INGRESS OF LODGEPOLE PINE AND WHITE SPRUCE REGENERATION FOLLOWING LOGGING AND SCARIFICATION IN WEST-CENTRAL ALBERTA

BY

W. D. JOHNSTONE

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NORTHERN FOREST RESEARCH CENTRE
CANADIAN FORESTRY SERVICE
ENVIRONMENT CANADA
5320 - 122 STREET
EDMONTON, ALBERTA, CANADA
T6H 3S5

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ABSTRACT

Established lodgepole pine (Pinus contorta Dougl. var. latifolia Engelm.) and white spruce (Picea glauca (Moench) Voss) regeneration were sampled on 36 logged and scarified areas in west-central Alberta. Pine and spruce ingress may continue for up to 11 and 13 growing seasons after scarification, respectively. Current regeneration survey procedures are discussed in light of the ingress patterns observed and it is recommended that surveys be conducted 8 growing seasons after logging and that consideration be given to the acceptance of all seedlings irrespective of age. The need for prompt scarification after logging is demonstrated.

RESUME

On a échantillonné la régénération établie de Pin tordu latifolié (Pinus contorta Dougl. var. latifolia Engelm.) et d'Epinette blanche (Picea glauca (Moench) Voss) dans 36 surfaces exploitées et scarifiées dans le centre-ouest de l'Alberta. La venue du Pin et de l'Epinette peut se poursuivre jusqu'à 11 et 13 saisons de croissance respectivement à la suite d'un scarifiage. L'auteur démontre la nécessite d'un prompt scarifiage après exploitation. Il analyse les modalités d'inventaire de la régénération en cours à la lumière de modèles de venue observés et recommande que les relevés soient effectués après la 8e saison de croissance de l'exploitation et de songer à accepter tous les semis, sans tenir compte de l'âge.

CONTENTS

INTRODUCTION

Current timber management regulations in Alberta (Anon. 1973) require that logged areas be surveyed 7 years after logging (the year of logging being year one) to determine the adequancy of regeneration. At that time, an area is judged to be satisfactorily regenerated if 40% of the 4-m^2 (1 milacre) survey plots are stocked with an acceptable, established seedling (either one 3+-year-old or two 2-year-old, vigorous seedlings) (Anon. 1971). Recently, the timing of the survey has been questioned (Crossley 1976). The current study was conducted at the request of the Alberta Forest Service to determine the rate of seedling ingress following logging and scarification.

METHODS

All data used in this study were collected in the Edson Forest on North Western Pulp and Power Ltd's forest management agreement area near Hinton, with the exception of an eight-plot sample taken near Whitemud Tower in the Peace River Forest. In the Hinton area, sampling was carried out in winter-logged, clear-cut blocks, which varied in size from 4 to 40 ha (10 to 100 acres). All of the cut blocks had been drag-scarified 1 or 2 years after logging and at least 11 years had elapsed between scarification and sampling. A total of 35 blocks was sampled in the Hinton area. Near Whitemud Tower, sampling was conducted in an area in which a spruce stand had been selectively logged (diameter-limit cut) in 1952 and blade-scarified in 1959.

Four 0.001-ha (1/400 acre) circular plots, each at 40-m (2-chain) intervals, were established on a diagonal transect through each cut block. All regeneration within each plot was cut at ground level, where a stem disc was collected from each. The number of stems sampled per plot varied from 0 to 106 and the number per cut block varied from 6 to 209. In the laboratory, the number of annual growth rings (total age from seed) of each stem disc was determined using microscope and dyes. Two of the cut blocks sampled were subsequently rejected because they contained 1-year-old spruce seedlings, which suggested that the period of ingress was not yet complete.

ANALYSIS

The number of surviving seedlings germinating in each year was obtained for each plot. Data for the four plots from each cut block (eight plots in the case of the Whitemud Tower sample) were combined and subtotals by year of germination were obtained. For each block, these yearly subtotals were accumulated from the oldest to the youngest seedlings and a cumulative percentage frequency, by year of germination, was calculated.

