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# AN APPRAISAL OF RECENT PLANTATIONS IN FORESTS OF THE PRAIRIE PROVINCES

by K. Froning



NORTHERN FOREST RESEARCH CENTRE  
EDMONTON, ALBERTA  
INFORMATION REPORT NOR-X-31

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CANADIAN FORESTRY SERVICE  
DEPARTMENT OF THE ENVIRONMENT  
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AN APPRAISAL OF RECENT PLANTATIONS IN FORESTS OF THE  
PRAIRIE PROVINCES

by

K. Froning\*

SUMMARY

A survey of forest plantations established in Alberta, Saskatchewan, and Manitoba, was conducted by the Canadian Forestry Service during 1971. The work was carried out in co-operation with Provincial departments responsible for reforestation and included plantations established in 1965, 1967, and 1970. The objective was to evaluate the success of forest tree planting carried out in the recent past and to determine, if possible, the causes for mortality or plantation failures. This information is considered essential for the determination of research requirements and to gauge operational success.

Prior to the field survey, detailed plantation records were obtained from existing records of the Provincial Departments. The sampling procedure was designed to provide an estimate of survival with an error not greater than  $\pm 10\%$  of the calculated mean at a probability level of 90%.

In Alberta, survival of older plantations in particular, has been generally low and mainly due to high vegetative competition on poorly and unprepared planting sites. The results reflect the short historic development of silviculture in Alberta--a period less than ten years. Spruce survival was 10% higher than pine survival; the average for both species

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combined being 35%. Container plantings with the "Ontario tube" type container have been less successful than conventional bare rooted stock plantations.

Site preparation before planting is strongly correlated with survival, and planting in the rough has resulted in dense vegetative competition and consequent high mortality. In support of this statement, recently established machine plantings show good early survival.

Careful planning, particularly with regard to site selection, site preparation, care and transportation of planting stock and improved stock quality and early planting could prevent much of the mortality in Alberta plantations.

Saskatchewan's forest plantation projects of the years under appraisal have also had limited success. Climatic and soil conditions combined with the practice of planting on unprepared sites are the factors primarily responsible for high mortality.

In Manitoba plantation projects the success has generally been satisfactory. On some areas there was outstanding survival. On an average, 71% of all spring-planted seedlings are surviving over a great variety of planting sites. In contrast, fall planted stock showed 47% survival.

Site preparation in Manitoba's forest plantations increased from 69% in 1968 to 79% of all plantations established in 1970.

Drought is considered the most outstanding reason for mortality in Manitoba's forest plantations. Rabbit damage, although substantial in certain areas, at time of the appraisal, has not resulted in great losses.

## INTRODUCTION

Inadequate survival data of operational tree planting in the forested regions of Alberta, Saskatchewan, and Manitoba has precluded an estimate of the success of this reforestation method. An evaluation of recent planting projects was conducted by the Canadian Forestry Service with full support from the three provincial forest services during the summer of 1971. The objectives were to determine success of the past 6 years of operational plantings and, if possible, to identify causes of mortality. The results are useful to determine research requirements for the immediate future and to define areas of special concern to forest managers.

This assessment is part of a broader study to assess the success of all reforestation techniques being carried out by Provincial Governments and private industries in the Prairie Provinces. The present report represents the completion of the first phase of the study, namely the assessment of the success of current operational planting programs. The second phase, beginning in 1972, will consist of the appraisal of artificially regenerated forests other than plantations.

Organized tree planting in the Prairie Provinces dates back to the early 1900's. For more than thirty years it was usually associated with tree planting for farm shelterbelt purposes. Concern for forest resources, being depleted by harvest and wildfires, awakened in the 1930's and has grown steadily, particularly in the later 1950's and the 1960's.

It is estimated that in 1965 the combined tree-planting expenditures for the three provinces were \$300,000; four years later, by

1969, such expenditures were estimated to have been \$570,000. Indications are that the amount of the 1969 expenditures will be doubled by 1976 (Anon. 1971; Cayford and Bickerstaff, 1968; McDougall and Kennedy, 1971).

#### METHODS

Ideally an appraisal of the success of plantations in recent years would include all plantations for the period under consideration. However, limited resources dictated a more restricted alternative. Forest managers and silvicultural research personnel agreed that assessment of plantations at 1, 4, and 6 years after planting would provide sufficient information.

In order to locate as many of the plantations as possible, the co-operation of Government agencies was sought and obtained. Headquarters offices of some of the agencies had this information readily available while the others provided generous access to their files. Notes on the history of the site, on plantation details, and photocopies of maps and other relevant documents were prepared for each plantation.

Plantation files were later checked against records filed in the various district and field offices, and corrections were made where necessary. Discussions with personnel in district and field offices frequently provided additional information. Some plantations were omitted at random when it was found that there was a concentration of very similar plantations in a relatively small and uniform area.

The basic sampling unit comprised a plot of ten consecutive seedlings planted in a row. The sampling intensity was designed to provide an estimate of survival with a standard error not greater than  $\pm 10\%$  of the calculated mean at a probability level of 90%.

Initial steps in the field consisted of familiarization with the plantation area and its boundaries. Existing plantation file records were checked against the field observations and corrected if necessary or possible. On the basis of identifiable physiographic, edaphic or vegetational differences, an area was then subdivided into discernable strata. Ten plots were sampled within each stratum by distributing these approximately evenly over the area of a stratum. From these, the variance was calculated in the field. The obtained value was substituted in Stein's formula (Steel and Torrie, 1960) which yielded the total number of sample plots required for the desired precision (see Appendix I).

Required additional samples were taken by randomly walking over the area to points sighted ahead of the sampler: (tree stumps, grass clumps, branches, small shrubs or larger herbs, etc.) The seedling nearest to the object sighted would be considered the first seedling in a new plot which would continue in a predetermined cardinal direction. The sampler would turn and walk in any direction to sight the next object for a subsequent plot. The aim was to distribute the total number of plots over the entire area of the stratum. In larger plantations and uniform strata this frequently resulted in oversampling, because the number of plots established to cover an area exceeded the number of plots necessary for the required precision. Field notes were taken with respect to survival, spacing,

competition, etc. Some soil samples and photographs were taken of typical conditions.

A number of plantations did not lend themselves to the survey technique for various reasons (i.e. high mortality combined with high density of competition). Where this was the case, samplers were instructed to provide notes giving reasons and also commenting on the general condition of the plantations. If possible, survival tallies were then made in survival plots formerly established by provincial forest services.

The rating of competition was based on ocular evaluation of degrees of competition to root and shoot systems. Four categories of competition were recognized: high, medium, low, and sparse density.

Soil moisture classes were estimated on the basis of soil texture, mottling characteristics, and degree of drainage. Plant indicators served to provide additional clues for soil moisture classification. Soil moisture rating for the main rooting zone was expressed in numerical values from one to four, the index "1" designating a very dry site and "4" indicating a wet site (see Appendix II).

The following is a list of the species found in plantations throughout the three provinces and indicates the abbreviations used throughout this report.

<u>Common Name</u>	<u>Abbreviation</u>	<u>Scientific Name</u>
Douglas fir	dF	<u>Pseudotsuga menziesii</u> (Mirb.) Franco
Colorado spruce	cS	<u>Picea pungens</u> Engelm.
Engelmann Spruce	eS	<u>Picea engelmannii</u> Parry

White spruce	wS	<u>Picea glauca</u> (Moench) Voss
Lodgepole pine	lP	<u>Pinus contorta</u> Dougl.
Jack pine	jP	<u>Pinus banksiana</u> Lamb.
Red pine	rP	<u>Pinus resinosa</u> Ait.
Scots pine	sP	<u>Pinus sylvestris</u> L.

In the presentation of results, each of the provinces has been treated separately. Whereas basic survival data for each province are presented in Tables 1, 11, and 14, more detailed descriptions of plantations are given in Appendices V, VI, and VII. References to plantation numbers in the text relate to plantations as they are described in Appendices V, VI and VII. Fig. 1, 2, and 3 indicate locations of these plantations in the Provinces of Alberta, Saskatchewan, and Manitoba.

#### ALBERTA

Forest tree planting in Alberta began over forty years ago on a trial and experimental scale. Operational planting was not carried out until the early 1960's.

Provincial Crown forests were managed solely by the Alberta Forest Service (A.F.S.) until 1954. Upon entering forest management agreements with industrial organizations at that time there developed an awareness of the economic importance of the forest resources and reforestation programs were expanded significantly by 1959 (McDougall and Kennedy, 1971).



Fig.1. Location of Alberta Forest Plantations Established During 1965, 1967, and 1970, and Appraised in 1971.

Currently there are three active forest management agreements in Alberta. They cover an area in excess of 10,000 square miles of the province. Agreement holders harvest forest products on a sustained yield basis and they are required to reforest cutover areas. Only one agreement holder (Northwestern Pulp and Power Ltd., at Hinton) has been in operation long enough to have an operational reforestation program where the results of planting can be assessed.

Timber quota holders operating on the other Crown forests, managed by the A.F.S., are basically responsible for the reforestation of cutovers. They have the option of either undertaking the work or paying a reforestation levy of \$2.00 per thousand board feet, in which case the A.F.S. conducts the reforestation program.

If a quota holder elects to reforest, he must prove that the area is stocked according to A.F.S. standards seven years after cutting. If these standards are not met, then he is given an additional three years to do so. Since adoption of this policy by the A.F.S., just seven years have passed and a rapid increase in demand for planting stock is expected. Quota holders, until now, have not planted any seedlings (McDougall and Kennedy, 1971).

The A.F.S. has a growing reforestation program on understocked Crown lands. During the period March 31, 1959 to March 31, 1970 approximately 9,000 acres were planted with conventional seedlings either by hand or machine, and approximately 4,000 acres were planted with container-grown stock (Ontario-type tube).



Alberta forests are divided into eleven Forest Districts (areas) for administrative purposes and planting results are here analyzed on the basis of those Districts. Data were also pooled on the basis of the two major forest regions in the province, namely the Foothills and Boreal Forests.

The Northwestern Pulp and Power Company's forest tree planting program is one which has been based almost exclusively on containerized planting. Pioneering in co-operation with the Alberta Forest Service and the Canadian Forestry Service in developing the culturing and planting techniques since 1962, the company's container planting program became operational in 1965. In that year, approximately 200,000 Ontario-type tubelings were planted. During 1966 and 1967 there was expansion of that program to 500,000 with nearly one million seedlings for the 2 years (Johnson and Marsh, 1967). In 1970, a total of 3,191 acres were planted with 1,073,760 lodgepole pine and 233,704 white spruce tubelings.

Monitoring of survival and growth was undertaken by the Canadian Forestry Service (C.F.S.). Problems with survival and growth of seedlings planted in rigid, root restricting and non-degradable containers led to a change in technique, namely to "plug" planting. This method will be operational this year (1972).

### RESULTS

The survey and appraisal of forest plantations on Crown lands of Alberta involved approximately 90% of the population of seedlings planted

TABLE 1.

SURVIVAL OF PLANTED SEEDLINGS IN  
SOME ALBERTA FOREST PLANTATIONS

Forest District	Plan-tation No.	Survi-val %*	Species	Planta-tion age	Forest District	Plan-tation No.	Survi-val %	Species	Planta-tion age
<u>ATHABASCA</u>	1	25(S)	wS	4	<u>FOOTNER LAKE</u>	32	48(S)	wS	1
	2	<10	wS	4		33	88	wS	1
	3	58(S)	wS	1		33a	77(S)	wS	1
	4	69	jP	1		33b	86(S)	wS	4
	4a	67(S)	wS	1					
<u>BOW RIVER</u>	5	<10	1P	6	<u>GRANDE PRAIRIE</u>	34	21(S)	1P	4
	6	76	1P	6			72	wS	4
	7	<10	1P	6		34a	44(S)	wS	6
	8	<10	1p	6		34b	77(S)	1P	1
	9	<10	1p	6				wS	1
	10	<10	1p	1	<u>LAC LA BICHE</u>	35	81(S)	wS	1
			wS	1			42(S)	1P	1
	11	<10	1P	4		36	<10	jP	1
			dF	4		37	<10	wS	1
	12	<10	1P	1		38	<10	wS	1
	13	60	1P	1		39	12	wS	6 & 5
			dF	1	<u>ROCKY-CLEARWATER</u>		<10	jP	6
			wS	1		40	<10	wS	6
	14	<10	1P	1		41	<10	wS	4
	15	<10	1P	4					
			wS	4					
<u>CROWSNEST</u>	16	<10	dF	4		42	42	1P	4
	19	<10	1P	1		43	12	1P	4
			wS	1		44	31	wS	4
	20	<10	1P	1		45	40(S)	1P	4
	23	<10	dF	1		46	13(S)	1P	4
			1P	1		47	80	1P	1
	24	<10	1P	1		48	23(S)	1P	4
			dF	1		49	<10	1P	4
			wS	1		50	39	1P	4
	25	<10	eS	1		51	30(S)	wS	1
			wS	1		52	55(S)	1P	6
			dF	1		54	37(S)	wS	4
	27	<10	1P	1		55	58	wS	1
	28	<10	1P	1		56	40(S)	wS	1
			wS	1		58	89	1P	1

TABLE 1 (Continued)

SURVIVAL OF PLANTED SEEDLINGS IN

SOME ALBERTA FOREST PLANTATIONS

Forest District	Plan-tation No.	Survi-val %*	Species	Planta-tion age	Forest District	Plan-tation No.	Survi-val %	Species	Planta-tion age
<u>EDSON</u>	29	80	1P	6	<u>SLAVE</u>	59	48(S)	wS	4
	30	<10	1P	6	<u>LAKE</u>	60	6	1P	6
	31c	83(S)	1P	1		61	48	wS	6
	31d	60(S)	wS	1		62	90	wS	4
	31e	76(S)	1P	1		63	90	wS	1
	31f	63(S)	wS	1		64	72	wS	1
	31g	88(S)	1P	1		65	25(S)	wS	4
<u>PEACE</u>	73	<10(S)	wS	6	<u>WHITECOURT</u>	67	<10	wS	6
			1P	6		68	91	cS	1
	73a	<10(S)	1P	6		69	97	wS	1
	74	57	wS	1		70	<10	1P	4
		26	1P	1		72	43	wS	4
	75	71	wS	4					
		92	1P	4					
	76	76	wS	4					
		49	1P	4					
	77	63	wS	4					
	78	<10	wS	4					
			1P	4					
	79	<10	wS	4					

---

\* "S" indicates percentages calculated from survival plots or from recent A.F.S. survival plot records.

