A GENERALIZED SCHEME FOR THE NATURAL REGENERATION OF OLD-FIELD SPRUCE

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Foreword

This paper represents the author's conclusions based on research in Nova Scotia that began during the early 'fifties'. The measures advocated represent an intensive example of classical silvicultural methods applied to a Canadian forestry problem. If followed there is little doubt but that they would lead to satisfactory natural regeneration of old-field spruce stands. But since this research began, logging techniques have changed greatly and whether the methods suggested are economically feasible must be left to the individual manager to decide. The biological principles, however, are sound and may be of some guidance even if the scheme is not adopted in its entirety.

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INTRODUCTION

Old-field white spruce occupies about one-half million acres in Nova Scotia (Drinkwater, 1957)[1/]. The current practice is to clear cut these stands as soon as they become merchantable. This usually results in poor regeneration of spruce and many owners in Nova Scotia are attempting preparatory cuts to foster natural regeneration.

Since old-field spruce stands rarely have an advance growth, regeneration is difficult. However, the conditions necessary to produce natural regeneration are now fairly well understood. This report reviews present knowledge on this subject and advocates a system of cutting based on investigations by the writer and earlier workers. It is hoped that the presentation of these suggestions will stimulate large-scale practical trials.

Fundamental Principles

The development of natural white spruce reproduction in old-field stands in Nova Scotia characterized as follows:

1. Natural regeneration appears periodically in mature white spruce stands but it usually persists for only a few years and then dies as a result of suppression.

2. White spruce seedlings survive about 2 to 4 years if the overstorey crown cover exceeds about 80%; balsam fir may linger twice as long.

3. Sudden opening of the canopy usually results in excessive seedling mortality because of shallow root penetration.

[1/] Drinkwater, M. H. 1957. Field spruce in Nova Scotia, Dept. North. Aff. Nat. Res. Tech. Note No. 65.

4. Most advance growth usually die following removal of the overstorey and dense slash or drought inhibit later reproduction by the creation of a poor seedbed.

These facts of spruce seedling development coupled with results of experimental felling suggest the following generalizations for stand treatment:

1. Gradual opening of the canopy permits increased insolation of the forest floor hastening the reduction of raw humus and eventually the moss cover. This removes an obstacle to root development and allows gradual release of nutrients from the humus. Scarification also creates a better seedbed by physically mixing the humus and mineral soil.

2. A uniform cut resulting in a canopy density of 70 - 80% creates the most favourable conditions for the development of advance growth. Such a preparatory cut is essential where the stand is dense and the humus accumulation is high.

3. A strip cut is less effective than a uniform preparatory cut but is adequate to promote seedling survival and create a framework for logging and other management activities. The width of the felled strips in relation to tree height and topographic conditions is a decisive factor in the effectiveness of the felling.

4. A group cut is the least effective method and in some places will create extreme microclimatic conditions. Its application should be limited to special cases.

5. Economic considerations demand that a reasonable quantity of wood be obtained from each cut and that only a limited period should intervene between preparatory and harvest cuts.

6. Techniques designed specifically for gaining spruce regeneration will have a less favourable influence on balsam fir than on spruce. However, balsam fir will form a significant part in the new stands.

Consideration of these facts suggests that the most promising method of fostering natural regeneration of old-field white spruce stands by some form of strip shelterwood felling. The major considerations in strip felling design are the relative width and direction of the felled and unfelled strips.

A narrow strip felling, about equal to the stand height, preserves soil moisture and promotes dense seedling establishment on the strip but often results in poor survival. It usually does not result in windthrow in the adjacent stand or erosion on the strip. A wide strip felling, more than twice the stand height, yields more wood in the initial cut, promotes insolation and nitrification, is conducive to seedling survival, but increases chances of desiccation of the seedbed, erosion and peripheral windthrow.

A narrow unfelled residual strip increases light and heat penetration under the stand and accelerates nitrification, helps seedlings to survive, but increases desiccation and windthrow. A wide unfelled residual strip leaves the stand windfirm, preserves cool conditions in the stand and retards nitrification. It lowers volume of the initial harvest cutting and does not encourage advance growth.

