

STUDIES OF THE MORPHOLOGY OF JACK PINE CONE  
OPENING AND THE PHENOLOGY OF SEED  
DISPERSAL AND GERMINATION

Project MS-235

by

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FOREST RESEARCH LABORATORY

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INTRODUCTION

Regeneration of jack pine (Pinus banksiana Lamb.) cutovers in Manitoba is a major problem and site treatment is usually required prior to seeding or planting. A method presently being tested is scarification with a middlebuster plow, creating a furrow two to three inches deep and three to four feet wide with an overturned sod ridge on each side.

Logging operations are carried out during the winter months. Slash is generally lopped and scattered in conjunction with the operation, to supply a seed source for regeneration of the logged area. In order for regeneration to be successful the seed must be dispersed at a time favourable to germination and survival.

A study carried out in southeastern Manitoba in 1962 and 1963 showed that a large percentage of seed sown in late April germinated during the first three weeks of June (Sims 1964). It is also believed that seedlings which germinate early in the growing season have a better chance of survival than do those that germinate later. It is therefore imperative to know when the cones disperse and when the seeds germinate and how well the seedlings survive. Such information could bring about modifications of slash and site treatment to provide for a more favourable time of seed dispersal.

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## WORK COMPLETED IN 1967--EXPERIMENT I

Description of Area

The experimental area is located in Sec. 20 Twp. 2 Rge. 12 E.P.M. on the Sandilands Forest Reserve in southeastern Manitoba.

The site was scarified with a middlebuster plow in the fall of 1966 and was logged during the winter of 1966-67. Slash was scattered by the Department of Forestry, in addition to that done by the loggers, to give an even distribution throughout the area.

A summary of the former stand characteristics is given in Table I.

TABLE I  
SUMMARY OF STAND CHARACTERISTICS

Area (acres)	Trees /acre	Basal area /acre (sq.ft.)	Merchantable Vol. /acre (cords)
8.42	261.5	68.5	8.78

Study Plot Location

Fifty evenly spaced transects were located on the area. Each transect was 1.1 chains long and divided into 11 one-milacre quadrats. The northeast corner of each transect was marked by a wooden stake 2 x 2 inches by 2.5 feet. Wooden stakes 1 x 1 inch by 2.5 feet were used to mark the three remaining corners.

Cone Crop Sampling

The last quadrat in each transect was used as a sample plot to determine the number of cones per acre. Cones were recorded by three height classes; ground level--7 inches, 7 inches - 12 inches and those above 12 inches. Cones were noted as being open (at least 75 per cent of the cone scales open), partially open (at least one scale and not more than 75 per cent open) and closed.

On May 31, 1967 one quadrat was chosen at random in each of 25 transects in the 1966 study area. A total cone count was made to determine the effect of snowfall on the compaction of slash. The cones were grouped by height classes only.

### Cone Collections for Seed Dispersal Counts

On the 1967 area an attempt was made to obtain a collection every 28 days, but due to inclement weather and work schedules, this was not always possible. On the 1966 area collections were made on June 1 and October 19, 1967.

One quadrat was chosen at random from each transect. Only those four cones closest to the center of the quadrat in each height class were sampled. If there were fewer than four cones in any height class the sample was completed with cones in that height class outside the transect. If there were no cones in a height class inside the quadrat no sample was taken. The cones were noted as to condition (open, partially open or closed) and the open and partially open cones were placed in plastic bags with the appropriate tags. These were taken to the lab for examination. Indentations on the top of the cone scale indicated whether a seed had been dispersed. Loose seeds found in the bag were subtracted from the number obtained from cone scale counts.