An examination of the frequency trends suggested that a grouping of the data by species composition was warranted. Cut blocks were sorted into main species groups (i.e. pine, spruce, pine-spruce, etc.) based upon species predominance (i.e. 75%+ pine = pine group) of the regeneration. Six cut blocks were rejected because the species groups into which they were stratified contained only 1 or 2 cut blocks and were too small to be representative. In addition, the Whitemud Tower sample was treated as a unique group because of the differences in harvesting and scarification practices. Consequently, all subsequent analyses were based on 18 cut blocks in the pine group, 9 cut blocks in the spruce group, and the 8-plot Whitemud Tower group. Mean cumulative percentage frequencies by full growing seasons since logging and full growing seasons since scarification were calculated for each group.

RESULTS AND DISCUSSION

The results in Table 1 show the variation in stand density (number of stems) encountered in the study. These results indicate that there was large variation in stand density, and the larger variation among plots than among cut blocks suggests a clumpiness in the distribution of the regeneration, a fact confirmed by Bella (1976).

Relative rates of ingress with growing seasons following clear-

Table 1. Variation in stand density among plots and among scarified cutover blocks

Major species group	Characteristic	Mean		Standard deviation		Minimum value		Maximum value	
Pine	Stems/ha(/acre) - 72 plots	10 502	(4,250)	13 660	(5,528)	0	(0)	62 270	(25,200)
	Stems/ha(/acre) - 18 cut blocks	10 502	(4,250)	9 346	(3,782)	2 224	(900)	36 572	(14,800)
Spruce	Stems/ha(/acre) - 36 plots	15 073	(6,100)	22 417	(9,072)	0	(0)	36 572	(41,800)
	Stems/ha(/acre) - 9 cut blocks	15 073	(6,100)	16 657	(6,741)	1 483	(600)	51 645	(20,900)
Spruce (Whitemud Tower)	Stems/ha(/acre) - 8 plots	29 034	(11,750)	35 474	(14,356)	0	(0)	104 773	(42,400)

cutting and following scarification are shown in Figs. 1 and 2, respectively. Lodgepole pine ingress occurred for up to 11 growing seasons after scarification (or 13 after clear-cutting) and white spruce ingress continued for up to 13 growing seasons after scarification (or 15 after logging). Although somewhat different in rate, this pattern of lodgepole pine ingress was very similar to that reported by Crossley (1976). For the pine cut blocks examined, the earliest completion of ingress was 8 growing seasons after logging, and in 16 of the 18 blocks ingress was completed by the end of the eleventh growing season. Six of the 9 spruce blocks showed no further ingress following the fourteenth growing season after logging and 1 block showed no ingress after growing season 7. The relative rates of ingress shown in Figs. 1 and 2 can be converted to numbers of stems per unit by using the mean values presented in Table 1. In general, the long periods of ingress shown tend to confirm the results reported for spruce by Day and Duffy (1963) and for pine by Crossley (1976).

Figure 2 indicates the rate of ingress after scarification. These results plus the increasing risk of losing viable slash-borne seed with time after logging (Ackerman 1966; Lotan 1973) suggest that, in order to ensure prompt and adequate restocking 7 years after logging, scarification should not be needlessly delayed. However, as Crossley (1976) points out, in order to avoid overly dense stands, it may be advantageous to slightly delay scarification on pine sites.

What then are the implications of the results presented in light of Alberta's current forest management practices? This can best be illustrated by using the following hypothetical example. Suppose that a block of timber is winter-logged during one calendar year and then scarified in the late summer or fall of the following calendar year. Further suppose that the regeneration survey in the seventh calendar year is conducted in the spring, as is commonly done in order to overcome the problems presented by lesser vegetation. Because scarification was conducted after the first growing season following logging, it is probable that the first regeneration was established during the second growing season after logging (calendar year 3). According to

Figure 1. Pine and spruce ingress in scarified clearcuts related to full growing seasons after logging