TABLE 2.  
COMPARISON OF PINE AND SPRUCE SURVIVAL IN  
ALBERTA DURING 1965, 1967, and 1970

Forest District	1965				1967				1970			
	Pine		Spruce		Pine		Spruce		Pine		Spruce	
	No. <sup>1</sup>	% Surv.	No.	% Surv.	No.	% Surv.	No.	% Surv.	No.	% Surv.	No.	% Surv.
Athabasca	0	0	0	0	0	0	2	17%	1	69%	3	51%
Bow River	5	22%	0	0	0	0	0	0	2	9%*	0	0
Crowsnest	0	0	0	0	0	0	0	0	2	9%	0	0
Edson	2	44%	0	0	0	0	0	0	3	82%	1	60%
Footner	0	0	0	0	0	0	1	86%	0	0	3	71%
Grande Prairie	0	0	1	44%	0	0	0	0	0	0	0	0
Lac La Biche	0	0	1	9%*	0	0	1	9%*	1	9%*	2	9%*
Peace River	1	9%*	0	0	0	0	2	36%	0	0	0	0
Rocky Clearwater	1	55%	1	9%*	7	25%	1	31%	2	84%	3	43%
Slave Lake	1	6%	1	48%	0	0	3	54%	0	0	2	81%
Whitecourt	0	0	1	9%*	1	9%*	0	0	0	0	1	97%
Totals:	10		5		8		10		11		15	
Average % Survival		27%		24%		17%		39%		44%		59%

\* Plantations recorded as "Failures" in Appendix 5 have been assigned a value of 9%.

<sup>1</sup> No. refers to the number of plantations established from which data were usable in the preparation of this table.

TABLE 3  
SUCCESS OF ALBERTA CONTAINER PLANTATIONS  
FOR 1965, 1967 AND 1970

Forest District	No. Plantings Checked			No. Successfully established*			Ratio Success to Failure S:F	Success %
	1965	1967	1970	1965	1967	1970		
Athabasca	0	1	2	0	0	1	1:2	33
Bow River	0	1	1	0	0	1	1:1	50
Crowsnest	0	0	2	0	0	0	0:2	0
Edson	0	0	1	0	0	1	1:0	100
Footner Lake	0	1	0	0	1	0	1:0	100
Grande Prairie	0	0	1	0	0	1	1:0	100
Lac La Biche	1	1	0	0	0	0	0:2	0
Peace River	0	1	0	0	1	0	1:0	100
Rocky Clearwater	0	7	0	0	0	0	0:7	0
Slave Lake	2	0	0	0	0	0	0:2	0
Whitecourt	0	0	0	0	0	0	0:0	0
Alberta Totals	3	12	7	0	2	4	6:16	27%
Success Average				0%	17%	57%		

\* For purposes of this study, a successfully established plantation is one which shows a survival of 60 % or greater.

TABLE 4.

SUCCESS OF ALBERTA

CONVENTIONAL PLANTATIONS FOR 1965, 1967, AND 1970

Forest District	No. Plantings Checked			No. Successfully established*			Ratio Success to Failure	Success %
	1965	1967	1970	1965	1967	1970	S:F	
Athabasca	0	1	2	0	0	1	1:2	33%
Bow River	5	1	3	1	0	0	1:8	11%
Crowsnest	0	1	5	0	0	0	0:6	0%
Edson	2	0	4	1	0	4	5:1	83%
Footner Lake	0	0	3	0	0	2	2:1	67%
Grande Prairie	1	1	1	0	1	1	2:1	67%
Lac La Biche	1	0	3	0	0	0	0:4	0%
Peace River	2	4	1	0	2	0	2:5	28%
Rocky Clearwater	2	2	5	0	0	2	2:7	22%
Slave Lake	0	3	2	0	1	2	3:2	70%
Whitecourt	1	2	2	0	0	2	2:3	40%
Alberta Totals	14	15	31	2	4	14	20:40	33%
Success Average				15%	27%	45%		

\* For purposes of this study, a successfully established plantation is one which shows a survival of 60% or greater.

TABLE 5.

SITE PREPARATION AND RATIO OF SUCCESS\* TO  
FAILURE AND PERCENTAGE SUCCESS FIGURES BY FOREST REGION AND  
YEAR OF PLANTING FOR ALBERTA

A Site Preparation Including Container Plantings

Forest Regions	Prepared			Unprepared		
	1965	1967	1970	1965	1967	1970
	S:F	S:F	S:F	S:F	S:F	S:F
	and % Succ	and % Succ	and % Succ	and % Succ	and % Succ	and % Succ
Foothills Forests	0:2 0%	0:3 0%	2:9 18%	1:4 20%	0:9 0%	1:3 25%
Boreal Forests	0:2 0%	3:1 75%	7:2 78%	0:3 0%	1:8 11%	0:4 0%
Alberta Total	0:4	3:4	9:11	1:7	1:17	1:7
Success Average	0%	43%	45%	12.5%	5.5%	12.5%

B Site Preparation Excluding Container Plantings

Forest Regions	Prepared			Unprepared		
	1965	1967	1970	1965	1967	1970
	S:F	S:F	S:F	S:F	S:F	S:F
	and % Succ	and % Succ	and % Succ	and % Succ	and % Succ	and % Succ
Foothills Forests	0:1 0%	0:1 0%	2:7 22%	1:4 20%	0:3 0%	0:3 0%
Boreal Forests	0:0 0%	2:1 66%	6:1 85%	0:2 0%	1:6 14%	0:4 0%
Alberta Total	0:1	2:2	8:8	1:6	1:9	0:7
Success Average	0%	50%	50%	12.5%	10%	0%

\* Survival of 60% and greater.

TABLE 6.  
RATIO OF SUCCESS TO FAILURE AND PERCENTAGE SUCCESS  
FIGURES FOR CONVENTIONAL AND CONTAINER PLANTED  
STOCK IN MAJOR FOREST REGIONS OF ALBERTA

Forest Regions	Conventional			Total	Container			Total
	1965 S:F and %	1967 S:F and %	1970 S:F and %	S:F and ave %	1965 S:F and %	1967 S:F and %	1970 S:F and %	S:F and ave %
Foothills Forest *	2:7 (22%)	0:4 (0%)	6:11 (35%)	8:22 (27%)	0:0 (0%)	0:8 (0%)	2:2 (50%)	2:10 (16%)
Boreal Forest **	0:5 (0%)	4:7 (36%)	8:6 (57%)	12:18 (40%)	0:3 (0%)	2:2 (50%)	2:1 (67%)	4:6 40%
Alberta Total	2.12 15%	4:11 27%	14:17 45%	20:40 33%	0:3 0%	2:10 16%	4:3 57%	6:16 27%

\* Bow River, Crowsnest, Rocky-Clearwater and Edson Forest Districts.

\*\* Athabasca, Footner Lake, Grande Prairie, Lac La Biche, Peace River, Slave Lake and Whitecourt Forest Districts.



TABLE 7.  
COMPARISON OF THE SUCCESS OF PLANTING TECHNIQUES IN  
ALBERTA MAJOR FOREST REGIONS BY RATIO OF SUCCESS TO FAILURE  
AND THE PERCENTAGE SUCCESS

Forest Region	Method of Planting		
	Hand, conventional	Hand, container	Machine, conventional
	S:F	S:F	S:F
Foothills Forests	7:23 (23%)	2:10 (17%)	1:0 (100%)
Boreal Forests	7:16 (30%)	4:6 (40%)	5:1 (83%)
Alberta Total	14:39	6:16	6:1
Success Average	(47%)	(32%)	(85%)

TABLE 8. EVALUATION OF NORTHWESTERN PULP AND POWER  
COMPANY'S ONTARIO-TYPE TUBE PLANTINGS AT  
HINTON, ALBERTA

SPRUCE				PINE			
Year of Planting	1st Year Survival	3rd Year Survival	5th Year Survival	Year of Planting	1st Year Survival	3rd Year Survival	5th Year Survival
1965	84%	69%	55%	1965	82%	70%	65%
1966	65%	42%		1966	71%	55%	
1967	69%	46%		1967	45%	32%	

Source: Johnson, 1971

TABLE 9. ENCOUNTERED AND RECOGNIZED PROBLEMS IN ALBERTA  
FOREST PLANTATIONS AND RELATIVE FREQUENCIES BY  
FOREST DISTRICT AND OF ALL FORESTS

FOREST DISTRICT	TOTAL NO. OF PLANT'S	SURVEY TECHN. NOT APPLIC-ABLE		SEVERE COM-PETITION ABOVE		SEVERE COMPET- FROM WEEDS		SIGNIFICANT PLANTING ERRORS		POOR SITE PREPARATION		NO SITE PREPARATION		DROUGHT		POOR RECORDS		BROWSE		NOT FOUND AND INACCESSIBLE		POOR PLANTING STOCK REPORTED BY A.F.S.		FIRE AND OTHER		FROST HEAVING		OTHER	
		PLANT'S	% F.D.*	PLANT'S	% F.D.	PLANT'S	% F.D.	PLANT'S	% F.D.	PLANT'S	% F.D.	PLANT'S	% F.D.	PLANT'S	% F.D.	PLANT'S	% F.D.	PLANT'S	% F.D.	PLANT'S	% F.D.	PLANT'S	% F.D.	PLANT'S	% F.D.	PLANT'S	% F.D.	PLANT'S	% F.D.
ATHABASCA	6	4	67	4	67	5	83	3	50	2	33	2	33					2	33										
BOW RIVER	11	9	82			9	82	7	64	6	54	3	27	7	64									1	9	2	18		
CROWSNEST	13	9	69			4	31	3	23	4	31	5	38	2	15	7	54	1	8	4	31	3	23	1	8	2	15		
EDSON	10	6	60	2	20	2	20					2	20			2	20			2	20						5	20	
FOOTNER	7	14																		6	85								
GRANDE PRAIRIE	4																			4	100								
LAC LA BICHE	7	6	85	6	85	6	85			1	14	4	57							1	14	1	14						
PEACE RIVER	8	2	25	5	63	5	63	2	25	2	25					2	25	2	25	1	13								
ROCKY-CLEARWATER	17	10	59	5	29	13	76	6	35	4	24	12	70	2	12	2	12			1	6	1	6			6	35		
SLAVE L.	7	2	29	3	43	4	57	1	14	1	14	2	29			3	43	2	29	2	29			1	14				
WHITECOURT	5	4	67	3	50	5	83			2	33	3	50			3	50	1	17			2	33						
ALL	96	53	55	28	29	53	55	22	23	22	23	35	36	11	11	19	20	8	8	21	22	8	8	3	3	10	10	5	5

\* % OF FOREST DISTRICT PLANTATIONS

in the years 1965, 1967, and 1970. Plantation survival data (Table 1) show the great variation in success of operational planting in those years; from less than 10% to 92% survival.

On a purely arbitrary basis and for purposes of this study, more than 60% survival is considered successful establishment of a plantation 1, 4, or 6 years after planting. Although some mortality extends into the second and third year after planting, it is known that most mortality occurs during the first year (Mr. J. Soos, personal correspondence, 1970).

Included in this presentation are results from plantations which were not surveyed in detail, but for which the Alberta Department of Lands and Forests (A.D.L.F.) provided data recently collected on survival plots established at time of planting. Where such data are presented, the figures, though correct for those plots, should be interpreted with caution. Survival plots are not always representative for the plantation. For example, in such plots, numerous seedling counts have led to reduction of competition by trampling and cleaning.

Complete analysis of data by species was not done because of the limited number of plantations available for analysis and because of the apparent overriding influence of other factors such as site preparation. In Table 2 spruce and pine survival by year and forest district are compared, regardless of factors such as type of planting or site preparation.

Applying the 60% survival criterion to determine the success for all Alberta plantations, 0%, 17%, and 57% of the container and 15%, 27%, and 45% of the conventional plantations were successful for the years 1965, 1967, and 1970 respectively (Table 3 and Table 4).

The sharp increase in the number of successful plantations, for the year 1970, undoubtedly reflects improvements in planting practices such as site preparation (Table 5) and a marked improvement in the quality of storage and shipping of planting stock (Dr. D. Hocking, personal communication, 1972). The percentage success figure for conventional planting stock in the Boreal Forests\* is 13% higher than that for the Foothills Forests\*\* (40% and 27% respectively - see Table 6). In container plantings this difference is 24% (40% and 16% respectively).

A factor contributing to the greater success of conventional plantations in the Boreal Forests is the larger number of recent machine plantings, which were 83% successful in that region. The Foothills region only had one machine planting; it was successful (Table 7).

More severe climatic conditions in the Foothills undoubtedly play a significant role in lower success rates. Percentages in Table 7 include 25 conventional, 7 container, and 6 machine plantings which at the time of the survey in 1971 were only one year old.

Site preparation also played a significant role in improved plantation success, although data for prepared sites include those for which preparation was considered to be inadequate. (Table 5). The success for Alberta plantations, including container plantings, is 0%, 43%, and 45% for prepared sites as opposed to only 13%, 6% and 13% for unprepared sites, for the years 1965, 1967, and 1970, respectively. Eliminating container plantations, the corresponding figures are 0%, 50%, and 50% and 13%, 10%, and 0% for the same years.

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\* Athabasca, Footner Lake, Grande Prairie, Lac La Biche, Peace River, Slave Lake, and Whitecourt Forests.

\*\* Bow River, Crowsnest, Edson, and Rocky Mountain House - Clearwater Forests.

Results of the container planting program carried out by the Northwestern Pulp and Power Co. in the years 1965, 1966, and 1967, are shown in Table 8. The data are based on an investigation of over 7,000 pine and 8,000 spruce seedlings on a variety of sites (Johnson, 1971). Plantations were almost exclusively established on scarified areas. Five year survival rates of 55% for white spruce and 65% for lodgepole pine compare very favorably with plantings established in other Alberta regions.

#### DISCUSSION OF PROBLEMS

From this survey of forest plantations in Alberta, it became evident that biological problems relating to plantation survival were secondary to human errors which appear to have been primarily responsible for predisposing seedlings to stresses to which they eventually succumbed.

High on the list of human errors is the practice of planting in unprepared or poorly prepared sites, and 59% of all Alberta plantations fall into these categories (Table 9). It is not surprising, therefore, that 55% of the appraised plantations are recorded as suffering severely from "weed" competition; the term weed including herbaceous growth up to about 8 ft in height (Table 9). Plantations with heavy slash accumulations are also included. The lack of quality of site preparation also finds expression in the same table under "severe competition from above". This condition includes situations where seedlings appear to be suffering

severely from heavy overstory, which is usually dense aspen or poplar residuals; 29% of all plantations fall under this category (Table 9) and some of these may also have been included under "severe weed competition" as both conditions were present. In container plantations with very small seedlings, the effect of leaf smothering was obvious when competition from above was severe.