### WORK COMPLETED IN 1967; SUPPLEMENTARY STUDY TO EXPERIMENT I

The supplementary study to experiment I was established immediately adjacent to experiment II in the trough portion of a furrow created by a middlebuster plow. Seventy-two seed traps each 1/20,000 acre in size and constructed of fourdrenier wire were placed in the trough and filled with sieved sand to a depth of approximately one inch. Firm contact between the soil in the trap and that in the furrow was established. Ten closed jack pine cones from the previous season's cone crop were attached to string and suspended over each seed trap at soil level, four inches above soil level and nine inches above soil level. At each height cones were suspended two inches under slash and two inches over slash (in the soil level treatments cones were placed directly on the slash). The traps were located in eight blocks each containing the nine treatments.

The cones were examined at monthly intervals from May to October and classed as open or closed. Released seed was collected by sieving the sand in each trap.

Weekly maximum air temperatures were recorded at four, and nine inches above the ground, at ground level and at soil surface contained in a seed trap.

The area was fenced as in previous years to protect against rodent predation.

### WORK COMPLETED IN 1967--EXPERIMENT II

#### Study Plot Location

The study area was located in the northeast quarter of Section 20 Township 2 Range 12 E, Sandilands Forest Reserve. Ten plots each containing 12 1/20,000-acre quadrats were established in the trough portion of a furrow created by a middlebuster plow. All slash and cones were removed from the furrow and immediate area as a precaution against natural regeneration

interfering with the experiment. Numbered 2-inch by 2-inch wooden stakes were used to mark the northeast corner of each plot, each quadrat was marked by a numbered 1-inch by 1-inch wooden stake located in the northeast corner. Small barricades (1-inch by 1-inch wooden stakes) were placed between the quadrats to prevent washing of seeds from the spots.

The area was enclosed by a low fence constructed of galvanized metal as a precaution against rodent damage.

### Plot Seeding

Plot seeding was carried out at two week intervals beginning May 9 and ending October 10.

One quadrat in each plot was randomly selected and sown with 50 jack pine seeds. The seed was treated with Arasan, Endrin and aluminum flakes. The compound contains fungicidal properties and also acts as an animal repellent.

Germination test conducted in the laboratory showed the seed to have a germination capacity of 97.0 per cent.

Again, as in the 1966 study<sup>2</sup> the seed was lightly covered at time of planting.

### Germination and Mortality Counts--Area IV

Germination and Mortality counts were carried out at weekly intervals beginning on May 16 and continuing until October 10. Germinants were marked with coloured plastic skewers (a different color for each week) and the week of germination recorded. Dates of mortality were recorded and dead seedlings were removed.

### Germination and Mortality Counts--Areas III and II

Germination and mortality counts were carried out at two week intervals beginning on May 30 and continuing until October 3. New germination was marked with a coloured plastic skewer and period of germination recorded. Mortality of dead seedlings was recorded and the seedlings were removed.

### Seedling Measurement

Total height and 1967 growth of seedlings on areas II, III and IV were obtained in late September. Branching and the number of seedlings browsed were recorded.

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Throughout the remainder of this report the 1965, 1966 and 1967 study areas of experiment II and supplementary study to experiment I will be referred to as area II, III and IV respectively.

Climatic Data

(1) Temperature: Daily air temperature was recorded on area IV from May 9 to October 10 using a Negrette and Zambra thermograph. The instrument was housed in a bird cage shelter and was serviced at two week intervals.

(2) Precipitation: Rainfall was collected weekly on area IV using three Beal-type rain gauges. Collections were made for the period May 16 to October 10.

RESULTS--EXPERIMENT I

Cones Per Acre in Slash

Table 2 shows the total cone sample by height class and condition after logging for the 1967 area.

Table 3 shows the number of cones on the 1966 area by height classes. The number of cones in the 0-7 inch class increased by 10 per cent in 1967. Cones in the 7-12 inches and 12 + inches classes decreased by 3 per cent and 7 per cent respectively.