A Proposed Scheme of Shelterwood Fellings

A system of up to four fellings is proposed. A uniform shelterwood felling is used as a preparatory cut. Two years later strips are established and three years later a second uniform release cut is made if necessary. The final cut clears the remaining portions of the stand when the regeneration is suitably established.

The process requires a minimum of two years with two fellings or a maximum of 12 years if four fellings are necessary. Only extreme cases can shorten or extend these limits. The method, is outlined schematically with adaptations for climatic and topographic conditions in Fig. 1 and Table 1.

The preparatory cut is intended to produce microclimatic conditions in the stand conducive to natural regeneration. The strip cut to establish the main regeneration should be made when a good seed crop is expected. A further release cut may be necessary between the strip cut and final harvest. The strip and final cuttings are the only two mandatory requirements of the system; preparatory and release cuts are conditional. In most cases at least one of the conditional cuts will be necessary.

If a preparatory cut is necessary, about 30% of the volume should be removed uniformly. Suppressed trees, balsam fir and undesired species (maple, alder, juniper, etc.) should be felled. The 1-to-3-year period of preparation should include artificial measures of seedbed preparation, such as scarification, improvement of drainage conditions or introduction of new species as conditions require.

From both ecological and economic considerations the strip cut requires careful planning. The establishment and survival of regeneration are controlled through the direction and the width of felled and unfelled strips. The strip cut should remove about one-quarter of the original volume if applied after a preparatory cut, and about one-third if no preparatory cut is made. The width of strips is determined by the stand height, usually being equal to it or wider (Table 1). Topography and windthrow hazard determine the width of the unfelled strips.

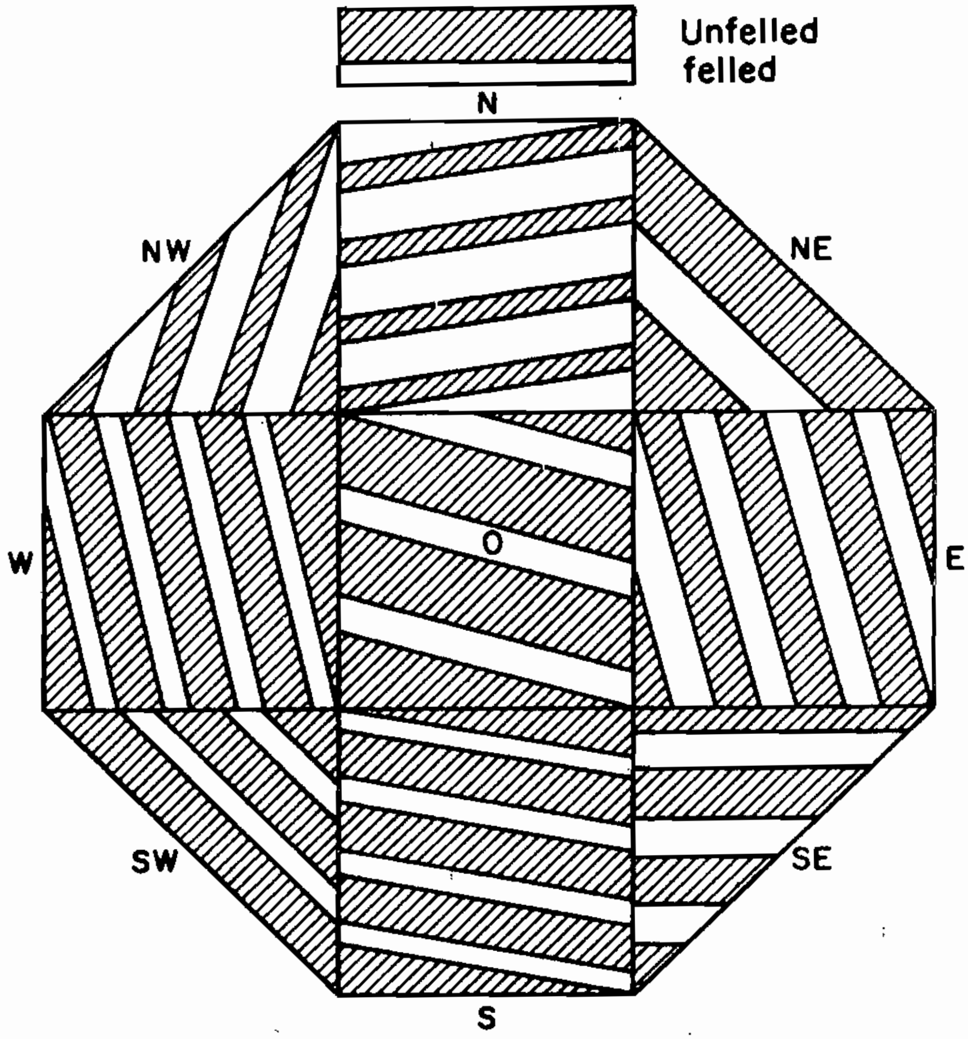
There will be an establishment period of 2 to 4 years after the strip cutting. If, regeneration is still inadequate or poorly developed in the uncut strips towards the end of the period, a release cut should be made to foster additional regeneration. This should remove half of the volume leaving about the same amount for the final harvest. There is a risk of windthrow after the release cut and although this is not destructive to regeneration it hinders logging and represents economic loss.

