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- Establishment Report 1963 -

SEED RELEASE FROM SLASH-BORNE LODGEPOLE PINE CONES AFTER CLEARCUTTING

(Project A-80)

by

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Calgary, Alberta

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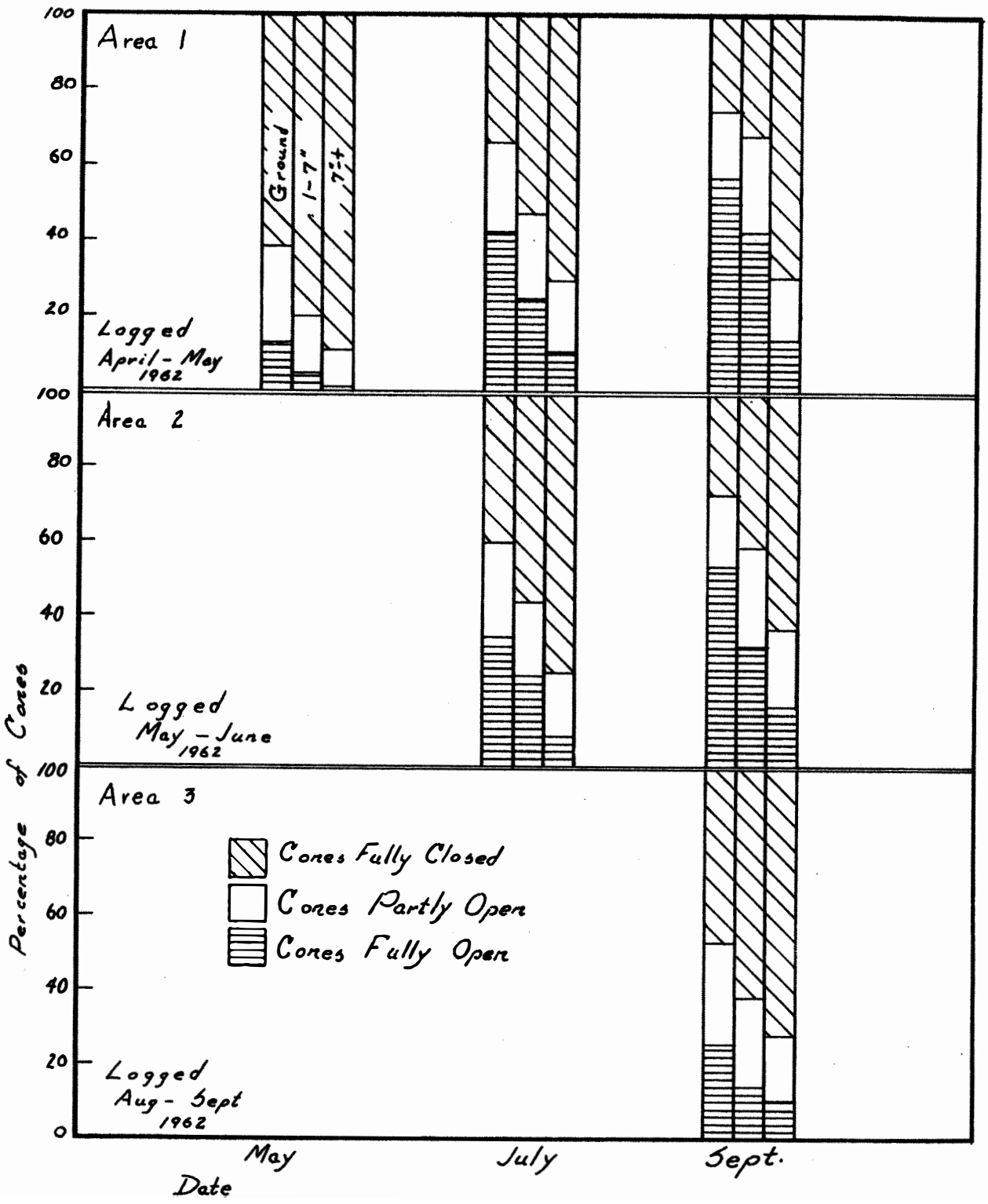

Fig. 1 Pattern of Cone Opening After Logging by Area and Cone Position Relative to Ground Surface— All Ages of Cones.