TABLE 2

NUMBER OF CONES IN SLASH BY HEIGHT ABOVE-GROUND CLASS--1967 AREA, PINEY

Cone condition	Height above ground (inches)			All cones
	0-7	7-12	12 +	
Open	0	0	0	0
Partially open	0	0	0	0
Closed	4,035	856	449	5,340
Total	4,035	856	449	5,340
Cones per acre	80,700	17,120	8,980	106,800

TABLE 3

NUMBER OF CONES IN SLASH BY HEIGHT ABOVE GROUND CLASS--1966 AREA, PINNEY

	Year of sample	Height above ground (inches)			All cones
		0-7	7-12	12 +	
Cones per acre	1966	75,760	9,700	9,860	95,320
Per cent		80	10	10	
Cones per acre	1967	71,160	5,700	2,520	79,480
Per cent		90	7	3	

#### Cone Collections for Seed Dispersal Analysis

Table 4 summarizes the monthly cone collections by height class and condition. Most cone opening activity for the 0-7 inches level took place during July and August, while those cones above 7 inches showed very little activity throughout the summer.

Table 5 illustrates cone samples collected in 1967 from the 1966 area. Per cent of cones open increased in all classes from that of the previous year. The per cent of closed cones decreased in the two lowest height classes.

#### Monthly Seed Dispersal per Acre

Monthly seed dispersal on the 1967 area for open and partly open cones grouped by height class is shown in Table 6. Greatest seed dispersal occurred in the 0-7 inch class, followed by the 7-12 inch class. Almost 50 per cent of total seed dispersal occurred during August.

Collections obtained from the 1966 area showed that no additional seed was dispersed in 1967. This conclusion may be due partly to the difficulty in ascertaining seed dispersal from weathered cones.

### RESULTS

#### Supplementary Study to Experiment I

Tables 7 and 8 show the periodic seed dispersal and per cent open cones for each cone height class and slash treatment. Most seed was dispersed by cones in the soil-level height class in each treatment, followed by the 4-inch height class. No seed was dispersed from cones suspended at the 9-inch height in any slash treatment. Only cones in the soil-level height class dispersed seed in the slash-over-cones treatment. Most seed was dispersed by cones in the slash-under-cones treatment followed by the no-slash treatment.



TABLE 4

NUMBER OF OPEN, PARTIALLY OPEN AND CLOSED CONES AT MONTHLY INTERVALS--1967 AREA, PINEY

Date	Height above ground (inches)											
	0-7				7-12				12 +			
	Open	Partially open	Closed	Total	Open	Partially open	Closed	Total	Open	Partially open	Closed	Total
May 30	37	8	142	187	0	0	168	168	0	0	128	128
July 5	62	9	121	192	8	4	152	164	2	1	124	127
Aug. 2	68	17	101	186	21	6	124	151	1	1	122	124
Sept. 7	112	16	60	188	30	8	94	132	0	2	118	120
Oct. 2	112	12	69	193	10	11	121	142	0	2	98	100
Total	391	62	493	946	69	29	659	757	3	6	590	599
Per cent	41	7	52		9	4	87		1	1	98	

TABLE 5

NUMBER OF OPEN, PARTIALLY OPEN AND CLOSED CONES--1966 AREA, PINEY

Date	Height above ground (inches)											
	0-7				7-12				12 +			
	Open	Partially open	Closed	Total	Open	Partially open	Closed	Total	Open	Partially open	Closed	Total
June 1/67	81	9	97	187	11	5	87	103	3	2	75	80
Oct. 19/67	67	9	104	180	13	5	106	124	0	0	92	92
Total	148	18	201	367	24	10	193	227	3	2	167	172
Per cent	40	5	55		11	4	85		2	1	97	

TABLE 6

PERIODIC SEED DISPERSAL PER ACRE FROM SLASH--1967 AREA, PINEY

Date	Height above ground (inches)			Total	Pounds per acre
	0-7 <sup>1</sup>	7-12 <sup>2</sup>	12 + <sup>3</sup>		
May 30	217,224	0	0	217,224	1.63
July 5	378,099	14,663	3,168	395,930	2.98
Aug. 2	0	23,218	0	23,218	0.17
Sept. 7	576,764	44,804	0	621,568	4.67
Oct. 2	0	0	0	0	0
Total	1,172,087	82,685	3,168	1,257,940	9.45

1

Based on 80,700 cones per acre.