The survey method as outlined earlier could not be applied to 55% of all Alberta plantations. The main reason for the large proportion is the high mortality on heavily weed-infested areas. Only a few planted seedlings could be found and the task of locating rows was impossible. Planting in very irregular rows or spots and faulty recording of locations where planting had been undertaken contributed to difficulties in applying survey techniques. Variations such as superimposed treatments (i.e. fill-in with identical stock or seeding prior to or after planting) or establishment of natural regeneration sometimes appeared heavy enough to render large areas fully stocked although planting projects under appraisal were failures.

Although serious planting errors may not be detected in a year or more after planting, faulty planting has been noted and appears to be significant in certain forests (Table 9). Poor planting, where noted included such practices as:

1. planting too deep or too shallow either by hand or machine,
2. planting too loose: without adequate soil compaction,
3. planting in heavy slash or deep duff or under heavy overstory,
4. planting at irregular spacing for no apparent reason.

5. planting along roads only and not over the entire area as indicated in records,
6. planting of stock in areas where natural regeneration was indicated as sufficiently existent at time of planting.

The northern section of the Province is often plagued by high rabbit populations which cause severe mortality in pine and heavy damage in spruce plantations. These problems appear to be associated with areas where ideal shelter and browse conditions exist, such as in plantations with heavy grass cover, dense aspen sucker growth, heavy slash, or windrows. While some damage can still be expected in the coming years, rabbit populations were at the peak of their ten-year cycle in the past year (Mr. E. Telfer, personal correspondence, 1972).

A relatively large number of plantations were either inaccessible because of terrain or were not found. Poor records contributed significantly to the latter problem.

Determination of the quality of planting stock used was of course impossible. The column "Poor planting stock" in Table 9 was added because poor quality was mentioned on occasion by field office personnel or it was found in notes of existing plantation records. The reported problems ranged from dried out flushed seedlings to severely moulded and poorly graded planting stock. It may be stressed, that these conditions are generally referred to in discussions relating to plantations established in the years 1965 and 1967.

In Table 9, the column "Fire and Other" refers to two plantations destroyed by fire in addition to one severely damaged in a pipeline construction project.



The problem of frost heaving is generally associated with container plantations. Planting in mineral soil, normally necessary for successful planting operations, increased mortality of container stock in rigid tubes through frost heaving on practically all sites.

Plantations recorded in Table 9 under "other" are those which were not appraised because of heavy snow cover at the time of the survey in the Edson and Grande Prairie districts.

### CONCLUSION

Results from the appraisal clearly show that most past planting programs in Alberta have not been successful. There is sufficient evidence to draw the conclusion that biological problems are not the main reason for high mortality.

Careful planning, especially in site selection, and increased attention to improved site preparation combined with higher standards in quality of planting stock and early spring planting could prevent much of the mortality. Co-ordination of the planting program between agencies involved (for supply, handling, and planting of stock) should be streamlined to maximize the chances of success for the ultimate product: the surviving vigorous seedling. The overall planting policy must be directed towards doing "what ought to be done" rather than doing what appears most satisfactory at present in terms of area planted, convenience of operations, and cost involved.

An objective evaluation must become an integral part of all future operations, so that errors can be detected immediately and corrected.

The keeping of high quality records is essential for this purpose, particularly in an era of frequent transfer of personnel.

The many failures associated with rigid container planted stock have already been widely recognized and data in the present report only support earlier observations by individuals of various agencies.

Trials conducted with "plug" planting stock appear very promising at present. Just how successful the program will become at operational levels remains to be proven. Good sites and site preparation associated with high standards in seedling quality and planting procedure can be expected to yield vastly improved results for the new program.

#### SASKATCHEWAN

In Saskatchewan, the primary role of the silvicultural section of the Forestry Branch of the Department of Natural Resources is that of providing a continuing program of reforestation and afforestation.

The "Northern Reforestation Unit" activities centre around operation of the provincial tree nurseries and reforestation through planting, scarification, and/or seeding of burnt and cut-over areas and abandoned farm land (Anon. 1971). The four administrative Regions are: Prince Albert, Meadow Lake, Hudson Bay, and the Northern. The "Southern Afforestation Unit" is mainly involved in activities which are implied in its name; more specifically in the distribution of planting stock in southern Saskatchewan, recommendations for tree planting on recreational sites, and in the conduct of recreational tree planting projects.

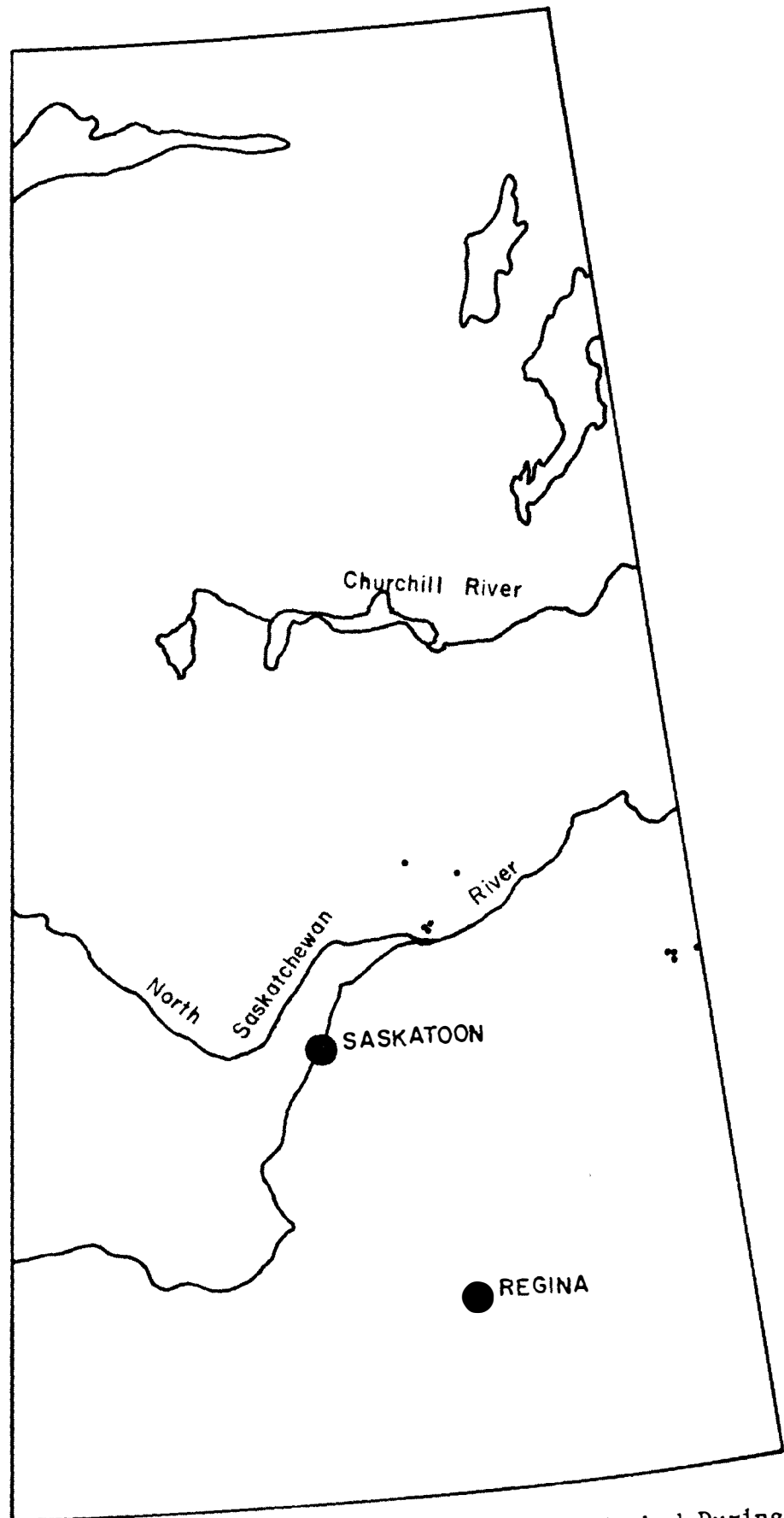


Fig.2. Location of Saskatchewan Forest Plantations Established During 1965, 1967, and 1970, and Appraised in 1971.

In the Northern Reforestation Unit, some special agreements concerning reforestation on cut-over areas were made between the Saskatchewan Government and some wood-using industries, the largest being the Prince Albert Pulp Company, Saskatchewan Pulpwood Limited, Simpson Timber Company, and MacMillan Bloedel Limited.

One such special agreement in essence states that the company will be responsible for the reforestation of 10% of its cut-over area per year, provided that after 5 years natural regeneration has not reached the minimum standards established by the Saskatchewan Government.

According to another special agreement the Government will be responsible for the execution of reforestation programs on that company's cutover areas and it will be compensated at a rate of \$0.20 per cord or \$40,000, whichever is the greater (Mr.J.Soos, personal correspondence, 1972).

To date, a total of some 13 million trees have been planted in Saskatchewan's provincial forests, and since 1964 there have been two provincial nurseries in operation. The production of coniferous seedlings in 1971 amounted to 1,250,000. It is planned that this production will be expanded to 4,350,000 by 1973; 5,340,000 by 1974 and to 7,000,000 by 1977. The two nurseries have a current capacity to produce 20 million conifer seedlings annually; the production of container grown stock is considered to be almost unlimited (Anon., 1971). Most of the present and future production is and will be white spruce with some jack pine and a small amount of black spruce.

Container planting in Saskatchewan has remained on a trial basis since 1967. Since then, about 100,000 container grown seedlings

have been planted annually. Numerous failures associated with the split styrene or "Ontario type tube" led to the start of "plug" planting on a trial basis in 1971. If it proves successful, expansion of this program is anticipated.

RESULTS AND DISCUSSION OF PROBLEMS

Tree planting operations for the period under review in Saskatchewan's forests are concentrated in the Prince Albert and Hudson Bay Regions. Table 10 shows the total number of seedlings shipped for reforestation and afforestation projects and figures include some hardwood and shrub species which were utilized in recreational plantings of the Province.

TABLE 10.

TOTAL NUMBER OF SEEDLINGS SHIPPED FROM PROVINCIAL NURSERIES IN SASKATCHEWAN  
DURING 1965, 1967, AND 1970.

NURSERY	TYPE	1965	1967	1970
Big River	Conventional Container	584,264	387,000	713,000
Prince Albert	Conventional	25,000	772,975	1,537,500
		197,620*		185,155**
	Container	-	93,500	100,000

\* Hardwood rooted cuttings

\*\* Species for recreational plantings

Source: D.N.R. Annual Reports

Of the nine forest plantations which were to be appraised, two proved inaccessible; one of which was reported to be a failure (#9) presumably the result of very poor planting, and excessive competition.

TABLE 11  
SURVIVAL OF PLANTED SEEDLINGS IN  
SOME SASKATCHEWAN FOREST PLANTATIONS

FOREST REGION	Plantation No.	Survival %	Species	Plantation Age
<u>PRINCE ALBERT</u>	1	62	jP	1
	2	48	jP	1
	3	24	jP	1
	4	80 (H)*	wS jP	1
<u>HUDSON BAY</u>	6	<10	wS	4
	7	<10	wS	4
	8	84 (S)**	wS	1
	9	<10	wS	6

\* Survival tally on haul roads and skid trails only

\*\* Survival tally on survival plots only

Although climatic and edaphic conditions have in some plantations led to failure, the practice of planting on unprepared sites with resulting severe competition, has undoubtedly contributed significantly to the performance of plantations in Saskatchewan.

Table 12 shows that six out of eight plantations for which data were available appear to have suffered severely from vegetative competition. Four out of these eight plantations have been damaged by drought.

TABLE 12  
SUMMARY OF ENCOUNTERED PROBLEMS IN PLANTATIONS ESTABLISHED IN SASKATCHEWAN  
DURING 1965, 1967, AND 1970

Type of Problem	Plantation Number
Drought	1, 2, 3, 6
Rabbits	1
Wind erosion	3
Competition	2, 4, 6, 7, 8, 9*
Smothering	7
Flooding	8
Poor planting*	9
Inaccessible	5, 9

\* D.N.R. reported

The quality of planting stock at the time of planting could not be determined. Some plantation records show that the 3 - 0 stock in particular was very small and difficult to plant by machine. It is indicated that early survival of 3 - 0 stock was greatly reduced when compared with conventional 2 - 2 stock.

Although irregular spacing was observed more frequently there was insignificant evidence of poor planting otherwise.

For the majority of plantations, there are excellent plantation



records available. The notes not only include maps, but also such pertinent data as number of planters and daily production, weather and ground conditions during and after planting, size and general quality of planting stock, notes on transportation of seedlings and hold-over or heeling-in procedures etc. In addition to the above information, data frequently include first year survival figures from a number of survival plots in which each seedling was staked. The preparation of such plantation records should become routine procedure for all plantations established. To simplify the method, a standard form providing pertinent information could be introduced (Appendix VIII).

#### CONCLUSION

Forest plantation projects of recent years have been largely unsuccessful in Saskatchewan. Climatic and soil conditions combined with the practice of planting on unprepared sites, resulting in excessive competition, are the factors believed to be primarily responsible for high mortality rates.

The selection of good quality sites combined with superior site treatment could increase the survival rates substantially. The discontinuation of rigid wall container and the beginning of "plug" planting - where combined with proper site selection and treatment - is likely to increase the success of planting programs to a large degree.