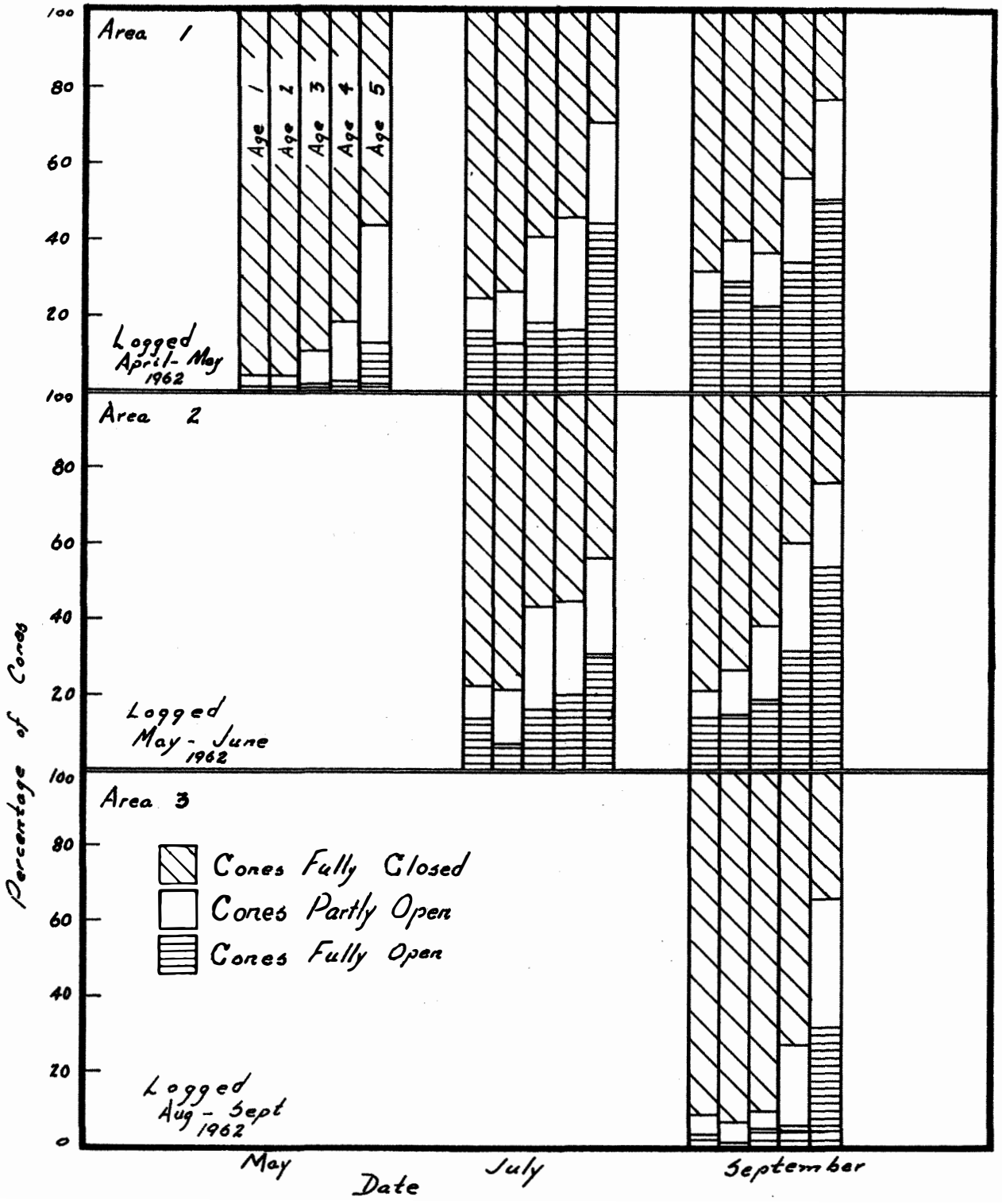

Fig 2. Pattern of Cone Opening After Logging by Area and Cone Age - All Cone Positions

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Establishment Report, 1962-3

Seed Release From Slash-Borne Lodgepole Pine Cones After Clearcutting

Project A-80

by

R.F. Ackerman

INTRODUCTION

This project was initiated in 1962 to determine the rate of seed loss from slash-borne serotinous cones of lodgepole pine after clearcutting. This information is considered essential if scarification or controlled burning programmes are to be planned for the lodgepole pine type with reasonable assurance that an adequate seed supply will be available before treatment.