2

Based on 17,120 cones per acre.

3

Based on 8,980 cones per acre.

Cones in the slash-under-cones treatment opened sooner than cones in any other slash treatment. Total cones open for the slash-under-cones and no-slash treatments were about equal at the end of the year.

Cones suspended over seed traps in the supplementary experiment were collected on October 19. These cones were examined for seed dispersal and the results are shown in Table 9.

Table 10 shows the maximum weekly temperature from May 23 to October 10 occurring at various levels. Little difference in average temperature between the 4-inch and 9-inch levels occurred. The average temperature of soil in the seed trap was slightly higher than the outside soil-surface temperature.

Some predation of seed was evident. Predation was heaviest for seed dispersed from May 30 to July 4.

TABLE 7  
 PERIODIC SEED DISPERSAL--POUNDS PER ACRE  
 SUPPLEMENTARY EXPERIMENT AREA IV

Collection period	Height above ground (inches)											
	No slash				Slash over cones				Slash under cones			
	0	4	9	Total	0	4	9	Total	0	4	9	Total
May 30	0.06	0	0	0.06	0	0	0	0	0.56	0	0	0.56
July 4	0.96	0	0	0.96	0.06	0	0	0.06	2.32	0	0	2.32
August 10	3.56	0.10	0	3.66	0.90	0	0	0.90	2.68	0.03	0	2.71
September 7	1.06	0.04	0	1.10	1.27	0	0	1.27	0.73	0.05	0	0.78
October 4	0.08	0.01	0	0.09	0.15	0	0	0.15	0.16	0.01	0	0.17
Total	5.72	0.15	0	5.87	2.38	0	0	2.38	6.45	0.09	0	6.54

TABLE 8

PER CENT OPEN CONES AT SPECIFIED PERIODS

SUPPLEMENTARY EXPERIMENT AREA IV

Collection period	Height above ground (inches)											
	No slash				Slash over cones				Slash under cones			
	0	4	9	Total	0	4	9	Total	0	4	9	Total
May 30	13.8	0	0	5.0	0	0	0	0	40.0	0	0	13.3
July 4	75.0	0	0	25.4	7.5	0	0	2.5	81.2	0	0	27.1
August 10	91.2	10.0	0	33.8	33.8	0	0	11.2	97.5	13.8	0	37.1
September 7	95.0	21.2	0	38.8	52.5	0	0	17.5	100.0	20.0	0	40.0
October 4	95.0	22.5	0	39.2	61.2	0	0	20.4	100.0	20.0	0	40.0

TABLE 9

SEED DISPERSAL PER ACRE BASED ON CONE SCALE COUNTS ON SUPPLEMENTARY  
STUDY TO EXPERIMENT I-1967 AREA, PINEY

Treatment	Height above ground (inches)			Total
	0 <sup>1</sup>	4 <sup>1</sup>	9 <sup>2</sup>	
No slash	1,315,410	262,275	0	1,577,685
Pounds per acre	9.9	2.0	0	11.2
Slash over cones	863,490	0	0	863,490
Pounds per acre	6.5	0	0	6.5
Slash under cones	1,049,100	112,980	0	1,162,080
Pounds per acre	7.9	0.8	0	8.7

1  
Based on 40,350 cones per acre.

2  
Based on 17,120 cones per acre.

TABLE 10  
 MAXIMUM TEMPERATURE °F  
 SUPPLEMENTARY EXPERIMENT AREA IV

Week Ending	LEVEL			
	Ground	Trap	4" above ground	9" above ground
May 23	106	105	82	82
30	112	117	87	87
June 6	104	119	85	85
13	111	113	83	84
20	112	121	87	88
27	104	115	86	87
July 4	108	111	93	94
11	106	119	95	94
18	112	125	96	95
25	121	129	102	101
August 1	111	118	97	97
8	101	108	96	94
15	105	115	99	98
22	102	119	101	99
29	102	116	100	98
September 5	113	102	95	92
12 to 19	108	111	94	91
29	96	96	88	86
October 3	92	94	85	83
10	75	71	65	63
Average	105.0	111.2	90.8	89.9