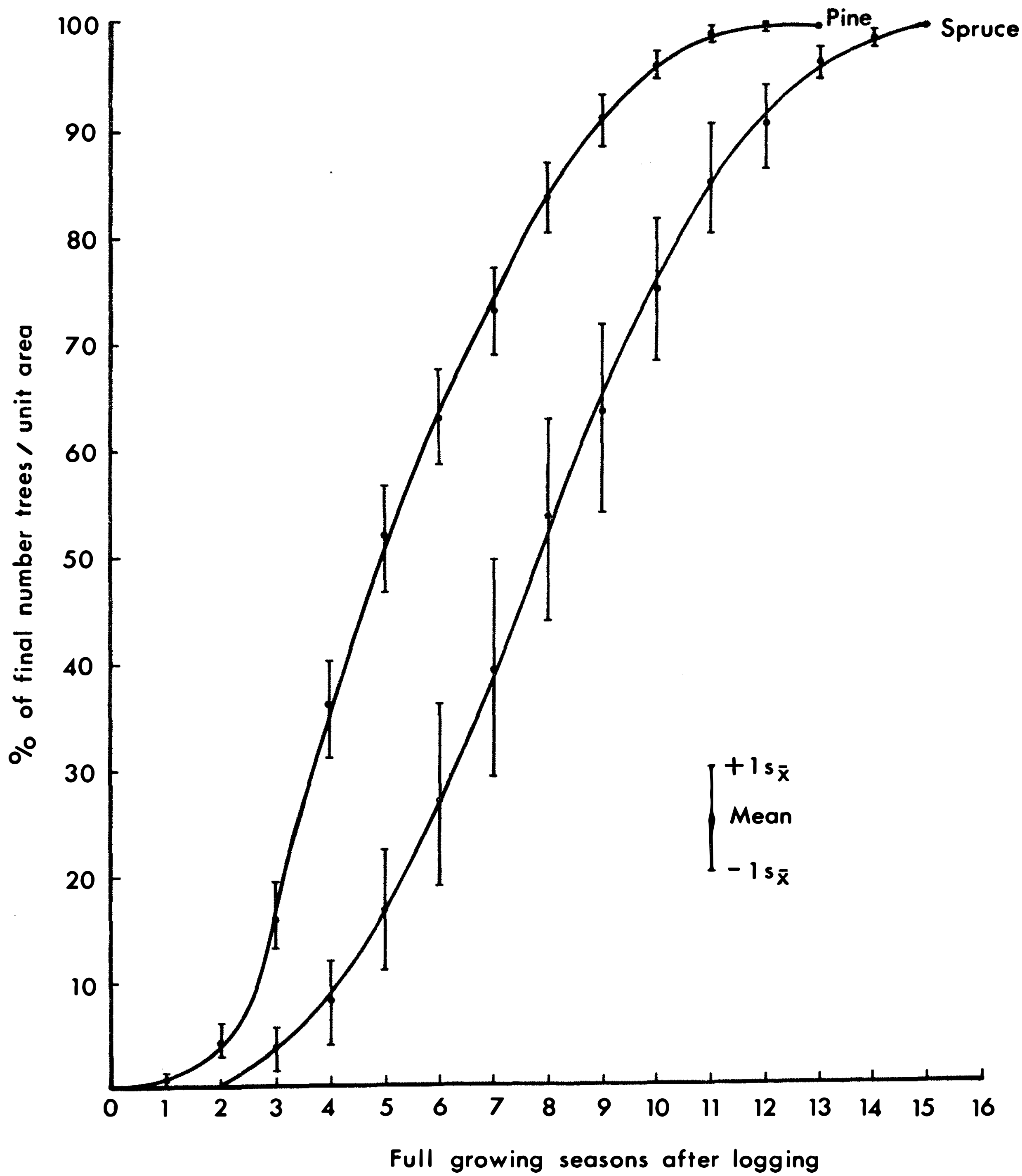