The study was initiated in the High Foothills Section of Alberta on areas operated by North Western Pulp and Power Ltd.

METHODS AND MATERIALS

General

The methods outlined in the project plan were followed with little modification. Three areas, each approximately five acres, were selected to represent winter, spring and summer logging. The general approach was to determine, by sampling, the characteristics of the cone population before logging, the amount and quality of seed in the slash immediately after logging and at specified intervals thereafter.

Description of Stands and Sites

At the time of writing, site and stand descriptions are incomplete for the three areas. This will be remedied during the 1963 field season when there will be better opportunity to obtain the necessary information.

All areas were clearcut (no standing trees) during 1962, as follows:

Area 1 - April-May - to serve as winter logging.
Area 2 - May-June - spring logging.
Area 3 - August - summer logging.

Each area meets the following requirements:

1. Pure, mature, merchantable lodgepole pine.
2. Slash not lopped and scattered.
3. An abundant supply of cones.
4. Normal exposure and soil moisture. All areas are well drained. Areas 1 and 3 are located on upland till sites. Area 2 is located on alluvium.

RESULTS

Characteristics of the Cone and Seed Population Before Logging

To determine the characteristics of the population before logging, all the cones were collected from three codominant or dominant trees on each area. The following observations were made for each cone:

1. The percentage of the total surface area over which the rosin bond was ruptured.
2. Cone age.

It was not originally intended to include cone age as a variable in this study. It was early discovered, however, that cone age plays an important

role in the pattern of cone opening and, unless assessed, could mislead in the interpretation of some aspects of the data. Accurate ageing of all of the cones of this study was obviously an impossible task. However, it was noted that cone colour and texture changes with age from a glossy, yellow brown to a mottle grey. This effect of weathering was employed as an index of age, as follows.

Age Class

1 - No evidence of weathering; cones that matured the previous autumn.

2 - Cones weathered over 5-25% of surface area; 2-3-year-old cones.

3 - Cones weathered over 25-50% of surface area; 4-6-year-old cones.

4 - Cones weathered over 50-75% of surface area; 6-10-year-old cones.

5 - Cones weathered over entire surface area; all older cones.

These data are presented for the cone populations of each area in Table 1. Note that in this and subsequent tables, only three classes of free-scale area (described as degree of cone opening) have been employed.

1. Cone scales free over 0-20% of cone surface (closed).
2. Cone scales free over 21-80% of cone surface (partly open).
3. Cone scales free over 81-100% of cone surface (open).

Table 1. The Degree of Rosin Bond Rupturing by Age Class of Cone and Collection Area.

Degree of Cone Opening -	Cone Age Class - Young - Old					
	1	2	3	4	5	All
	Percentage of Cones					
Area 1						
Closed	100	100	99	87	79	89
Partly Open	-	-	1	13	19	10
Open	-	-	-	-	2	1
All	100	100	100	100	100	100
Area 2						
Closed	71	80	71	70	42	68
Partly Open	5	3	4	7	10	6
Open	24	17	25	23	48	26
All	100	100	100	100	100	100
Area 3						
Closed	100	100	91	77	47	71
Partly Open	-	-	9	21	38	23
Open	-	-	-	2	15	6
All	100	100	100	100	100	100

There are significant differences between areas in degree of cone opening. Assuming seed release has been proportional to degree of cone opening, seed loss from cones of Areas 2 and 3 has been 3 to 5 times the loss from Area 1.

The effect of age of cone on cone opening is evident on all three areas. The proportion of cones either wholly or partially open increases with age of cone.