## RESULTS--EXPERIMENT II

Germination and Mortality--Area IV

1. Germination: Table 11 shows weekly germination percentages for seed sown at two-week intervals beginning May 9 and ending October 10. Germination began during period 8 and continued until period 16. A total of 9.4 per cent of the seed sown germinated, and occurred largely during periods 9 and 10, when 28.7 per cent of the total germination occurred and during periods 13 and 14 when 53.2 per cent occurred. Seed sown in late August to early October resulted in no germination. Table 12 relates germination period number to week of germination.
2. Mortality: Per cent mortality for weekly germination period and two week seeding interval is shown in Table 13. Mortality of weekly germination ranged from a low of 18.1 per cent to a high of 100 per cent. Seedlings germinating in periods 13 to 16 inclusive suffered mortality losses ranging from 74.9 to 94.7 per cent.

Total mortality of germinants resulting from seed sown at two week intervals increased gradually from the first seeding (in all but one case) with each successive seeding until 100 per cent mortality occurred. Total mortality for the year was 57.3 per cent.

Germination and Mortality--Areas III and II

1. Germination Area III: Table 14 shows per cent germination that occurred on area III during 1966 and 1967. Total germination during 1967 was 5.2 per cent, considerably lower than the second year germination on area II (17.5 per cent). Although germination in 1967 occurred on all quadrats sown in 1966 the majority (41.7 per cent) occurred on quadrats sown after mid-August. Approximately 90.0 per cent of the total germination in 1967 occurred between early May and mid July.
2. Mortality Area III: Per cent mortality occurring in 1967 is shown in Table 15. Mortality was distributed fairly evenly between seeding intervals. Total mortality was 57.0 per cent with over 60 per cent occurring between late August and mid September.

Second year mortality of the 1966 stock is shown in Table 16. Seedlings germinating later than period number 15 (August 23, 1966 to August 29, 1966) suffered considerably higher winter mortality than those germinating earlier.

Overall, summer mortality was higher than winter mortality, 26.2 per cent as compared to 7.8 per cent.

3. Germination Area II: No germination occurred on area II during 1967.



TABLE 11  
 PER CENT GERMINATION<sup>1</sup> FOR EACH SEEDING DATE AND GERMINATION PERIOD  
 AREA IV

Seeding date	Germination period																						Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
May 9								2.3	4.5	4.5	0.0	0.6	2.3	0.4	0.8	0.2							15.7
23								2.5	2.3	2.9	0.2	0.4	2.3	0.2	0.8	0.6							12.2
June 6								0.6	5.2	1.8	0.0	0.2	2.5	0.6	0.2	0.4							11.5
20									4.9	6.4	0.2	0.6	5.4	1.0	0.0	0.0							18.6
July 4									0.2	0.4	0.0	3.3	12.4	3.3	1.4	1.0							22.1
18												0.2	17.7	9.5	1.6	1.4							30.5
Aug. 1													0.2	1.8	0.4	0.2							2.7
15															0.2								0.2
29																							
Sept. 19																							
26																							
Oct. 10																							
Seasonal percentage								0.4	1.4	1.3	0.03	0.4	3.6	1.4	0.5	0.3							9.4

<sup>1</sup> Per cent germination for each germination period is expressed as a per cent of 500 seeds sown at 97.0% viability.