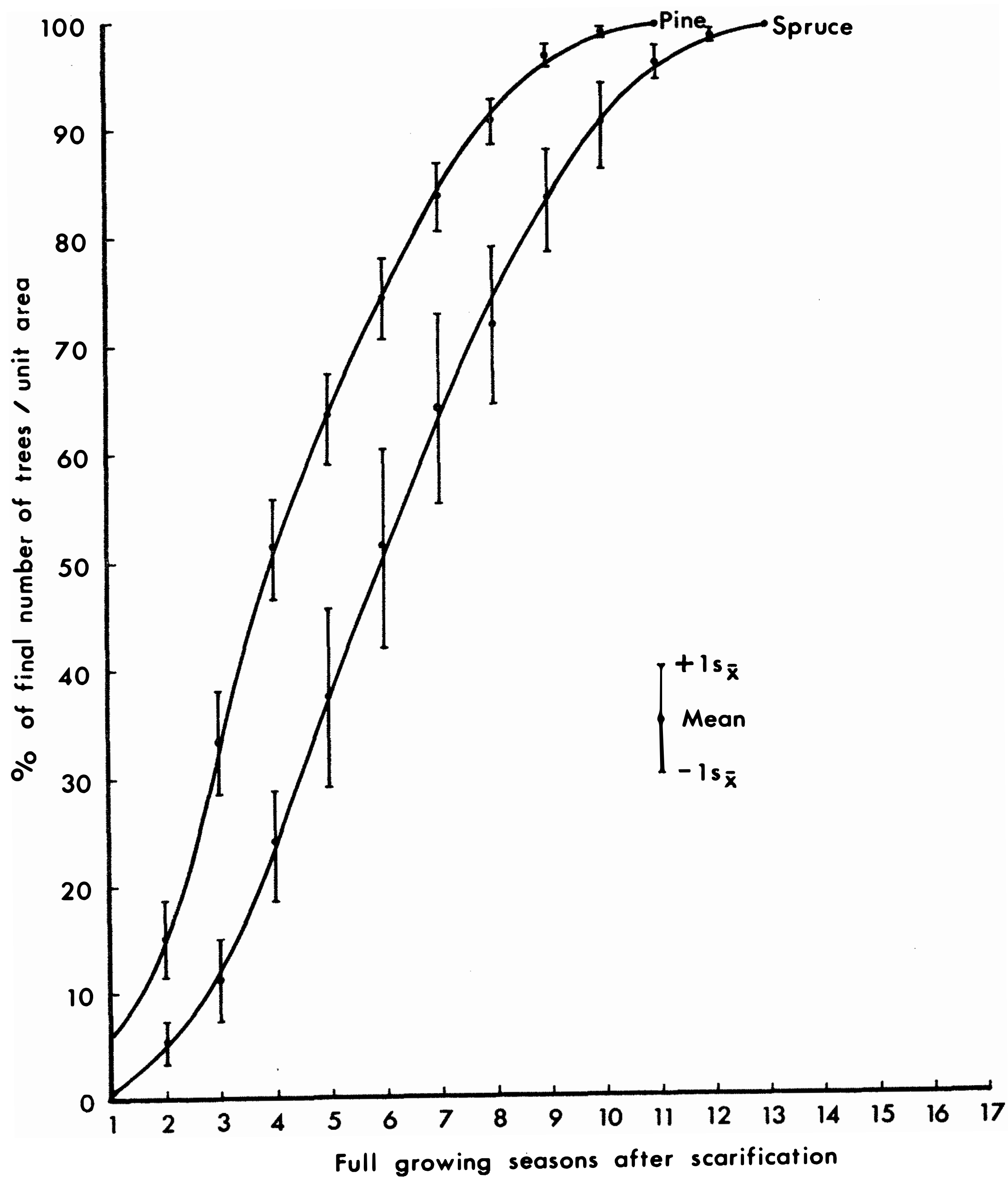