The effect of age of cone on cone opening makes more difficult classification of the cone populations as to serotiny. If it is assumed that non-serotinous cones will completely open at, or shortly after maturity and if it is assumed that the effect of age is a result of weathering, then the proportion of Age 1 and 2 cones that are completely open should serve reasonably well as an index of serotiny. By this technique the cone populations of Areas 1 and 3 are classified as completely serotinous and the population of Area 2 as approximately 80% serotinous.

All cones from the sample trees were opened by immersion, dried, and all seed extracted by tumbling. Ten samples of 100 seed were taken from each age class of cone and germination tests conducted to determine viability.

From previous tests it had been determined that prompt and complete germination could be obtained, without pretreatment, at a constant temperature of 70°F, at 60°-80°F alternating or at 60°F for the initial 4 days followed by 90°F for the remainder of the test. Preliminary tests were conducted for this seed at 70°F and 60°F followed by 90°F, the two temperature regimes most easily administered. Since there was no significant difference in the rate or level of germination a constant temperature of 70°F, maintained for 14 days, has been adopted for all germination tests of this study.

The real germination percentage is shown by source area and age of cone in Table 2.

Table 2. Real Germination Percentage by Area and Age of Cones.

Area Number	Age of Cones				
	1	2	3	4	5
	Real Germination-Percentage of App. Sound Seed				
1	94	98	99	98	98
2	97	96	94	97	95
3	98	No data	96	95	92

Storage in the tree had no effect whatsoever on the germination potential of the seed. The high percentage germination on all areas indicates also that a constant temperature of 70°F satisfies the requirements of this seed for complete and rapid germination.

The germinative capacity of this seed is shown, by source area and age of cone, in Table 3.

Table 3. Germinative Capacity by Area and Age of Cones.

Area Number	Age of Cones					
	1	2	3	4	5	All
	Germ. Capacity Percentage (App. Germ. + App. Sound)					
1	54	53	60	58	64	59
2	83	82	74	78	78	78
3	74	No data	75	87	70	78

Differences in germinative capacity between cone ages probably reflect periodic or annual differences in seed quality, not the effects of storage in the tree.

Differences between areas are evident. This sample indicates that the capacity of the seed population of Area 1 is considerably lower than for Areas 2 and 3.

Number and Vertical Distribution of the Cone Population Immediately After Logging

As soon as possible after logging 320 milliacre quadrats were established on each of the three 5-acre areas. Normally an unavoidable lag of approximately one month occurred between first cutting and establishment of the sample.

The 320 quadrats were laid out randomly on Area 1. The theoretical advantages of random location did not outweigh the effort involved however and the samples on Areas 2 and 3 were established systematically.

All cones were counted on each quadrat and the position of each cone relative to the ground surface was recorded as follows.

1. Cones having contact with the ground.
2. Cones situated 1- to 7 inches above the ground.
3. Cones situated more than 7 inches above the ground.

The results of this survey are shown in Table 4.

Table 4. Number and Vertical Distribution of Slash-borne Cones After Logging.

Area Number	Cone Position Relative to Ground Surface							
	Ground		1" - 7"		7" +		All	
	No. per Acre	%	No. per Acre	%	No. per Acre	%	No. per Acre	%
1	25,000	24	36,000	34	44,000	42	105,000	100
2	46,000	26	56,000	32	74,000	42	177,000	100
3	28,000	24	37,000	32	50,000	44	115,000	100

Although Area 2 has considerably more cones than Areas 1 and 3, there is an abundance on all three areas.

The proportion of cones in each height-above-ground class is remarkably uniform. The higher proportion in the 7" + class is a direct result of the areas remaining unlopped after logging.

Pattern of Cone Opening After Logging

Cone samples, consisting of 640 cones from each of the 3 height-above-ground strata, were obtained from each area during the first season, according to the following schedule.

Area 1 - May - as soon as possible after logging.
- July
- September

Area 2 - July - as soon as possible after logging.
- September

Area 3 - September - as soon as possible after logging.

To avoid bias in the sampling the 640-cone-sample from each strata was obtained by selecting the two cones in each strata nearest the centre stake of each of the 320 milliacre quadrats.