TABLE 12  
WEEK OF GERMINATION AND GERMINATION PERIOD  
AREA IV

Week of germination				Germination period
May	9	-	May 16	1
	17		23	2
	24		30	3
	31	June	6	4
June	7		13	5
	14		20	6
	21		27	7
	28	July	4	8
July	5		11	9
	12		18	10
	19		25	11
	26	Aug.	1	12
Aug.	2		8	13
	9		15	14
	16		22	15
	23		29	16
	30	Sept.	5	17
Sept.	6		12	18
	13		19	19
	20		26	20
	27	Oct.	3	21
Oct.	4		10	22

TABLE 13  
 PER CENT MORTALITY<sup>1</sup> OF GERMINANTS FROM EACH GERMINATION PERIOD  
 AREA IV

Seeding date	Germination period																						Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
May 9								18.2	18.2	40.9	0.0	33.3	90.9	100.0	100.0	100.0							43.4
23								41.7	18.2	35.7	100.0	0.0	63.6	100.0	75.0	66.7							44.1
June 6								33.3	24.0	22.2	0.0	0.0	91.7	100.0	100.0	100.0							46.7
20									8.3	25.8	100.0	66.7	80.8	100.0									43.3
July 4									100.0	100.0	0.0	12.5	66.7	62.5	57.1	100.0							59.8
18													75.6	76.1	100.0	100.0							77.7
Aug. 1													100.0	77.8	100.0	100.0							84.6
15															100.0								100.0
29																							
Sept. 19																							
26																							
Oct. 10																							
Seasonal percentage								30.8	18.1	33.3	100.0	19.2	74.9	76.8	85.2	94.7							57.3

<sup>1</sup> Per cent mortality based upon number of germinants in each germination period.

TABLE 14

## PER CENT GERMINATION ON AREA III AFTER TWO GROWING SEASONS

Seeding date 1966		Per cent germination <sup>1</sup>		
		1966	1967	Total
May	17	46.2	2.4	48.6
	31	39.9	3.1	43.0
June	14	52.4	2.2	54.6
	28	32.1	2.6	34.7
July	12	9.0	1.3	10.3
	26	19.2	2.6	21.8
Aug.	9	12.6	5.3	17.9
	23	7.7	1.3	9.0
Sept.	6	1.1	7.5	8.6
	20		10.8	10.8
Oct.	4		11.7	11.7
	18		11.7	11.7
Total for area		18.3	5.2	23.5

1

Expressed as a per cent of 500 seeds sown at 90.9% germination capacity in 1966.

TABLE 15  
 PER CENT MORTALITY OF SUBSEQUENT GERMINATION  
 AREA III

Seeding date 1966		Per cent mortality <sup>1</sup>
May	17	27.3
	31	42.8
June	14	70.0
	28	41.7
July	12	66.7
	26	66.7
Aug.	9	37.5
	23	33.3
Sept.	6	64.7
	20	61.2
Oct.	4	77.4
	18	47.2
Total for area		57.0

<sup>1</sup> Expressed as a per cent of the 1967 germinants for each seeding date.

TABLE 16

MORTALITY OF 1966 STOCK DURING SPECIFIED PERIODS--AREA III

Germination period	Per cent mortality <sup>1</sup>					
	No. seedlings fall 1966	No. seedlings spring 1967	Per cent mortality fall 1966 to spring 1967	No. seedlings fall 1967	Per cent mortality spring 1967 fall 1967	Per cent mortality fall 1966 to fall 1967
1						
2	1	1	0.0	0	100.0	100.0
3	25	23	8.0	17	26.1	32.0
4	27	27	0.0	23	14.8	14.8
5	124	123	0.8	108	12.2	12.9
6	59	59	0.0	33	44.1	44.1
7	190	185	2.6	142	23.2	25.3
8	171	168	1.8	129	23.2	24.6
9	53	53	0.0	42	20.8	20.8
10	6	6	0.0	5	16.7	16.7
11	8	8	0.0	3	62.5	62.5
12	3	3	0.0	3	0.0	0.0
13	45	45	0.0	27	40.0	40.0
14	20	19	5.0	8	57.9	60.0
15	12	12	0.0	7	41.7	41.7
16	6	4	33.3	1	75.0	83.3
17	40	14	65.0	8	42.8	80.0
18	18	8	55.6	4	50.0	77.8
19	17	10	41.2	7	30.0	58.8
20	8	0	100.0	0		100.0
21						
22						

<sup>1</sup> Per cent mortality based upon number of seedlings at the beginning of each period.