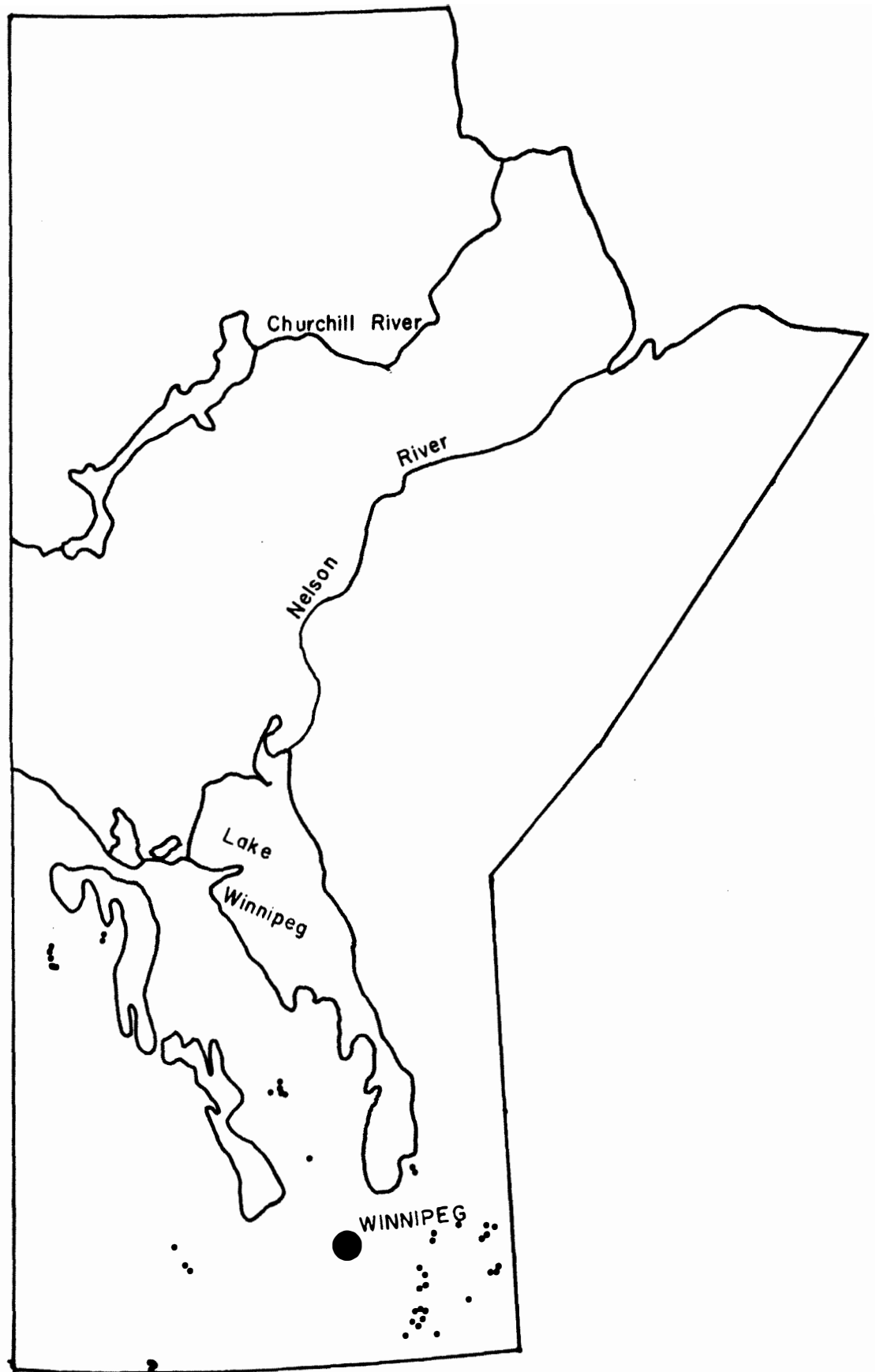


Fig.3. Location of Manitoba Forest Plantations Established During 1967, 1968, and 1970, and Appraised in 1971.

MANITOBA

Provincial forest lands in Manitoba are managed by the Resources Management Division of the Department of Mines, Resources and Environmental Management. The field work aspects of management of Provincial Parks are being carried out by the Parks Branch of the Department of Tourism, Recreation and Cultural Affairs. The Resources Management Division is divided into the Northern, Eastern, Southern, and Western Regions, in addition to the Development and Extension Service.

The history of tree planting in Manitoba's forests dates back to 1904. Planting was considered experimental to the early 1930's. An operational program in that era was initiated and largely concentrated in the Spruce Woods, Turtle Mountain, Duck Mountain, and Porcupine Mountain Forest Reserves. More recent planting programs are those concentrated in the Southern, Eastern, and Western Regions, including the Whiteshell and Spruce Woods Provincial Parks.

The mainstay of Manitoba's forest economy since 1965 rests with small companies operating under the quota system of timber disposal. Unlike the situation in Alberta, the responsibility for reforestation of cut-over lands rests with the Province.

The Abitibi Manitoba Paper Company, one of two large lease-holders on provincial Crown land is required to carry out their cutting operations on a sustained yield basis. There is no specific agreement with respect to reforestation on the lease holding.

The other large lease holder, Churchill Forest Industries has a written agreement wherein it is stated that the responsibility for reforestation of cut-overs rests with the Provincial Government.

Overall, the Resources Management Division ensures that certain standards in cutting operations, which will facilitate reforestation, are adhered to.

To the year 1959, 15½ million trees had been planted since 1904 (Webster, 1959). Several small nurseries existed to supply the stock for various small planting programs. Today, all tree seedling production is centralized in the "Pineland" Provincial Tree Nursery at Hadashville, which has a capacity of growing up to 12 million conventional seedlings annually. Data presented in Table 13 indicate the trend of tree planting in Manitoba.

TABLE 13.

TREE PLANTING IN MANITOBA FROM 1960 TO 1971

Year	No. of seedlings planted	Year	No. of seedlings planted
1960	convent.* 1,149,000	1967	convent. 2,579,000
1961	convent. 732,000	1968	convent. 4,854,000
1962	convent. 2,010,000	1969	convent. 6,000,000
1963	convent. 2,946,000		contain.** 100,000
1964	convent. 2,533,000	1970	convent. 5,500,000
1965	convent.		contain. 120,000
1966	convent. 3,628,000	1971	convent. 4,700,000
			contain. 80,000

Source: Dept. of Mines and Nat. Res. Annual Reports; L.D. Nairn  
personal correspondence, 1972.

\* Conventional bare rooted

\*\* Container

Provincial forestry practice in pre-planting site preparation has changed significantly since 1966. The operational changes over the recent years made the appraisal of plantations established in 1965 unsuitable with respect to present day practices. Eliminated from the appraisal also were those 1967 plantations which were either severely damaged or destroyed in the unusually extreme drought year of 1967 or those which were established by techniques now considered outdated. Instead, some plantations established in 1968 were appraised to better evaluate the success of current operational planting methods.

Container planting in Manitoba began in 1969 and is still in the trial stage. Trials now predominantly involve (bio-degradable) paper container grown stock and an increase in the production is expected to produce stock for operational planting on a broad scale. Container plantations in Manitoba were not appraised in this survey.

#### RESULTS AND DISCUSSION OF PROBLEMS

The appraisal of recent plantations in Manitoba included 11%, 47%, and 62% of all conventionally planted seedlings for the years 1967, 1968, and 1970 respectively. Although some plantations failed completely, the success generally is satisfactory and in several areas it is outstanding.

TABLE 14.

SURVIVAL OF PLANTED SEEDLINGS IN SOME  
MANITOBA FOREST PLANTATIONS

Region of Area	Plantation No.	Survival %	Species	Plantation Age
SOUTHERN REGION				
Sandilands	1	78	wS	4
		67	jP	
		37	rP	
	2	85	jP	3
	3	88	jP	3
	4	83	jP	3
	5	90	jP	1
	6	87	jP	1
	7	89	jP	1
	8	97	jP	1
	8a	96	jP	1
	9	91	jP	1
	10	86	jP	1
	11	56	jP	1
			rP	1
	12	57	jP	1
	13	58	jP	1
			rP	1
	14	98	wS	1
			wS	3
	14a	92	rP	3
Agassiz	15	83	jP	3
	16	77	jP	1
Turtle Mountain Prov. Park	25	67	wS	3
Spruce Woods Prov. Park	27	<10	wS	1
	28	65	jP	1
	29	85	jP	1
WESTERN REGION				
	30	76	jP	3
	31	41	wS	1
	32	68	wS	1
		84	jP	1
	33	<10	jP	1
	34	<10	jP	1
	35	79	wS	3

TABLE 14. (Continued)

SURVIVAL OF PLANTED SEEDLINGS IN SOME  
MANITOBA FOREST PLANTATIONS

Region of Area	Plantation No.	Survival %	Species	Plantation Age
EASTERN REGION	36	92	wS	1
	37	60	rP	3
	38	42	wS	1
	39	26	wS	1
	40	12	wS	1
	41	58	wS	1
	42	92	wS	3
	43	91	wS	3
Whiteshell Prov. Park	17	91	jP	3
	18	89	jP	3
			rP	
	19	89	wS	3
	20	83	jP	3
	21	76	jP	1
	22	95	jP	1
		96	rP	
		93	wS	
	23	<10	ws	1



TABLE 15.

SURVIVAL OF SPRING AND FALL PLANTED SEEDLINGS BY AREA AND SPECIES FOR  
MANITOBA FOREST PLANTATIONS

A: SPRING PLANTED

Region and Area	<u>YEAR OF ESTABLISHMENT</u>								
	1967			1968			1970		
	jP	wS	rP	jP	wS	rP	jP	wS	rP
	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %
Southern									
Sandilands	1 67	1 78	1 37	3 85	1 98	1 92	7 89	- -	- -
Agassiz	- -	- -	- -	1 83	- -	1 77	- -	- -	- -
Turtle Mt.	- -	1 9	- -	- -	1 67	- -	- -	- -	- -
Spruce Wds.	- -	- -	- -	- -	- -	- -	2 75	1 9	- -
Western	- -	- -	- -	1 76	1 79	- -	1 84	2 57	- -
Eastern	- -	- -	- -	- -	1 92	- -	- -	3 53	- -
Whiteshell	- -	- -	- -	2 87	1 -	- -	1 95	1 96	1 93
Total Number	1	2	1	7	4	2	11	7	1
Avg. Survival %	67	44	37	83	88	84	86	54	93

Avg. Survival all species

71%

TABLE 15. (Continued)

SURVIVAL OF SPRING AND FALL PLANTED SEEDLINGS BY AREA AND SPECIES FOR  
MANITOBA FOREST PLANTATIONS

B. FALL PLANTED

Region and Area	<u>YEAR OF ESTABLISHMENT</u>								
	1967			1968			1970		
	jP	wS	rP	jP	wS	rP	jP	wS	rP
	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %
Southern									
Sandilands	- -	- -	- -	- -	- -	- -	1 57	- -	- -
Agassiz	- -	- -	- -	- -	- -	- -	- -	- -	- -
Whiteshell	- -	- -	- -	- -	1 89	- -	2 42	- -	- -
Turtle Mt.	- -	- -	- -	- -	- -	- -	- -	- -	- -
Spruce Wds.	- -	- -	- -	- -	- -	- -	- -	- -	- -
Western	- -	- -	- -	- -	- -	- -	2 3	- -	- -
Eastern	- -	- -	- -	- -	1 91	1 60	- -	- -	1 12
Total Number	- -	- -	- -	- -	2 -	1 -	5 -	- -	1 -
Avg. Survival %	-	-	-	-	90	60	30	-	12

Avg. Survival all species

47%

TABLE 16.

NUMBERS OF CONVENTIONAL PLANTATIONS APPRAISED, RATIOS OF SUCCESS TO FAILURE, AND PERCENTAGES OF SUCCESS DURING 1967, 1968, AND 1970 IN MANITOBA

Region and Area	No. of Plantings Checked			No. Successful (60%+)			Ratio Success Failure*	% Success
	1967	1968	1970	1967	1968	1970		
Southern								
Sandilands	1	5	10	1	5	7	13:3	81
Agassiz	-	1	1	-	1	1	2:0	100
Turtle Mtn.	1	1	1	-	1	-	1:2	33
Spruce Woods	-	-	3	-	-	2	2:1	67
Western	-	2	4	-	2	1	3:3	50
Eastern	-	3	5	-	3	1	4:4	50
Whiteshell	-	4	3	-	4	2	6:1	86
TOTALS	2	16	27	1	16	14	31:14	69%

\* For purposes of this presentation any plantation showing a survival rate of less than 60% has been classed as a failure.

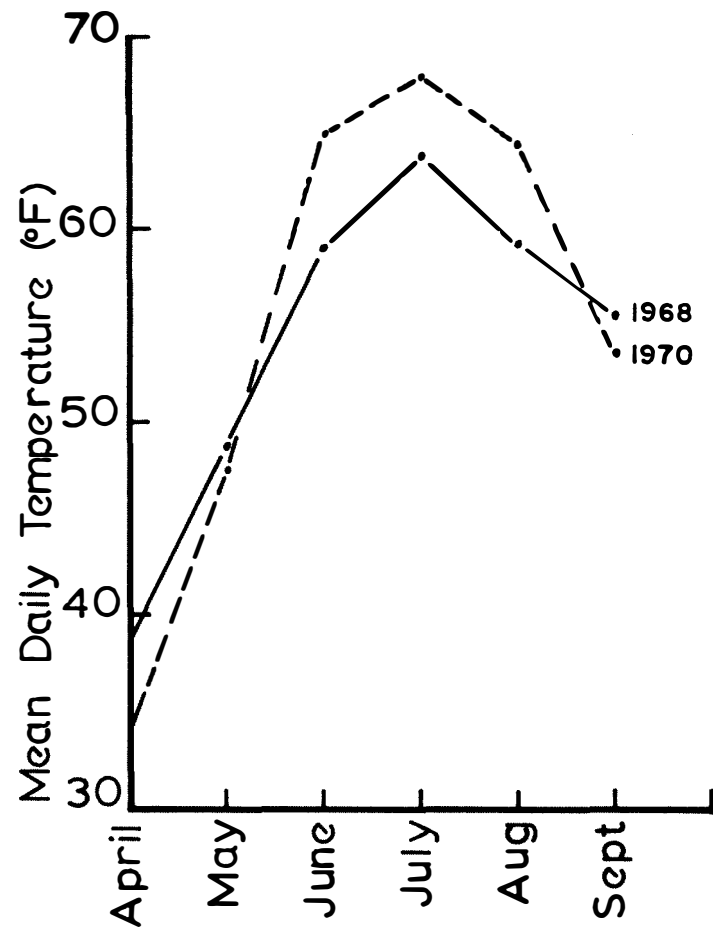
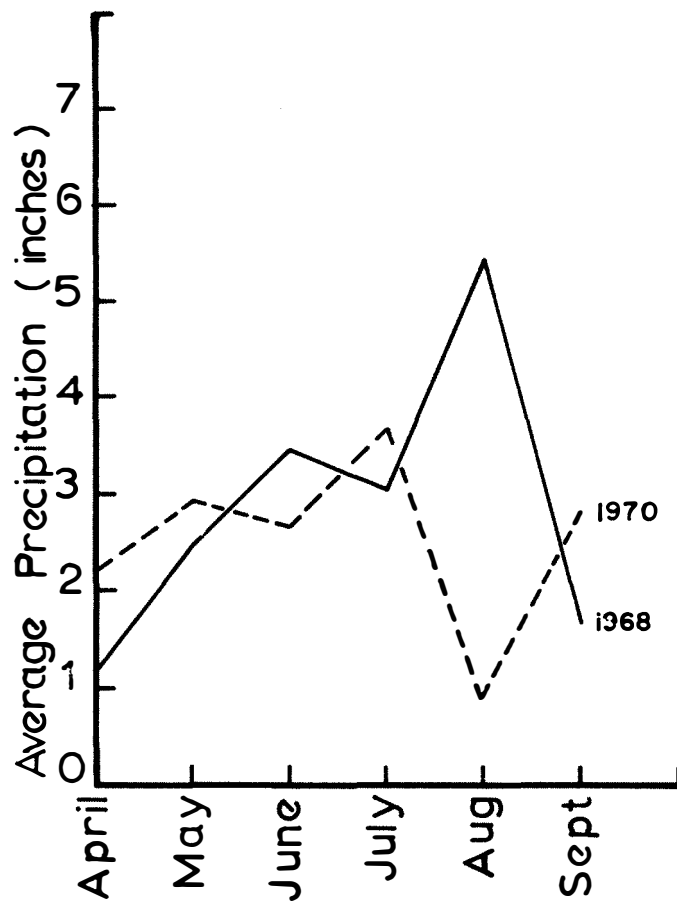


Fig.4. Average monthly mean temperature and rainfall for the 1968 and 1970 growing seasons in some selected forest areas of Manitoba (Source: Canada Department of Transport Monthly Records).