Figure 2. Pine and spruce ingress in scarified clearcuts related to full growing seasons after scarification



current survey standards, none of the 1-year-old seedlings which germinated during the fourth growing season after scarification can be tallied, and two 2-year-old seedlings, third growing-season-after-scarification germinants, must be present to be tallied. Consequently, the adequacy of stocking in our hypothetical cut block is judged solely on the basis of one-half or less of the seedlings which germinated four growing seasons after logging plus seedlings which germinated during the second and third growing seasons after logging. This example may be better illustrated as follows:

	Calendar year	Growing season after logging	Growing season after scarification	Acceptable seedlings Spring survey	Fall survey
Logged	1	0	0	--	--
Scarified (Fall)	2	1	0	--	--
	3	2	1	all	all
	4	3	2	all	all
	5	4	3	$\leq\frac{1}{2}$	all
	6	5	4	0	$\leq\frac{1}{2}$
Spring Survey	7	5	4	0	--
Fall Survey	7	6	5	--	0

Thus, although 63.5% of the total expected pine regeneration has germinated by the end of growing season 5 after scarification (fall of calendar year 7), the decision to sample in the spring plus the current established-seedling standards effectively reduce the number of growing seasons after scarification to 2½ and the percentage of expected seedling to about 23.5% (Fig. 2). In spruce, where regeneration ingress is much slower, only about 37.5% of the total expected regeneration is germinated five growing seasons after scarification (fall of calendar year 7) and this is reduced to about 8% (Fig. 2) using a spring survey and current established-seedling standards.

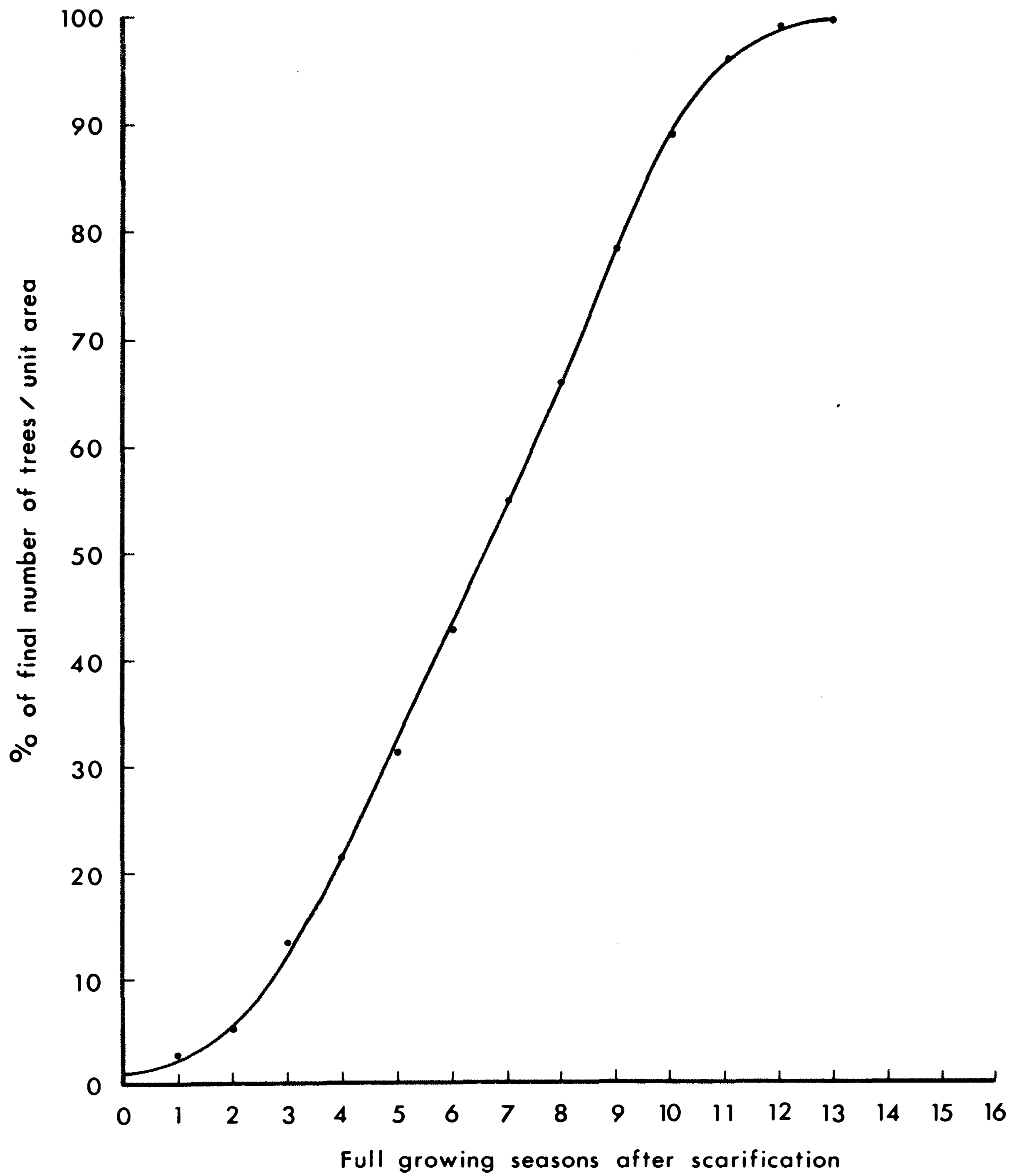
If the survey is delayed until the fall of calendar year 7 the number of effective growing seasons is increased to 3½ and the percentages of established seedlings increase from 23.5 to 42.5 for pine and from 8 to 16.5 for spruce (Fig. 2).