4. Mortality Area II: Per cent mortality of the germination occurring in 1966 is shown in Table 17. Total winter mortality was slightly less (2.1 per cent) than summer mortality (3.2 per cent). Over 50 per cent of the mortality that occurred, occurred between September 6 and October 3.

Per cent mortality of the original 1965 stock is shown in Table 18. As in the 1966 stock, winter mortality was slightly less (18.2 per cent) than summer mortality (21.0 per cent).

#### Seedling Measurement

1. Area IV: Table 19 shows the average height of germination occurring on area IV during 1967. The average seedling height was 0.4 inches. No branching occurred.

2. Area III: Table 20 shows the average height after two growing seasons and the 1967 growth for the 1966 stock. Seedlings germinating early in the growing season in 1966 appeared to have better second year growth and total height than those germinating later.

The average height of 1967 germination is shown in Table 21, little variation occurred in height growth. No branching developed.

3. Area II: The average height growth of the 1966 and 1965 stock is shown in Tables 22 and 23. Per cent branched and browsed are also shown. Greatest growth in 1967 occurred on seedlings from earlier germination periods.

#### Precipitation

Average weekly rainfall and maximum temperature recorded on Area IV is shown in Table 24. Total rainfall for the area was 7.99 inches, 60.5 per cent of the 30 year average for a corresponding period.

#### WORK PROPOSED FOR 1968 EXPERIMENT I

A total cone count by height class will be made on 25 transects on the 1967 area. This sample will illustrate slash compaction by snowfall. Two cone collections will be made on the area, one in June and one in September, to determine 1968 seedfall. Seedfall will be calculated using the figures from the 1967 total cone sample.

#### WORK PROPOSED FOR 1968 EXPERIMENT II

##### Germination and Mortality Counts--Areas III and IV

New germination, and mortality will be tallied at two-week intervals during the 1968 field season. Germination will be marked in a manner which will be distinguishable from seedlings already marked, and will be recorded by plot, quadrat and date. Mortality will be recorded in a similar manner.

An examination of all quadrats will be made in the spring of 1968 to determine over winter mortality.

TABLE 18  
MORTALITY OF 1965 STOCK DURING SPECIFIED PERIODS

## AREA II

Germination period	Per cent mortality <sup>1</sup>					
	No. seedlings fall 1966	No. seedlings spring 1967	Per cent mortality fall 1966 to spring 1967	No. seedlings fall 1967	Per cent mortality spring 1967-fall 1967	Per cent mortality fall 1966-fall 1967
1						
2						
3						
4	15	15	0.0	14	6.7	6.7
5	93	91	2.2	89	2.2	4.3
6	50	49	2.0	49	0.0	2.0
7	22	22	0.0	21	4.5	4.5
8	13	13	0.0	13	0.0	0.0
9	90	89	1.1	87	2.2	3.3
10	98	99	0.0	95	4.0	4.0
11	83	78	6.0	77	1.3	7.2
12	265	262	1.1	259	1.1	2.3
13	57	55	3.5	53	3.6	7.0
14	20	20	0.0	20	0.0	0.0
15	7	8	0.0	7	12.5	12.5
16	5	5	0.0	5	0.0	0.0
17						
18						
19	3	2	33.3	2	0.0	33.3
20	1	1	0.0	1	0.0	0.0
21						
22						

<sup>1</sup> Per cent mortality based upon number of seedlings at the beginning of each period.