Fall plantings on the average have yielded only 47% survival while spring planting resulted in an average survival of 71% (Table 15).

Accepting a 60% or higher survival figure as being a success for any spring or fall plantation 1, 3, or 4 years old, Table 16 shows the ratio of success to failure and the average success in percentages, for Manitoba areas. The success of plantations established in 1968 has been outstanding; all 16 plantations appraised (100%) were classed as successes. Only 14 of 27 (52%) plantations established in 1970 could be classed as successful after only one growing period. The reasons for this significant difference are believed to be climatic. Fig. 4 shows average mean temperatures and precipitation for the first growing season of seedlings planted in 1968 and 1970. Although the seasonal averages do not provide any clues, the distribution of the precipitation and average temperature shows that in the latter part of the growing season of 1970 drought conditions with low precipitation and higher temperatures prevailed. Conditions in 1968 were more favorable (Fig.4).

The need for site preparation before planting has now been recognized in Manitoba. Based on the appraisal of 16 plantations established in 1968, five (31%) received no site treatment prior to planting. For 26 plantations established in 1970, the corresponding figure dropped to five (19%) plantations without site treatment. Burning, chopping and barreling, and dozer stripping are the site preparation techniques most frequently employed. Although the various methods have been carried out with varying degrees of adequacy, generally they must be said to have given satisfactory results in exposing mineral soil and eliminating

competition. Only on some difficult sites - those with shallow and rocky soil or very dense overstory and competition - was the quality found to be greatly reduced. At times, poor site preparation resulted in poor planting, but usually it led to increased competition by species such as aspen, poplar, hazel, willow, and grasses and many other annual or perennial herbs and shrubs as a result of the minor disturbance.

For many of the areas visited, good plantation records were available, although some desirable information was missing for some. Standardization of reporting would be useful as it could lead to a better analysis of problems in the future. The recording form such as outlined in Appendix VIII could encourage the follow-up of each plantation project. The practice of placing plantation markers within each plantation has been found to be very useful. It informs the visitor of size of the area, the number and type of seedlings planted, the date of planting and the details of any fill-in operations.

The following are comments relating to conditions and problems found in plantations of the forest areas visited in Manitoba.

#### SOUTHERN REGION

##### Sandilands

Most of the plantations in the Sandilands show very satisfactory survival rates. Notable exceptions are the fall plantings.

The mortality which has occurred appears to be largely the result of drought rather than other factors. Competition ratings are generally low, although some localized areas deviate from this considerably.

Even in areas of higher competition, seedlings appear vigorous with some reduction of survival generally. Grasses are the main competitor in the region. On moist sites, willows, aspen suckers, and ferns along with other shrubs and grasses offer some competition for young seedlings where the site preparation was partially successful only.

While planting appears to have been carried out well, there was some evidence of poor planting in plantation #13 where deep planting may have contributed to mortality to a higher degree.

Fall plantings appear to have suffered from drought more than spring plantings. This is also demonstrated in plantation #13. Survival at the southern portion, where moisture conditions are more favorable, was significantly higher than in the remaining portion of that plantation.

In plantation #1 red pine seedlings planted on gravel have suffered from drought more severely than jack pine. Spruce, planted in the lower lying more moist portions of that plantation, show satisfactory survival.

Records for plantations established during recent years in the Sandilands are excellent.

#### Agassiz

Survival figures for the two plantations in this area alone would indicate success of the projects. Weeds and extremely heavy brush competition made an accurate appraisal difficult. Where competition is extreme and where site preparation was carried out poorly, there is no evidence of planting. Jack pines planted in well prepared ground in

plantation #15 are very satisfactory. Scots pine planted in the area at some other time have been browsed heavily by rabbits and are in generally poor condition. Surviving scattered red pine seedlings show good vigour and growth. Problems in plantation #16 are similar in nature. Severe browse damage from rabbits was observed on jack pine seedlings. Competition and drought on coarse textured soils appear to constitute the major problems leading to mortality in the Agassiz area.

#### Turtle Mountain Provincial Park

Plantation 24 could not be appraised because of fill in operations undertaken in 1968. Current survival, considering stock planted in 1967 and 1968, shows 56% with heavy competition.

Plantation 25, composed of 2 distinct areas (grassland and cut bloc) and loamy sites, was found to be suffering from heavy competition. Drought and competition are believed to be the main factors responsible for mortality. Remaining seedlings are in healthy and vigorous condition.

Plantation 26 situated in an area of difficult and dry sites could not be appraised because of heavy competition and distances of 60 to 100 ft between located seedlings forced the abandonment of this project. Bulldozer strips frequently exposed granite and limestone rock. Planting problems and drought appear to be the reasons for poor and spotty survival which in addition was lightly damaged by rabbit browsing.

#### Spruce Woods Provincial Park

Plantation 27, established in an abandoned farm field with remaining heavy alfalfa was a complete failure. The site, a moderately dry silt loam soil showing a pH reading of 7.0 and in combination with



alfalfa can be regarded as "off site" for the planting of spruce even if normal precipitation should occur during the first growing season. This plantation reportedly was affected by a drought period in its year of establishment after which survival was recorded as 45%.

Mortality on plantation 28 was found to be mainly due to drought. Survival in numerous plots on north facing slopes ranged from 90 to 100%. South and southwestern aspects or exposures and the top of knolls showed a distinctly higher mortality. Grasses and herbs offered a moderate degree of competition to the plantation.

Plantation 29 located on a dry site of fine sand (pH 7.0) shows good survival (85%). A survival count by species (jack pine and scots pine mixed) was not possible. Although competition from weeds was only light (mostly annual weeds and quack grass) about 50% of the surviving seedlings appeared damaged by rabbit or rodent browsing.

#### WESTERN REGION

Plantations in the Western Region are largely aimed at stand conversions. The method of dozer stripping appears to be partially successful in eliminating the generally heavy competition from aspen, poplar, hazel, willow and herbs and grasses. Where good success has been achieved, it has occasionally left strips or parts thereof in a pavement-like condition. In plantation 30, two methods of site preparation were used. In the open area of the plantation, which was burned over in 1961, planting in furrows yielded 68% success while in the moderately tree covered area planting in

dozer strips resulted in 86% survival.

Although located closely together the fall plantings (#33 and #34) showed marked differences in density of vegetation cover, both plantations are complete failures believed to be the result of drought conditions on the fine sandy soil.

Irregular planting was noted in plantation 32, but this may have been necessary because of the inadequately bulldozed strips.

Damage from browsing by rabbits was general in plantations of this region; the degree of damage varying from light to severe. Mortality as a result of browsing now is not highly significant, but it can be expected to increase should seedlings be attacked consecutively for a number of years.

#### EASTERN REGION

Plantations in this region with exception of the Whiteshell area are largely stand conversions from aspen to spruce on cut-over or burned-over areas. On generally level terrain, the very shallow calcareous soils with rock outcrops and boulders appear to have made site preparation and planting very difficult. During even short periods of drought, seedlings are adversely affected and severe competition is believed to be aggravating the problems of mortality. Discing (plantation 40) is shown ineffective for good site preparation. On heavier soils, seedlings planted in depressions were found to be killed presumably by drowning.

Poor planting evidenced occasionally is largely due to planting on rocky and shallow soils where roots of seedlings were not adequately covered or where the roots were forced into a shallow hole (hockey stick)

or where they were planted too deep, conditions permitting.

Rabbit damage in the area was general and ranged from light (plantations 39 and 42) to severe (plantations 41 and 38).

Fall planting for the area cannot be recommended even though plantation 43 shows outstanding results. The planting of bare rooted stock in the fall is believed to be very risky.

#### Whiteshell Provincial Park

The generally excellent survival largely reflects good site preparation and planting. Soils vary greatly between and within plantations. Rock outcroppings are frequent in several areas and planters generally succeeded in avoiding shallow ground. Competition density and species vary with soil depth and texture and is heaviest on the deeper finer textured and moist sites. Aspen, poplar and willow suckers, alder, ferns and grasses offer the highest degree of competition in the Whiteshell plantations.

Rabbit damage was noted in plantations 21 and 22. Records for plantation 21 were inconsistent with observation in that jack pine rather than white spruce was the planted species.

Plantation 23 completely failed. While bedrock was frequently exposed, the characteristics of the soil were those of a moist and wet clay site. Poor planting, evidenced in form of exposed or semi-exposed roots was generally noted. In addition, there was extremely heavy competition from aspen and poplar suckers.

### CONCLUSION

Spring planting programs in Manitoba's forests must be considered successful because 71% of all seedlings planted over a great variety of sites are surviving. Fall planting in contrast is unsuccessful as only 47% of the seedlings planted in autumn survived.

Climatic drought and notably in 1970, is considered the most outstanding reason for mortality. Several factors may interact to result in fatal moisture deficits. In periods during which soil moisture approaches critical levels, competition will effectively withdraw the last moisture reserves available for the planted seedling which is frequently in a weakened condition. Soil texture, its depth, the waterholding capacity of the soil profile, the depth to the water table, seedling quality and condition, and the quality of planting itself are all significant factors which, when unfavorable can lead to severe mortality by drought.

Damage from browsing by rabbits is substantial, particularly in plantations of the Western and Eastern Regions. So far, mortality has not been highly significant, but it can be expected to increase rapidly should the high population persist for 1971-1972.

In Manitoba poor planting was noted very infrequently. Losses due to faulty planting are believed to be minimal although it is a factor difficult to assess. The condition and quality of planting stock, at time of planting, could not be determined. Records do not indicate any shortcomings.

There is an awareness of the problems associated with fall planting. The current trend is to eliminate fall planting, but for

operational reasons, this goal has not been achieved. It is hoped that the use of "plug" type container grown seedlings will facilitate a prolonged spring planting period. This technique when fully operational can make the risky fall planting unnecessary. Early trials with "plug" seedlings grown in "Japanese paper pots" are said to show good promise (Gilmore, 1972).

Biological problems from insects or disease were found to be very minor in nature and could be discounted in considerations of causes for mortality of seedlings in Manitoba plantations.

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Thanks are also given to the numerous staff members of provincial agencies involved who provided information and assistance and made the project far easier to complete.

K. Froning.

# APPENDIX I

EXAMPLE FOR THE CALCULATION OF THE TOTAL NUMBER OF SAMPLE PLOTS REQUIRED TO PROVIDE A SURVIVAL ESTIMATE WITH AN ALLOWABLE STANDARD ERROR NOT GREATER THAN  $\pm 10\%$  OF THE CALCULATED MEAN AT A PROBABILITY LEVEL OF 90%.

A clearcut and planted area is to be sampled for survival of planted seedlings.

Randomly distributed, ten sampling plots gave the following results (from ten seedlings per plot).

Surviving:

Plot #	$X_i$	$X_i^2$
1	9	81
2	8	64
3	8	64
4	8	64
5	7	49
6	7	49
7	6	36
8	2	4
9	4	16
10	8	64

$$\sum X_i = 67 \quad \sum X_i^2 = 491$$

$X_i$  = individual observations

$\sum$  = the sum of

$n$  = the number of observations (samples)

$$= 10$$

$d$  = the half width of the confidence interval

$$= 0.10\bar{X}$$

$t_i = t_{C,1}$  with 10 - 1 or 9 d.f.

$$= 1.83$$

$$\text{Substituting in: } n_2 = \frac{t_i^2 S^2}{d^2}$$

$$= \frac{(1.83)^2 (4.6)}{[(0.10) (6.7)]^2}$$

$$= 34.2$$

$n_2$  or the number of plots required in this area equals 35 plots.

$$\text{Mean } (\bar{X}) = \frac{\sum X_i}{n}$$

$$= \frac{67}{10}$$

$$\bar{X} = 6.7$$

$$\text{Variance } S^2 = \frac{\sum X_i^2 - \frac{(\sum X_i)^2}{n}}{n - 1}$$

$$= \frac{491 - \frac{(67)^2}{10}}{9}$$

$$S^2 = 4.6$$



## APPENDIX II

### IDENTIFICATION OF SOIL MOISTURE CLASSES

Class	Definition	Description
1	Very dry	Very loose; sand dunes and coarse gravelly and sandy deposits; stable rapid to excessive drainage.
2	Moderate	Medium textured soils, friable, no marked or slight mottling; moderately to imperfectly drained.
3	Moist	Medium to fine textures; mottles common and easily recognizable, poorly drained.
4	Wet	Usually finer textures; mottles abundant, gleying intense; very poorly drained; bogs.