Modifications to the Generalized System

The generalized system presented above is designed as a basis for planning in various conditions. It will be necessary to adjust cutting periods and strip widths and directions to achieve the proper conditions of moisture, light and humus in relation to the development stage of the seedlings. Microclimate and topography largely govern seedling development but variations in regeneration cutting can modify the microclimate. A cool, moist condition as on north slopes and in deep valleys is associated with slow seedling development. To obtain more insolation on such sites the felled strips should be wider and uncut strips narrower, with longer periods between cuts. A warm dry climate, as on south slopes, generally results in rapid development of seedlings. Here the objective will be to conserve moisture and to moderate insolation by cutting narrow strips and leaving wide ones, with short time intervals between cuts.

Windthrow and erosion hazard require particular attention in planning. Proper orientation of the strips and shortening the time interval between cuts may lessen these hazards. On slopes steeper than 20% (10°) the declination of strips from the east-west base is reduced and the felled strips are narrower.

Each operation will have to be individually planned. A regeneration cut should cover three to four times more area than a clear cut if equivalent volumes are required, because of the smaller volume taken in the partial fellings. Special care will be required in the timing and methods of logging and extraction. The strip direction and extraction roads should be planned together. The method outlined here will increase costs but they represent the only relatively sure way of ensuring natural regeneration of spruce when old-field stands are harvested.



Aspect	Declination from the E-W base	Width: Felled	Width: Unfelled	Purpose
		Units of average tree height		
O	15° W	1.5	3	Reduce insolation
NE	40° W	2	3	Promote morning insolation and diffuse light
E	75° W	1.5	2	
SE	0	1.5	2	
S	10° W	1	2	Reduce after-noon insolation
SW	45° W	1	2	
W	75° W	1	2	
NW	75° E	2	1	Promote diffuse light
N	10° E	2	1	

Fig. 1. Topographic scheme for direction and width of strips.

Table 1. Cutting scheme for regeneration of Nova Scotia old-field spruce

Cuts and regeneration period	Years	% of volume			Canopy density %	Expected % stocking of spruce reproduction							Additional activities after felling
		Removed		Remains		Establishment			Survival			Final	
		From start	From present			Advance growth	Main	Add.	Advance growth	Main	Add.		
Preparatory cut (Uniform shelterwood)		30	(30)	70	-	20	-	-	-	-	-	-	
Period of preparation (conditional)	3+1	-	-	70	70	-	-	-	15	-	-	15	Surface drainage scarification sowing, disease protection, strip marking
Strip cut (Strip Shelterwood)		24	30	46	-	-	-	-	-	-	-	-	
Period of establishment	3+1	-	-	46	0-25, 28-80	-	60	-	15	40	-	55	Care of seedlings reproduction survey mark cut, reduce vegetation
Release cut (Uniform Shelterwood)		23	50	23	-	-	-	-	-	-	-	-	
Period of consolidation (conditional)	2+2	-	-	23	0-25, 25-40	-	-	40	10	35	25	70	Care of seedlings
Final cut		23	100	0	-	-	-	-	-	-	-	-	