Following collection (in units of 40 cones) the age class and degree of rosin bond rupture were determined for each cone. All seed remaining in the cones were then extracted, counted and tested for germination as previously described.

The pattern of cone opening in the slash, by source area and cone position is shown in Figure 1. These data illustrate well the effect of cone position on the rate of cone opening and justify recognition of the height-above-ground strata in the sampling.

The effect of cone position on cone opening is evident in the data derived from the first sample after logging. There are two reasons for this.

1. Cone opening that occurred during the delay between logging and collection of the first sample.
2. A higher proportion of the cones situated on the ground are old cones (ages 4 and 5). This is thought to be due to the brittleness of the older cones, particularly those on standing dead, and the resultant tendency to break free when the trees are felled.

The pattern of cone opening during the first season, as affected by age of cone is shown in Figure 2. These data substantiate the previously indicated influence of cone age on the rate of cone opening.

The pattern of cone opening for the entire cone population, all ages and all positions is summarized in Table 5. These data were derived by weighting according to the number of cones in each height-above-ground stratum.

Table 5. The Pattern of Opening of All Cones by Area.

Degree of Cone Opening	Date, 1962		
	May	July	September
	Percentage of All Cones		
Area 1 - Logged April-May, 1962			
Closed	79	55	46
Partly Open	16	22	20
Open	5	23	34
All	100	100	100
Area 2 - Logged May-June, 1962			
Closed		60	47
Partly Open		20	22
Open		20	31
All		100	100
Area 3 - Logged August, 1962			
Closed			63
Partly Open			22
Open			15
All			100

On Area 1, after a full spring-summer season only 34% of the cones are fully open. Area 2, logged during the spring months of May and June, does not differ significantly from Area 1. Two reasons are suggested for this.

1. Both areas were logged prior to the warm, mid-summer months.

2. The effect of later logging on Area 2 is masked by the higher proportion of the cone population that is not serotinous (Table 1).

The effect of late season logging is evident on Area 3 where, by early September only 15% of the cones were fully open.

Seed Quality

Real germination is shown in Table 6 for each area by position of cones and date of sampling in 1962.

Table 6. Real Germination Percentage by Area, Position of Cones and Date of Sampling - After Logging.

Cone Position Relative to Ground Surface	Date of Collection - 1962		
	May	July	September
	Real Germination-Percentage of App. Sound Seed		
Area 1 - Logged April-May, 1962			
Ground	88	89	92
1" - 7"	90	66	84
7" +	79	95	89
Area 2 - Logged May-June, 1962			
Ground		86	81
1" - 7"		91	87
7" +		93	80
Area 3 - Logged August, 1962			
Ground			87
1" - 7"			90
7" +			92

As yet, there are no differences in seed quality that can be attributed to either storage in the slash or proximity to the ground. For this reason all collections have been combined to derive germinative capacity of the seed population (Table 7).

Table 7. Germinative Capacity by Area and Position of Cones.

Area Number	Position of Cones Relative to Ground Surface			
	Ground	1" - 7"	7" +	All
	Germ. Capacity % (App. Germ. + App. Sound)			
1	69	70	76	72
2	69	70	74	72
3	59	76	74	72

There is a suggestion that the germinative capacity of the seed from cones located on or near the ground is lower than that of seed from cones located well above the ground. The differences are not statistically significant however and comment is reserved until the evidence of future collections is available.

The germinative capacity of the entire seed population is remarkably similar on all three areas. This is in contradiction to the germinative capacity indicated by the seed sample obtained from standing trees before logging. An attempt will be made to resolve this contradiction by additional sampling, but in the interim it should be noted that the sample after logging is by far the larger and more representative.

Rate of Seed Release

The number of sound seed per acre shortly after logging and the percentage of seed released during the first summer are shown in Table 8.

Table 8. Rate of Seed Release From Slash-borne Cones During the First Season After Logging.