### IDENTIFICATION OF SOIL TEXTURAL CLASSES

Abbreviation	Texture	Description
V C	Very coarse	Sands - coarse, medium, fine and loamy sands
C	Coarse	Sandy loams
M	Medium	Loams, silt loams
M F	Moderately fine	Clay loams, silty clay loams
F or V F	Fine to very fine	Clays and heavy clays

APPENDIX III

TYPE OF PLANTING AND NUMBER OF ACRES PLANTED IN ALBERTA FOREST DISTRICTS  
DURING 1965, 1967, AND 1970

Forest District	Type	A C R E S		
		1965	1967	1970
ATHABASCA	Conventional		92	24
	Container		12	160
	Mixed			49
BOW RIVER	Conventional	158	84	280
	Container		18	64
CROWSNEST	Conventional		38	475
	Container			370
	Unknown		103	
EDSON	Conventional	148	204	235
	Container			60
FOOTNER LAKE	Conventional			263
	Container		167	
GRANDE PRAIRIE	Conventional	116	190	389
	Container			109
LAC LA BICHE	Conventional	80	142	54
	Container	17	12	
PEACE RIVER	Conventional	46	243	150
	Container		18	
ROCKY CLEARWATER	Conventional	220	187	383
	Container		251	
SLAVE LAKE	Conventional		158	348
	Container	60		
WHITECOURT	Conventional	32	134	299
	Container		12	
TOTAL	Conventional	800	1,472	2,900
	Container	77	490	763
	Unknown		103	
	Mixed			48
GRAND TOTAL		877	2,065	3,712

Source: A.F.S. Annual Reports

# APPENDIX IV

## ENCOUNTERED AND RECOGNIZED PROBLEMS IN ALBERTA PLANTATIONS BY FOREST DISTRICT AND PLANTATION NUMBER\*

FOREST DISTRICT	NUMBER OF PLANTATIONS	SURVEY TECHNIQUE NOT APPLICABLE	SEVERE COMPETITION ABOVE	SEVERE COMPETITION FROM WEEDS	SIGNIFICANT PLANTING ERRORS	POOR SITE PREPARATION	NO SITE PREPARATION	DROUGHT	POOR RECORDS	BROWSE	NOT FOUND AND INACCESSIBLE	POOR PLANTING STOCK (REPORTED BY A.S.F.)	FIRE AND OTHER	FROST HEAVING	OTHER
ATHABASCA	6	1,2,3,4b	1,2,3,4a	1,2,3,4a,4b	1,3,4b	3,4a	1,2			1,4					
BOW RIVER	11	5,7,8,9,10,11,12,14,15		5,6,7,9,10,11,12,14,15	5,6,8,9**,10,11,12	7,8,10,11,12	5,6,9	5,7,8,10,13,14,15					13	13,15	
CROWSNEST	13	16,17,18,23,24,25,27,28		16,17,18,27	17,27,28	20,24,25,27	16,17,18,21,22,26,28	23,25	16,17,18,21,22,26,28	18	19,20,21,22,26	21**,24**,25**	23	20,27	
EDSON	10	30	29,30,	29,30			29,30		31A,31B		31A,31B				31C,31D,31E,31F,31G
FOOTNER LAKE	7	32							32,33A,33B,33C,33D		32,33A,				

\* Refers to Numbers Assigned in Appendix V.

\*\* Reported by A.F.S.

APPENDIX IV (Continued)

FOREST DISTRICT	NUMBER OF PLANTATIONS	SURVEY TECHNIQUE NOT APPLICABLE	SEVERE COMPETITION ABOVE	SEVERE COMPETITION FROM WEEDS	SIGNIFICANT PLANTING ERRORS	POOR SITE PREPARATION	NO SITE PREPARATION	DROUGHT	POOR RECORDS	BROWSE	NOT FOUND AND INACCESSIBLE	POOR PLANTING STOCK (REPORTED BY A.S.F.)	FIRE AND OTHER	FROST HEAVING	OTHER
GRANDE PRAIRIE	4	34	34							34	34A, 34B, 35				34A, 34B
LAC LA BICHE	7	36, 37, 38, 39, 40, 41	36, 37, 38, 39, 40, 41	36, 37, 38, 39, 40, 41			36, 37, 38, 40, 41				40A,	40A**			
PEACE RIVER	8	78, 79	73A, 74, 76, 77, 78	73A, 75, 76, 77, 78	73, 74	78, 79	77, 78		73, 75	73, 74	73A	75			
ROCKY-CLEARWATER	17	44, 45, 46, 48, 49, 51, 52, 53, 54, 55	51, 52, 53, 54, 58	42, 43, 45, 48, 49, 50, 51, 52, 53, 54, 55, 56, 58	42, 43, 45	42, 49, 55, 58	43, 44, 45, 46, 48, 49, 50, 51, 52, 53, 54, 56	50, 51	51, 56					42, 43, 46, 48, 49, 550	

\*\* Reported by A.F.S.

APPENDIX IV (Continued)

FOREST DISTRICT	NUMBER OF PLANTATIONS	P L A N T A T I O N N U M B E R													
		SURVEY TECHNIQUE NOT APPLICABLE	SEVERE COMPETITION ABOVE	SEVERE COMPETITION FROM WEEDS	SIGNIFICANT PLANTING ERRORS	POOR SITE PREPARATION	NO SITE PREPARATION	DROUGHT	POOR RECORDS	BROWSE	NOT FOUND AND INACCESSIBLE	POOR PLANTING STOCK (REPORTED BY A.S.F.)	FIRE AND OTHER	FROST HEAVING	OTHER
SLAVE LAKE	7	59,61	60, 61, 62	59**60 61,62	60	61	59,60		60,61,64	62, 63	59,65		60		
WHITECOURT	6	67,70,71, 72	68, 69 71	67,68,69 71,72	68,69	67,71,72			70,71,72	67		70*71*			

\*\* Refers to Numbers Assigned in Appendix V.

\*\* Reported by A.F.S.

APPENDIX V

SURVIVAL, LOCATION, AND PERTINENT DATA ON SOME PLANTATIONS ESTABLISHED IN ALBERTA FOREST DISTRICTS

DURING 1965, 1967, AND 1970

ATHABASCA FOREST

Plantation No.	Survival <sup>1</sup> %	Location Reg. <sup>2</sup> Twp. Rge.	Species	No. of Seedlings	Age of Stock	Planting Time	Method Planted <sup>3</sup>	Seedlings Counted	No. of Acres	Site Prep. <sup>4</sup>	Type of Planting <sup>5</sup>	Moisture Class <sup>6</sup>	Texture <sup>7</sup>	pH	Compet- ition <sup>8</sup>	Site History <sup>9</sup>
1	25-S	B18a 89-10	wS	8,000	10 wks	June 67	H	113	11.7	N	Cont.	2	MF	6.1	H	B
2	F	B18a 90-9	wS	44,800	3-0	June 67	H	0	92	N	Conv.	3	M	NT	H	U
3	58-S	B18a 86-6	wS	38,200	10 wks	Spring 70	H	260	160	D.S.	Cont.	3	M	6.3	H	U
4	69	B18a 90-8	jP	18,000	3-0	June 70	M	340	24	N	Conv.	3	M	5.8	L	R
4a	67-S	B18a 90-8	wS	30,550	10 wks	June 70	H	120	49	D.S.	Cont.	3	MF	7.0	H	U
4b	28	B18a 90-8	wS		3-0	June 70	H	150		N	Conv.	2	C	5.7	M	U

BOW RIVER FOREST

5	F	SA1 23-5	1P	28,000	3-0	Spring 65	H	0	20	N	Conv.	1	MF	5.4	H	C
6	76	SA1 23-5	1P	16,800	3-0	May 65	H	250	48	N	Conv.	2	MF	5.4	M	C
7	F	SA1 24-6	1P	18,000	3-0	Spring 65	H	0	60	PB	Conv.	2	MF	NT	S	C
8	F	SA1 24-7	1P	5,400	3-0	Spring 65	H	0	18	PB	Conv.	2	MF	NT	S	C
9	F	SA1 31-9	1P	5,000	3-0	Spring 65	H	0	12	N	Conv.	2	MF	NT	M	C
10	F	SA1 24-6	1P	94,450	3-0	June 70	H	0	122	S	Conv.	2	NT	NT	M	C
11	F	SA1 24-6	wS dF	70,000	3-0	June 67	H	0	84	S	Conv.	2	MF	NT	H	S
12	F	SA1 24-6	1P	77,700	3-0	June 70	H	0	83	S	Conv.	1	NT	NT	H	S

APPENDIX V (Continued)

Plantation No.	Survival <sup>1</sup> %	Location Reg. <sup>2</sup> Twp. Rge.	Species	No. of Seedlings	Age of Stock	Planting Time	Method <sup>3</sup> Planted	Seedlings Counted	No. of Acres	Site Prep.	Type of Planting <sup>5</sup>	Moisture Class <sup>4</sup>	Texture <sup>7</sup> pH	Compet- ition <sup>8</sup>	Site History <sup>9</sup>		
13	60	SA1	24-6	1P dF wS	70,350	15 wks	July 70	H	420 0	64 75	N S	Cont. Conv.	1 1	MF NT	NT NT	N H	CB C
14	F	SA1	24-6	1P	52,800	3-0	May 70	H	0	?	S	Cont.	1	NT	NT	H	B
15	F	SA1	24-6	1P wS	9,000	10 wks	July 67	H									
CROWSNEST FOREST																	
16	F	SA1	3 2	dF	12,150	?	Spring 67	H	0	38	N	Conv.	4	MF	NT	M	C
17	F	SA1	10-4	?	13,100	?	Spring 67	?	0	53	N	?	2	NT	NT	M	C
18	F	SA1	12-1	?	2,600	?	Spring 67	?	0	12	N	?	1	NT	NT	H	P
19	F	SA1	6-5	1P wS	32,180	3-0	Spring 70	H	0	103	N	Conv.	3	NT	NT	?	?
20	F	SA1	6-4	1P	34,000	14 wks 1 yr.	Spring 70	H	169	?	?	Cont.	3	C	NT	?	C
21	?	SA1	7-4	1P dF	7,450	3-0	June 70	?									
22	?	SA1	12-2	wS 1P dF	48,900	?	Spring 70	?	0	164	?	Conv.	?	M	5.6	?	?
23	F 1P	SA1	6-4	dF	14,050	3-0	May 70	H	0	30	N	Conv.	1	MF	5.4	L	CB
24	F	SA1	10-1	1p dF wS	5,375	3-0 3-2	May 70	H	0	17	S	Conv.	2	NT	NT	S	C

## APPENDIX V (Continued)

CROWSNEST FOREST																		
Plantation No.	Survival <sup>1</sup>	Location Reg. <sup>2</sup> Twp. Rge.		Species	No. of Seedlings	Age of Stock	Planting Time	Method Planted <sup>3</sup>	Seedlings Counted	No. of Acres	Site Prep.	Type of Planting <sup>5</sup>	Moisture Class <sup>4</sup>	Texture <sup>7</sup>	pH	Compet- ition <sup>8</sup>	Site History <sup>9</sup>	
25	F	SA1	10-1	eS wS eS dF	20,775	3-0	May 70	H	0	38	S	Conv.	1	NT	NT	S	C	
26	F	SA1	11-1	?	4,700	?	Spring 67	?	0	38	?	?	?	?	?	?	?	
27	F	SA1	10-5	1P	65,200	14 wks.	June 70	H	50	201	S	Cont.	2	MF	NT	M	C	
28	F	SA1	10-5	1P	33,400	3-0	June 70	H	0	94	N	Conv.	4	MF	7.0	L	C	
EDSON FOREST																		
29	80	B19a	52-20	1P	?	?	Spring 65	H	230	44	N	Conv.	2	M	6.3	H	U	
30	F	B19c	53-22	1P	38,225	3-0	June 65	H	0	104	N	Conv.	2	MF	NT	H	U	
31	F	B19a	54-17	?	14,400	3-0	Spring 67	H	0	36	?	Conv.	?	NT	NT	?	?	
31a	?	B19a	53-20	?	40,500	3-0	Spring 67	H	0	142	?	Conv.	?	NT	NT	?	C	
31b	?	B19a	53-20	1P	13,600	3-0	Spring 67	H	0	26	?	Conv.	?	NT	NT	?	?	
31c	83S	B19c	48-22	1P	40,000	?	July 70	H	150	60	N	Cont.	?	NT	NT	?	?	
31d	60S	B19a	56-18	wS	6,250	3-0	June 70	H	123	28	?	Conv.	?	NT	NT	?	?	
31e	76S	B19a	56-20	1P	45,450	3-0	Spring 70	H	175	103	N	Conv.	?	NT	NT	?	B	
31f	63S	B19a	55-17	wS	19,750	3-0	Spring 70	H	140	90	N	Conv.	?	NT	NT	?	S	
31g	88S	B19a	56-20	1P	6,000	3-0	Spring 70	H	40	14	N	Conv.	?	NT	NT	?	B	



## APPENDIX V (Continued)

FOOTNER LAKE FOREST

Plantation No.	Survival %	Location Reg. <sup>2</sup> Twp. Rge.	Species	No. of Seedlings	Age of Stock	Planting Time	Method Planted	Seedlings Counted	No. of Site Acres Prep <sup>4</sup>	Type of Planting <sup>5</sup>	Moisture Class <sup>6</sup>	Texture <sup>7</sup> pH	Compet- ition <sup>8</sup>	Site History <sup>9</sup>
32	48S	B18b 110-7	wS	22,400	3-0	June 70	H	0	40	?	Conv.	4	NT NT	H C
33	88	B18b 118-21	wS	24,000	3-0	June 70	H	400	40	D.S.	Conv.	2	VC 7.5	L U
33a	77S	B23a 108-12	wS	22,000	3-0	Spring 70	H	0	52	?	Conv.	?	NT NT	M ?
33b	86S	B18b 113-21	wS	12,000	10 wks.	Spring 67	H	0	167	?	Conv.	?	NT NT	? ?
33c		B18b 111-22	wS	5,150	3-0	Spring 70	H	0	36	S	Conv.	4	NT NT	? C
33d		B18b 111-23	wS	8,800	3-0	Spring 70	H	0	40	S	Conv.	4	NT NT	? C
33e		B18b 111-22	wS	3,800	3-0	Spring 70	H	0	55	S	Conv.	4	NT NT	? C

GRANDE PRAIRIE FOREST

34	21S	B19a 65-5	1P wS	41,175 29,300	3-0	Spring 67	H	0	190	N	Conv.	4	NT NT	H U
34a	44S	B19a 65-11	wS	82,800	3-0	Spring 65	H & M	0	116	?	Conv.	4	NT NT	? ?
34b	77S	B19a 63-6	1P wS	34,000 34,000	12 wks.	Spring 70	H	599 800	109 389	? ?	Cont. Conv.	? 4	NT NT NT NT	? ? ?
35	81S	B19a 77-2	wS	100,000	3-0	Spring 70	M	800	389	?	Conv.	4	NT NT	? ?
36	F	18a 72-21	jP	23,496	3-0	Spring 70	H	0	22	N	Conv.	4	VC 5.5	H B
37	F	B18a 72-21	wS	12,600	3-0	Spring 70	H	0	18	N	Conv.	4	VC 5.5	H B
38	F	B18a 72-21	wS	9,800	3-0	Spring 70	H	0	14	N	Conv.	4	V 8.0	H U

APPENDIX v (Continued)

GRANDE PRAIRIE FOREST

Plantation No.	Survival <sup>1</sup> %	Location Reg. <sup>2</sup> Twp. Rge.	Species	No. of Seedlings	Age of Stock	Planting Time	Method Planted <sup>3</sup>	Seedlings Counted	No. of Site Acres Prep <sup>4</sup>	Type of Planting <sup>5</sup>	Moisture Class <sup>6</sup>	Texture <sup>7</sup>	pH	Compet- ition <sup>8</sup>	Site <sup>9</sup> History
39	12 F	B18a 70-19	wS jP	8,588	12 wks	? 65 & 66	H	210 390	? SC	Cont.	4	M	6.4	M	U
40	F	B18a 71-20	wS	24,700	3-0	Spring 65	H	0	80 N	Conv.	4	MF	5.5	H	U
40a	?	B18a 69-10	wS	63,325	3-0 3-2	Spring 67	H	0	142 ?	Conv.	?	?	?	?	?
41	F	B18a 68-9	wS	8,300	10 wks	Fall 67	H	0	12 N	Cont.	4	M	NT	H	U