The pattern of spruce regeneration ingress following selective cutting (Fig. 3) is similar to that following clear-cutting (Fig. 2) although there is a difference in the rate of ingress between the fourth and eleventh growing seasons after scarification.

When considering the preceding results, the reader is reminded that:

1. As a result of the method used, only surviving seedlings have been measured and, because the mortality rate is unknown, it is impossible to estimate the actual number of germinants. Be that as it may, there is no reason to believe that the relative rates of ingress and mortality are interdependent.
2. Although the aging of the seedlings was conducted with the utmost care, any bias in the data (in the statistical sense) will probably be negative because it is more likely to underestimate rather than overestimate age. If a negative bias does indeed exist, it would shift the ingress curves (Figs. 1-3) to the right, thus resulting in a conservative estimate (underestimate) of the rate of ingress.
3. Finally, the increase in density with time (ingress) as measured in this study is not directly equivalent to an increase in stocking percent, which depends upon the distribution of acceptable seedbeds as measured by conventional regeneration surveys. In the conventional survey, once a survey quadrat is stocked by an established seedling all subsequent ingress is ignored. However, the results do suggest that there is a good chance that some of the quadrats unstocked six or even seven growing seasons after logging may subsequently become stocked through normal regeneration ingress.

Figure 3. Spruce ingress in a scarified selection cut related to full growing seasons after scarification



CONCLUSIONS AND RECOMMENDATIONS

There is considerable variation in the amount and rate of both pine and spruce regeneration ingress following clear-cutting and scarification in west-central Alberta. Ingress of pine and spruce may continue for up to 11 and 13 growing seasons following scarification, respectively. Because of survey timing and current established-seedling standards, the assessment of stocking is based upon a relatively small proportion of the expected final population of regeneration. This proportion is almost doubled if the survey is conducted in the fall instead of the spring of the seventh calendar year (i.e. following the sixth growing season after logging). The results clearly demonstrate that prompt scarification after logging, particularly on spruce sites, will greatly enhance the chances of achieving the minimum stocking standard. Because of substantial species differences in the pattern and rate of regeneration ingress, consideration of separate survey standards and procedures for pine and spruce may be warranted.

It is recommended that:

1. Regeneration surveys should be conducted following the *eighth growing season after logging,* thus allowing for more complete ingress than the present survey system. This schedule would "catch", on the average, approximately 80% of the expected pine and 50% of the expected spruce regeneration (Fig. 1), and still allow for remedial action on unsatisfactorily stocked cutovers before 10 years after logging.
2. Because even a survey conducted eight growing seasons after logging results in a conservative estimate of final stocking, consideration should be given to acceptance of *all seedlings,* irrespective of age.

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