TABLE 19  
SEEDLING MEASUREMENTS 1967 GERMINATION  
AREA IV

Germination period	No. seedlings measured	Av. height (inches)	Per cent branched
1	0		
2	0		
3	0		
4	0		
5	0		
6	0		
7	0		
8	17	0.4	0.0
9	67	0.4	0.0
10	53	0.4	0.0
11	0		
12	22	0.4	0.0
13	49	0.4	0.0
14	20	0.4	0.0
15	4	0.4	0.0
16	1	0.4	0.0
17	0		
18	0		
19	0		
20	0		
21	0		
22	0		

TABLE 21  
 HEIGHT MEASUREMENTS--1967 GERMINATION

## AREA III

Seeding date (1966)	No. seedlings measured	Average height (inches)	Per cent branched
May 17	7	0.4	Nil
31	6	0.6	"
June 14	2	0.6	"
28	7	0.6	"
July 12	2	0.6	"
26	4	0.5	"
Aug. 9	16	0.5	"
23	3	0.5	"
Sept. 6	12	0.5	"
20	21	0.5	"
Oct. 4	15	0.5	"
18	26	0.5	"

TABLE 22  
 HEIGHT AND GROWTH MEASUREMENTS--1966 GERMINATION

## AREA II

Seeding date 1965	No. seedlings measured	Average height (inches)		Per cent branched	Per cent browsed
		Total height after 2 growing seasons	1967 growth		
May 4	67	1.5	0.7	8.7	1.4
18	19	1.9	1.0	10.5	
June 1	71	1.9	1.0	11.6	
15	39	2.6	1.4	25.0	4.2
29	18	1.6	0.8	27.8	5.6
July 13	51	1.6	0.8	7.5	1.9
27	73	1.9	1.0	26.0	4.1
Aug. 10	57	2.0	1.1	38.6	12.3
24	71	2.5	1.6	21.1	
Sept. 7	148	2.2	1.3	43.2	6.2
21	151	2.1	1.2	20.5	6.0
Oct. 5	138	2.4	1.7	36.2	15.2

TABLE 23

## HEIGHT AND GROWTH MEASUREMENTS--1965 GERMINATION

## AREA II

Germination period number	Number of seedlings measured	Average height (inches)		Per cent branched	Per cent browsed
		Total height after 3 growing seasons	1967 growth		
1					
2					
3					
4	13	5.7	3.4	100.0	100.0
5	89	5.9	3.7	80.9	51.7
6	47	7.3	4.6	95.7	55.3
7	24	6.4	4.2	95.8	66.7
8	12	6.1	4.2	83.3	50.0
9	88	5.7	3.6	80.7	50.0
10	94	5.5	3.3	80.8	52.1
11	76	4.5	2.9	81.6	50.0
12	252	4.1	2.4	73.8	47.4
13	52	3.8	2.2	71.2	30.8
14	20	3.8	1.8	65.0	35.0
15	7	3.9	2.0	57.1	28.6
16	6	5.2	2.7	66.7	16.7
17					
18					
19	1	1.5	0.6		
20	1	9.3	6.8	100.0	
21					
22					

### Height and Growth Measurements

Total height and 1968 growth will be measured on seedlings established in 1966, 1967 and 1968 on areas III, IV and V.

### Sample Plot Establishment

Sample plots will be established on a dry site in 1968 as previously outlined in this report (page 21). The area will be fenced as in 1967 for protection against rodents. Plot seeding, germination and mortality counts will be carried out as previously described in this report.

### REFERENCES

- Bruce, N.G. and Walker, N.R. 1967. Studies of the morphology of jack pine cone opening and the phenology of seed dispersal and germination.
- Sims, H.P. 1964. Characteristics of soil temperature and moisture, germination of jack pine seed, and seedling establishment, of seedbeds created by a Middlebuster plow in southeastern Manitoba. Canada Dept. Forestry, Forest Research Branch, Unpubl. MS 64-MS-17. 38 pp.