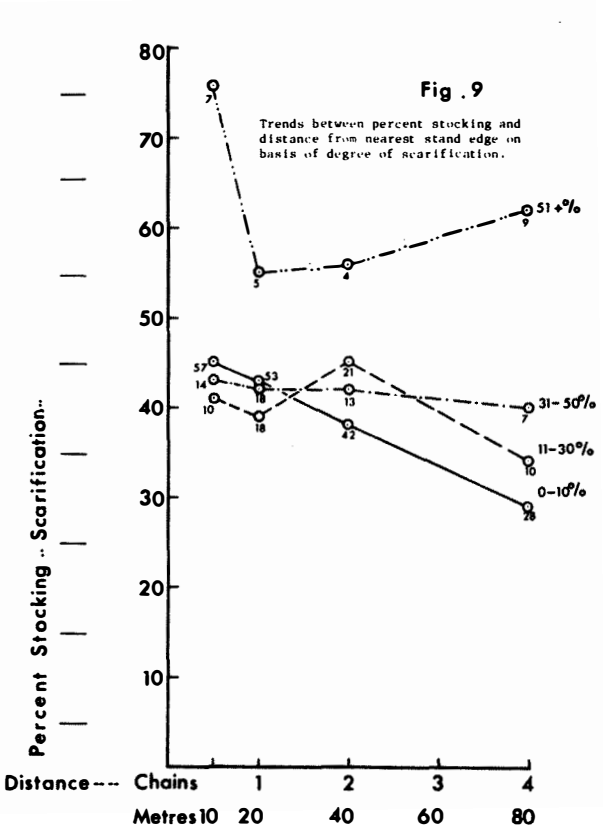


Fig . 9
Trends between percent stocking and distance from nearest stand edge on basis of degree of scarification.
51 +%
31- 50%
11-30%
0-10%
Percent Stocking -- Scarification
80
70
60
50
40
30
20
10
Distance -- Chains 1 2 3 4
Metres 10 20 40 60 80

including deciduous species, averaged between 60 and 70%. Therefore, the type of logging practised has resulted in successful restocking as defined by Alberta Department of Energy and Renewable Resources standards (Anon. 1971).

AREA OF CUT WITHIN 80 m OF A STAND EDGE

The results of this study apply to stocking conditions within 80 m of a stand edge. Cut strips wider than 200 m were too few to provide meaningful results. However, it is quite probable that the results indicated in Fig. 8 would apply considerably beyond 80 m. Sampling done in the Edson Forest where wider cuts are available was used as a check. The results show a similar trend at 160 m from stand edge. The percentage of a cut within 80 m of a stand edge is shown below for different cut sizes and dimensions:

Area (ha)	Width (m)	Length (m)	Percentage of cut within 80 m of stand edge
4	200	200	96
8	200	400	88
16	400	400	64
	200	800	84
24	400	600	56
	200	1200	83

SEEDLING HEIGHT

Because seedlings were not aged, an average height-age relationship is not available. Average height of the white spruce seedlings on all cuts examined was 48 cm, with a range between 3 and 137 cm.

CONCLUSIONS

The results of this survey demonstrate that the method of logging presently practised in the Mixedwood Forest Section of Alberta, specifically the Slave Lake, Footner Lake, and Peace River Forests, has resulted in successful restocking of logged areas. It must be emphasized that different results might be obtained if clear-cutting in the true sense were practised. Although the logged areas surveyed are generally referred to as strip and patch clear-cuts, there is often a considerable number of nonmerchantable, seed-producing residual trees left after logging that have an influence on resulting regeneration.

Number of seedlings per hectare was greatly affected by distance from stand edge in a classicial trend. However, percent stocking was only marginally affected by this parameter in the population sampled and was largely dependent on the distribution of suitable seedbeds. Therefore, restricting strip width within the 16- to 24-ha size limitation probably is not necessary. A short, wide strip within the present size restriction would probably do as well as a long narrow strip. The number of trees per hectare would be higher on the latter but this may be a disadvantage at a later date when juvenile stand treatment may be required to reduce stocking.

It should be emphasized that the results from this survey apply only to blocks or strips smaller than 24 ha. In fact, the average size of cut surveyed was 15 ha.

ACKNOWLEDGMENTS

The Alberta Department of Energy and Renewable Resources shared the operational cost of maintaining a seven-man crew in the field and

provided the necessary helicopter time to reach areas of difficult access. Department field staff at Peace River, Footner Lake, and Slave Lake were most cooperative and made a difficult field assignment pleasurable. Messrs. F. Dendwick, C. Rentz, and G. Stevenson of the Canadian Forestry Service, Edmonton, supervised field crews and compiled and analyzed data for this report.

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