Cone Position	Sampling Date, 1962					
	May		July		September	
	No. of Sound Seed per Acre -m.	% Release	No. of Sound Seed per Acre -m.	% Release	No. of Sound Seed per Acre -m.	% Release
Area No. 1 - Logged April-May, 1962						
Ground	304	0	250	18	203	33
1 - 7"	575	0	491	15	363	37
7" +	793	0	793	0	614	23
All	1,672	0	1,534	8	1,180	30
Area No. 2 - Logged May-June, 1962						
Ground			490	0	362	26
1 - 7"			808	0	616	24
7" +			1,225	0	1,171	4
All			2,523	0	2,149	15
Area No. 3 - Logged August, 1962						
Ground					276	0
1 - 7"					601	0
7" +					830	0
All					1,707	0

On Area 1, logged in early spring, (equivalent to winter logging) 30 per cent of the total seed supply was lost from slash-borne and free cones by September. On Area 2, logged during early summer, 15 per cent of the seed was lost by September.

It is of incidental interest that the maximum number of seed per cone (based on sample units of 40 cones) was found to be 31 seeds.

DISCUSSION

A maximum seed loss of 30 per cent during the first summer season after logging, or less than 30 per cent if logging takes place during the summer, is considerably lower than expected. The fact that the areas were not lopped, that a large proportion of the cones are situated well above the high temperature regimes which occur at or near the ground surface has undoubtedly contributed significantly to this result.

Considering the abundance of seed present in the slash of all areas the writer is tempted to conclude that there is little silvicultural advantage in cultural treatments such as scarification or controlled burning during the first season, if such early treatment involves organizational or administrative difficulties. However, the observed rate of seed loss during 1962 must be considered with regard for the weather conditions of that season, which were notably cool and moist. Analysis of this factor will be undertaken in 1963 when official climatic summaries are available for the period and seed loss during the second season can also be evaluated.

This experiment was not designed to investigate, in any detail, the factors affecting cone opening and seed loss. The effect of cone position relative to the ground surface has been substantiated however, and in addition, considerable evidence has accumulated to indicate a relationship between cone opening characteristics and age of cone. Two hypotheses are suggested.

1. Change in texture and colour of the cone surface, resulting in a lower albedo, facilitates attainment of the "critical" cone tissue temperature at any given radiation level. Also, growth of the tree bole or branch to which cones are attached may result in an increase in the total amount of radiation received by the cones.

2. With the passage of time there may be a chemical change in the bonding material that effects a lowering of the "critical" temperature.

These two hypotheses will be tested in 1963.

The data presented to date does not include an estimate of cone loss to squirrels during 1962. This information will be obtained in the spring of 1963, by recounts on a sample of quadrats, and the estimates of loss adjusted accordingly.

During the 1962 season, 3 cones, representing age classes 1, 3 and 5 were suspended, fully exposed, at ground level and at 1", 3", 6" and 12" above the ground. Rupture of the rosin bond was noted periodically and associated with on site measurements of true air temperature and cloud conditions.

Providing cloud did not prevent periods of direct solar radiation, the lowest maximum air temperature (°F) at which rupturing of the rosin bond was observed is shown below.

Cone Position	Age of Cone 1	3	5
Ground	70	65°	61°
1"	83	70°	67°
3"	83	70°	67°
6"	None	None	67°
12"	None	None	None

Note that cones situated 12" above the ground surface did not open during the 1962 summer season. The maximum air temperature observed during the study period however was only 83°F.

Regardless of air temperature, no cone opening was observed unless there were periods of direct solar radiation during the warm part of the day. During the summer months the approach of the warm part of the day is usually accompanied by a build-up of cloud cover. As a result cone opening was observed to occur at lower air temperatures during the spring months than during the summer months.

These data are applicable only to fully exposed cones. Cone opening in the slash may occur at lower or higher air temperatures depending on cone position relative to sources of shade, adjacency of nearby reflecting or radiating bodies, etc. The data does illustrate however that cone opening

can occur at true air temperatures considerably lower than previously suspected.

FUTURE WORK

Cone samples will be obtained from all areas in the spring and autumn of 1963. In addition, cone counts will be made on a sample of quadrats to determine loss to squirrels during 1962.