ROCKY MOUNTAIN HOUSE - CLEARWATER FOREST

42	42	B19c 35-9	1P	13,600	12 wks.	Aug 67	H	210	23 S	Cont.	2	M	5.8	H	C
43	12	B19c 36-9	1P	9,600	12 wks.	Aug. 67	H	150	21 N	Cont.	2	M	5.8	M	C
44	31	B19c 36-9	wS	6,800	16 wks.	Aug. 67	H	150	16 N	Cont.	2	MF	5.8	L	C
45	40-S	B19c 36-9	1P	52,500	3-0	Spring 67	H	?	110 N	Conv.	2	M	NT	H	C
46	13-S	B19c 36-9	1P	16,400	16 wks.	Sept. 67	H	0	11 N	Cont.	2	M	5.6	M	C
47	80	B19c 36-9	1P	40,700	3-0	Spring 70	M	240	134 S	Conv.	2	MF	5.6	S	B
48	23-S	B19c 36-9	1P	54,300	16 wks.	Spring 67	M	440	101 N	Cont.	2	M	5.2	H	C
49	F	B19c 36-9	1P	42,600	14 wks.	Sept. 67	H	50	68 N	Cont.	2	M	NT	H	S
50	39	B19c 35-9	1P	5,200	14 wks.	Aug. 67	H	120	10 N	Cont.	1	M	NT	H	C
51	30-S	B19c 39-11	wS	25,600	3-0	Spring 70	H	60	47 S	Conv.	1	M	5.4	H	B
52	55-S	B19c 41-14	1P	40,525	3-0	July 65	H	170	88 N	Conv.	4	F	6.3	H	B

## APPENDIX V (Continued)

ROCKY MOUNTAIN HOUSE - CLEARWATER FOREST

Plantation No.	Survival <sup>1</sup> %	Location Reg. <sup>2</sup> Twp. Rge.	Species	No. of Seedlings	Age of Stock	Planting Time	Method Planted <sup>3</sup>	Seedlings Counted	No. of Acres	Site Prep. <sup>4</sup>	Type of Planting <sup>5</sup>	Moisture Class <sup>6</sup>	Texture <sup>7</sup>	pH	Compt- ition <sup>8</sup>	Site History <sup>9</sup>
53	-	B19a 44-11	WS	77,600	3-0	June 65	H	0	132	N	Conv.	3	MF	5.8	H	U
54	37-S	B19a 44-11	WS 1P	53,050	3-0	Spring 67	H	190	77	N	Conv.	4	VF	6.0	H	U
55	58	B19c 41-15	WS	8,570	3-0	June 70	H	200	28	PB	Conv.	4	MF	6.4	H	CB
56	40-S	SA1 41-16	WS	13,250	3-0	Sept. 70	H	100	30	N	Conv.	4	NT	NT	H	S
57	?	B19a 44-11	WS	33,200	3-2	Spring 70	M & H	0	70	S	Conv.	4	NT	NT	?	B
58	89	B19a 47-10	1P	29,000	3-0	Spring 70	H	370	74	S	Conv.	4	MF	5.9	M	U

SLAVE LAKE FOREST

59	48S	B18a 72-2	WS	31,900	3-0	Aug. 67	H	0	65	N	Conv.	4	M	NT	H	?
60	6	B18a 75-6	1P	19,650	8 wks.	May 65	H	200	30	N	Cont.	4	MF	NT	M	B
61	48	B18a 74-6	WS	?	10 wks.	Spring 65	H	230	30	S	Cont.	3	F	6.4	M	?
62	90	B18a 81-10	WS	23,500	3-0	June 67	M	810	80	D.S.	Conv.	4	M	7.1	M	B
63	90	B18a 81-10	WS	100,800	3-0	Spring 70	M	960	175	D.S.	Conv.	4	VC	5.3	L	B
64	72	B18a 82-10	WS	100,800	2-0	Fall 70	M	310	173	D.S.	Conv.	4	C	6.5	L	B
65	25S	B18a 70-17	WS	6,600	3-0	June 67	H	0	13	N	Conv.	?	NT	NT	?	C
67	F	B19a 60-16	WS	19,650	3-0	July 65	H	0	32	?	Conv.	4	NT	NT	H	?
68	91	B19a 51-13	cS	26,600	3-0	Spring 70	H	210	55	D.S.	Conv.	4	F	6.0	M	S
69	97	B19a 51-13	WS	93,017	3-0	Spring 70	H	240	244	S	Conv.	4	F	5.6	M	S

WHITECOURT FOREST

APPENDIX V (Continued)

WHITECOURT FOREST

Plantation No.	Survival <sup>1</sup> %	Location Reg. <sup>2</sup> Twp. Rge.	Species	No. of Seedlings	Age of Stock	Planting Time	Method Planted <sup>3</sup>	Seedlings Counted	No. of acres	Site Prep. <sup>4</sup>	Type of Planting <sup>5</sup>	Moisture Class <sup>6</sup>	Texture <sup>7</sup>	pH	Compet- ition <sup>8</sup>	Site History <sup>9</sup>
70	F	B19a 60-18	1P	23,000	3-0	July 67	H	0	34	N	Conv.	?	NT	NT	?	?
71	?	B19a 45-10	wS	8,000	10 wks	June 67	H	H	12	N	Cont.	4	M	6.0	M	S
72	43	B19a 45-10	wS	9,800	3-0	June 67	H	70	50	N	Conv.	4	F	6.4	M	S

PEACE RIVER FOREST

73	FS	B19a 88-2	wS 1P	10,200	3-0	May 65	H	0	19	?	Conv.	?	?	?	?	?
73a	FS	B18a 94-23	1P	15,600	3-0	June 65	H	0	27	N	Conv.	3	M	NT	H	S
74	57 26	B18a 94-23	wS	77,400	3-0	Spring 70	M	200 200	150	D.S.	Conv.	1	VF	5.8	H	U
75	71 92	B19a 86-2	wS	8,564	12 wks	Sept. 67	H	400	18	S	Cont.	2	MF	NT	L	C
76	76 49	B19a 88-2	wS	25,370	3-1	June 67	H	300	106	S	Conv.	4	MF	NT	H	B
77	63	B19a 88-2	wS	11,870	3-1	June 67	H	400	27	N	Conv.	2	MF	NT	M	B
78	F	B18a 92-23	wS 1P	37,840	3-0	June 67	H	0	57	N	Conv.	3	MF	NT	H	S
79	F	B19a 19-22	wS	22,000	3-1	June 67	H	0	53	S	Conv.	3	VF	5.7	M	C

1 F = Failure (less than 10% survival) "S" indicates percentages calculated from survival plots or taken from recent A.F.S. survival plot records

2 Forest Regions recognized by Rowe (1959)

3 H = Hand planting, M = Machine planting

4 N = No preparation, D.S. = Dozed strip P.B. = Prescribed burn, S.C. = Scalped

5 Cont. = Container, conv. = conventional bare rooted

6 1 = very dry, 2 = moderate, 3 = moist, 4 = wet, (Refer to Appendix 2)

7 N.T. = Not taken, V.C. = Very coarse, C = Coarse, M = Medium, M.F. = Moderately fine, F = Fine, V.F. = Very fine (Refer to Appendix 2)

8 H = Heavy, M = Medium, L = Light, S = Sparse

9 B = Burned, U = Undisturbed, R = Reclaimed land, C = Clearcut, S = Select cut, C. B. = Clearcut and burned, P = Pasture

# APPENDIX VI

## SURVIVAL, LOCATION, AND PERTINENT DATA ON SOME PLANTATIONS ESTABLISHED IN SASKATCHEWAN

### FOREST REGIONS DURING 1965, 1967, AND 1970

#### Prince Albert

Plantation No.	Survival <sup>1</sup>	Location <sup>2</sup> Reg. Twp. Rge.		Species	No. of Seedling	Age of Stock	Planting Time	Method Planted <sup>3</sup>	Seedlings Counted	No. of Acres	Site Prep <sup>4</sup>	Type of Planting <sup>5</sup>	Moisture Class <sup>6</sup>	Texture <sup>7</sup>	pH	Competition <sup>8</sup>	Site History <sup>9</sup>
1	62	B18a	50-22	jP	299,000	3-0 2-2	Spring 70	M	600	275	N	Conv	1	VC	5.8	L	B
2	48	B18a	50-22	jP	40,250	3-0 2-2	Fall 70	M & H	450	37	N	Conv	1	VC	5.7	L	B
3	24	B18a	50-22	jP	87,200	12 wks	July 70	H	100	110	T	Cont	1	VC	5.8	L	B
4	80 H	B18a	58-27	ws jP	538,225	2-2	Spring 70	H	100	931	N	Conv	4	M	5.6	H	S
5	?	B18a	55-14	ws	512,000	4-0 2-2 12 wks	Spring 70	M	0	600	N	Conv Cont	4	NT	NT	?	B

#### Hudson Bay Sask.

6	F	B18a	42-4	ws	427,000	2-2	Spring 67	M	0	330	W	Conv	4	N.T.	N.T.	H	B
7	F	B18a	42-4	ws	45,000	6 wks	Spring 67	H	0	?	W	Cont	4	N.T.	N.T.	H	B
8	84 S	B18a	41-5	ws	145,000	2-2	Spring 70	H	980	170	N	Conv	4	MF	6.4	H	S
9	F**	B18a	43-30	ws	360,000	2-2	Spring 65	H	0	440	N	Conv	4**	N.T.	N.T.	H**	S

1 F = Failure (less than 10% survival); "S" indicates percentages calculated from survival plots; "H" indicates an area where survival was taken in haul and skid roads only

2 Forest Regions as recognized by Rowe (1959)

3 H = Hand planting; M = Machine planting

4 N = No preparation; T = Trenching; W = Windrowed

5 Cont = container, conv = conventional bare rooted

6 1 = very dry, 2 = moderate, 3 = moist, 4 = wet (Refer to Appendix 2)

7 NT = not taken, VC = very coarse, M = medium, MF = moderately fine (Refer to Appendix 2).

8 H = heavy, L = light

9 B = burn, S = selective cut

\*\* D.N.R. Reported

## APPENDIX VII

## SURVIVAL, LOCATION, AND PERTINENT DATA ON SOME PLANTATIONS ESTABLISHED IN MANITOBA

SANDILANDS:

DURING 1967, 1968, AND 1970

Plantation No.	Survival <sup>1</sup> %	Reg. <sup>2</sup>	Location Twp. Rge.	Species	No. of Seedling	Age of Stock	Planting Time	Method Planted <sup>3</sup>	Seedlings Counted	No. of Acres	Site Prepar- ation <sup>4</sup>	Type of Planting <sup>5</sup>	Moisture class <sup>6</sup>	Texture/ pH <sup>8</sup>	Com- peti- tion <sup>9</sup>	Site History <sup>10</sup>
1	78 67 37	L12	2 12	wS jP rP	280,600	3-0	Spring 67	H	3,360	300	B	Conv.	1,2	VC	6.5 H-L	C
2	85	L12	3 12	jP	230,000	3-0	Spring 68	H	1,670	352	B	Conv.	2	VC	6.5 L	C
3	88	L12	10 4	jP		3-0	Spring 68	M	920		N	Conv.	2	VC	NT M	C
4	83	L12	3 12	jP	78,500	3-0	Spring 68	H	1,150	108	C&B	Conv.	2	VC	6.7 L-M	C
5	90	L12	7 10	jP	41,000	3-0	Spring 70	H	410	37	B	Conv.	2	VC	NT L-M	C
6	87	L12	7 11	jP	102,400	3-0	Spring 70	M	810	97	N	Conv.	2	VC	NT L-M	C
7	89	L12	5 10	jP	238,500	3-0	Spring 70	H	1,780	336	C&B	Conv.	4	VC	NT M	C
8	97	L12	5 9	jP	249,500	3-0	Spring 70	H	1,660	340	PB,C&B	Conv.	2	VC	NT L	C
8a	96	L12	5 9	jP	104,400	3-0	Spring 70	H	1,230	87	B	Conv.	2	VC	NT L	C
9	91	L12	2 11	jP	246,300	3-0	Spring 70	H	3,150	235	C&B	Conv.	2	VT	NT M-H	C
10	86	L12	3 11	jP	54,000	3-0	Spring 70	H	540	50	C&B	Conv.	2	VC	NT M	C
11	56	L12	3 12	jP rp	163,950	2-0 3-0	Fall 70	H	2,330	160	C&B	Conv.	2	VC	NT L	C
12	57	L12	3 11	jP	42,500	2-0	Fall 70	H	1,545	43	C&B	Conv.	2	VC	NT L-M	C
13	58	L12	6 9	jP rP wS	295,700	3-0 2-0	Fall 70	H	2,380	320	C&B	Conv.	2	VC	NT L-M	C

APPENDIX VII (Continued)

SANDILANDS:

Plantation No.	Survival <sup>1</sup> %	Reg <sup>2</sup>	Location Twp. Rge.	Species	No. of Seedling	Age of Stock	Planting Time	Method Planted <sup>3</sup>	Seedlings Counted	No. of Acres	Site Prepar- ation <sup>4</sup>	Type of Planting <sup>5</sup>	Moisture class <sup>6</sup>	Texture <sup>7</sup>	pH <sup>8</sup>	Com- peti- tion <sup>9</sup>	Site History <sup>10</sup>
14	98	L12	4 14	wS	17,000	3-0	Spring 68	H	200		B	Conv.	2	C	NT	H	C
14a	92	L12	4 14	rP	258,000	3-0	Spring 68	H	850	382	B	Conv.	2	C	NT	H	C

AGASSIZ:

15	83	B15	13 9	jP	75,000	3-0	Spring 68	H	470	110	B	Conv.	23	VC	NT	H	C
16	77	B15	11 9	jP	106,600	3-0	Spring 70	H	970	159	C&B	Conv.	2	C	NT	H	C

WHITESHELL:

17	91	L11	9 17	jP	15,000	3-0	Spring 68	H	100	28	N	Conv.	2	C	5.4	M	C
18	89	L11	8 16	jP rP	12,000	3-0	Spring 68	H	200	28	B	Conv.	2	VC	NT	H	C
19	89	B14	13 12	wS	65,000	3-0	Fall 68	H	310	140	D.S.	Conv.	3	VF	6.7	M	U
20	83	B14	11 14	jP	18,000	3-0	Spring 68	H	200	28	N	Conv.	2	VC	NT	M&H	C
21	76	B14	14 14	jP	12,500	3-0	Fall 70	H	230	23	D.S.	Conv.	2	C	NT	S&H	U
22	95	B14	13 14	jP rP wS	38,000 18,000 4,000	3-0	Spring 70	H	270 200 190	34 12 6	B D.S. D.S.	Conv.	2	VC	5.7	L	B
23	F	L11	8 16	wS	14,200	3-0	Fall 70	H	0	31	D.S.	Conv.	4	VF	6.6	H	U

## APPENDIX VII (Continued)

TURTLE MOUNTAIN:

Plantation No.	Survival <sup>1</sup> %	Location Reg <sup>2</sup> Twp. Rge.	Species	No. of Seedling	Age of Stock	Planting Time	Method Planted <sup>3</sup>	Seedlings Counted	No. of Acres	Site Prepar- ation <sup>4</sup>	Type of Planting <sup>5</sup>	Moisture class <sup>6</sup>	Texture <sup>7</sup>	pH <sup>8</sup>	Com- peti- tion <sup>9</sup>	Site History <sup>10</sup>
24		B18a 1 22	wS	8,000	3-0	Spring 67	H	0	12	D.S.	Conv.	1		NT	H	U
25	67	B18a 1 22	wS	18,820	3-0	Spring 68	M	870	27	N	Conv.	2	M	6.8	H	R
26		B18a 1 22	wS	114,000		Spring 70 Fall		0	210	D.S.	Conv.	1	M	NT	H	R
<u>SPRUCE WOODS</u>																
27	F	B18a 8 14	wS	18,000	3-0	Spring 70	H	0	35	N	Conv.	2	M	7.9	H	R
28	65	B18a 11 11	jP	72,000	3-0	Spring 70	M	800	70		Conv.	1	VC	7.0	M	
29	85	B18a 9 14	jP scP	146,700	3-0	Spring 70	M	1,170	190	N	Conv.	1	VC	7.0	L	
<u>WESTERN REGION</u>																
30	76	B18a 41 26	jP	240,000	3-0	Spring 68	H	1,560	240	DS&F	Conv.	1	VC	6.6	L	C
31	41	B18a 40 26	wS	73,000	3-0	Spring 70	H	1,720	150	D.S.	Conv.	2	MF	7.0	M	U
32	68	B18a 41 26	wS jP	165,500 26,300	2-0 3-0	Spring 70	H	3,070		D.S.	Conv.	3	MF	7.0	M	U
33	5	B15 39 23	jP	176,000	3-0	Fall 70	H	540	218	B	Conv.	1	VC	6.9	H	B
34	1	B15 39 22	jP	45,700	3-0	Fall 70	M	410	67	N	Conv.	1	VC	6.9	L	B
35	79	B18a 39 27	wS		2-0	Spring 68	H	930	423	D.S.	Conv.	2	MF	NT	M	U



## APPENDIX VII (Continued)

## EASTERN REGION:

Plantation No.	Survival <sup>1</sup> %	Reg <sup>2</sup>	Location Twp. Rge.	Species	No. of Seedling	Age of Stock	Planting Time	Method Planted <sup>3</sup>	Seedlings Counted	No. of Acres	Site Prepar- ation <sup>4</sup>	Type of Planting <sup>5</sup>	Moisture class <sup>6</sup>	Texture <sup>7</sup>	Ph. pH <sup>8</sup>	Com- peti- tion <sup>9</sup>	Site History <sup>D</sup>
36	92	B15	17 8	wS	175,800	3-0	Spring 70	M	450	100	N	Conv.	1	VC	6.1	L	C
37	60	B15	17 8	rP	175,000		Fall 68	M	1,370	134	N	Conv.	1	VC	6.1	L	C
38	42	B15	26 4	wS	280,000		Spring 70	H	334	300	D.S.	Conv.	1	M	NT	H	B
39	26	B15	26 4	wS	129,000		Spring 70	H	1,000	160	D.S.	Conv.	1	M	7.7	M	B
40	12	B16	20 1	wS	100,000		Fall 70	H	230	100	Disc	Conv.	1	M	7.5	L	
41	58	B15	25 5	wS	175,000		Spring 70 Fall 70		1,610	200	D.S.	Conv.	2	M	8.1	M	U
42	92	B15	26 4	wS	357,000		Spring 68		4,060	744	D.S.	Conv.	1	MF	7.7	M	U
42	91	B15	26 4	wS	140,000		Fall 68		590	267	D.S.	Conv.	1	M	7.7	M	U

1 F = Failure (less than 10% survival)

2 Forest Regions as recognized by Rowe (1959)

3 H = Hand planting; M = Machine planting

4 N = No preparation, B = burned, C&amp;B = Chopped and barreled, PB = partial burn

5 Cont = container, conv = conventional bare rooted

6 1 = very dry, 2 = moderate, 3 = moist, 4 = wet (Refer to Appendix 2)

7 NT = not taken, VC = very coarse, M = medium,  
MF = moderately fine (Refer to Appendix 2)

8 NT = not taken

9 H = heavy, M = medium, L = light, S = sparse,  
L-M = light and medium10 B = burn, S = selective cut, C = clear cut,  
U = undisturbed, R = reclaimed stie

## APPENDIX VIII

### SUGGESTED PLANTATION RECORD FORM

LOCATION OF AREA:

district                      sect.                      twp.                      rge.                      map

SIZE: (attach detailed map)

acres

SITE: history

soil and texture

```
site - class
```

ground cover

```
site prepar. before planting (type, date, cost)
```

**PLANTING STOCK:**

total number of seedlings

[illegible]

origin of seed (area, sect. twp. rge.)

year of collection	nursery seed lot number
--------------------	-------------------------

lifting time                      seedl. age

storage period and type	arrival at HQ or field
-------------------------	------------------------

packaging

hold over method/place  
(heeling in?)

avge, size of seedlings

general condition

weather at time of arrival in the field

## PLANTING OPERATION

type of planting (hand, machine)

equipment used (shovel, dibble, make of machine)

spacing (in rows - between rows)

seedlings per acre

number of plots	seedlings/plot	marked plots, seedlings
-----------------	----------------	-------------------------

### FIRST YEAR SURVIVAL BY PLOTS

for replantings, attach another form

notes

notes

notes

APPENDIX IX

PHOTOSELECTIONS TO SHOW SOME TYPICAL CONDITIONS  
ENCOUNTERED IN FORESTS OF THE PRAIRIE PROVINCES

- (1) Aspen conversion and resulting heavy competition from suckering.
- (2) Planting in areas of heavy slash accumulation.
- (3) Planting of lodgepole pine under heavy overstory.
- (4) Surviving seedling in high weed competition.
- (5) Plantation in an area of high competition.
- (6) Successful red pine plantation in an area of medium competition.
- (7) and (8) Seedling and plantation in area of low competition.
- (9) Sparse vegetational competition.
- (10) Drought killed seedling in a plantation with sparse competition.
- (11) Sparse degree of competition on a scalped and machine planted area.

APPENDIX IX (Continued)



(1) Aspen conversion and resulting heavy competition from suckering.



(2) Planting in areas of heavy slash accumulation.

APPENDIX IX (Continued)



(3) Planting of lodgepole pine under heavy overstory.



(4) Surviving seedling in high weed competition.



APPENDIX IX (Continued)

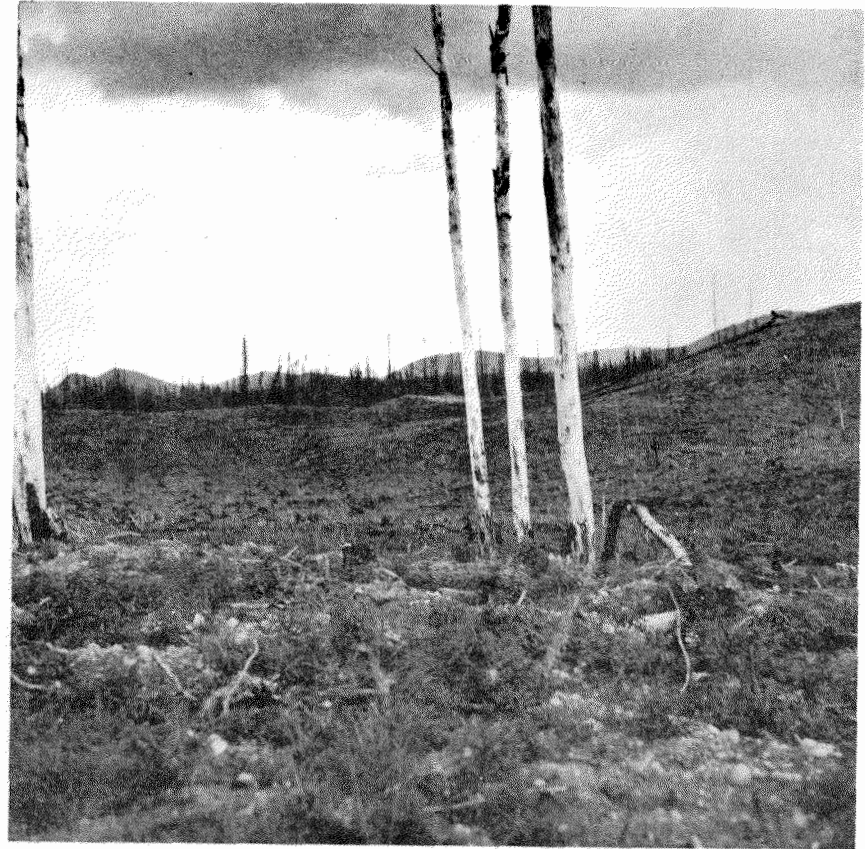


(5) Plantation in an area of high competition.



(6) Successful red pine plantation in an area of medium competition.

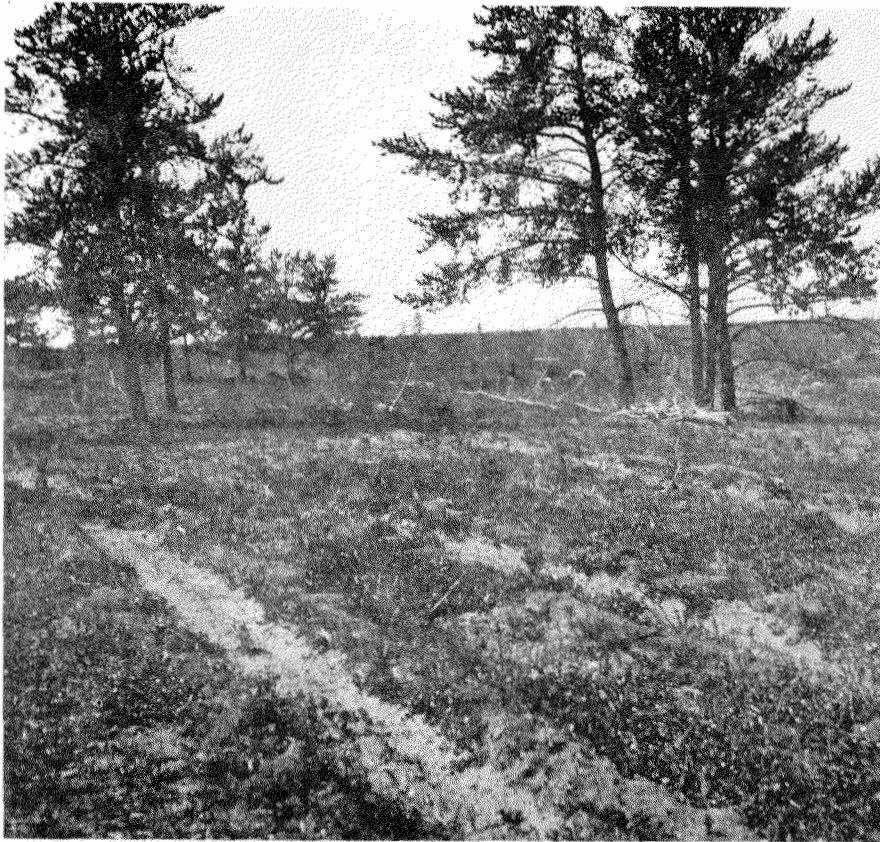
APPENDIX IX (Continued)



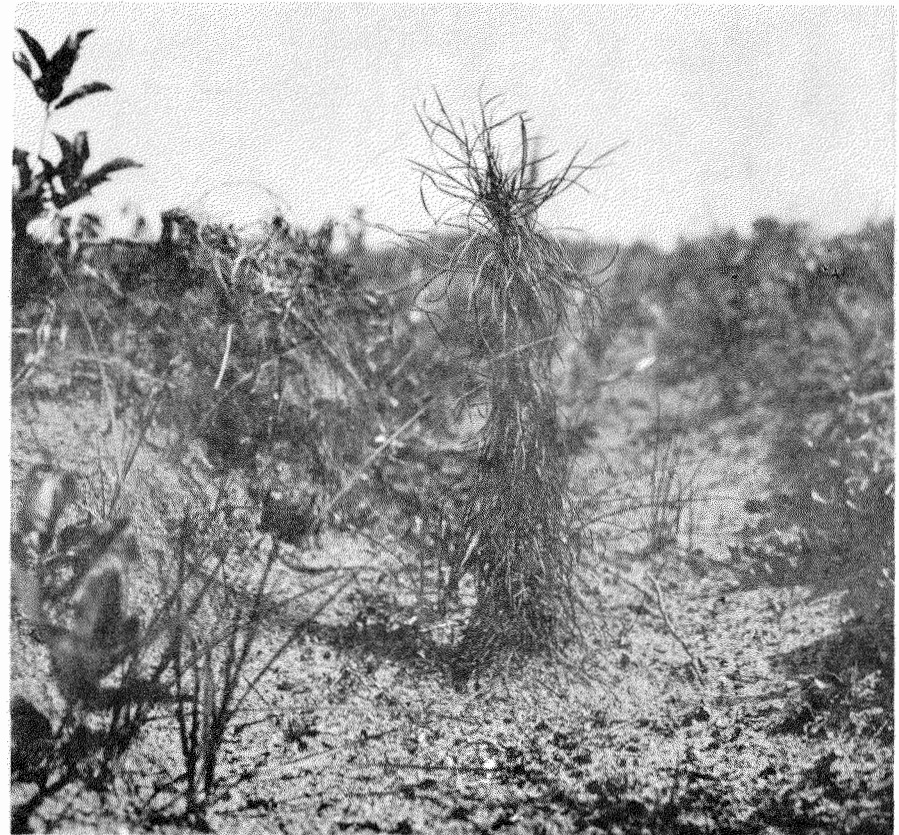
(7) and (8) Seedling and plantation in area of low competition.



APPENDIX IX (Continued)

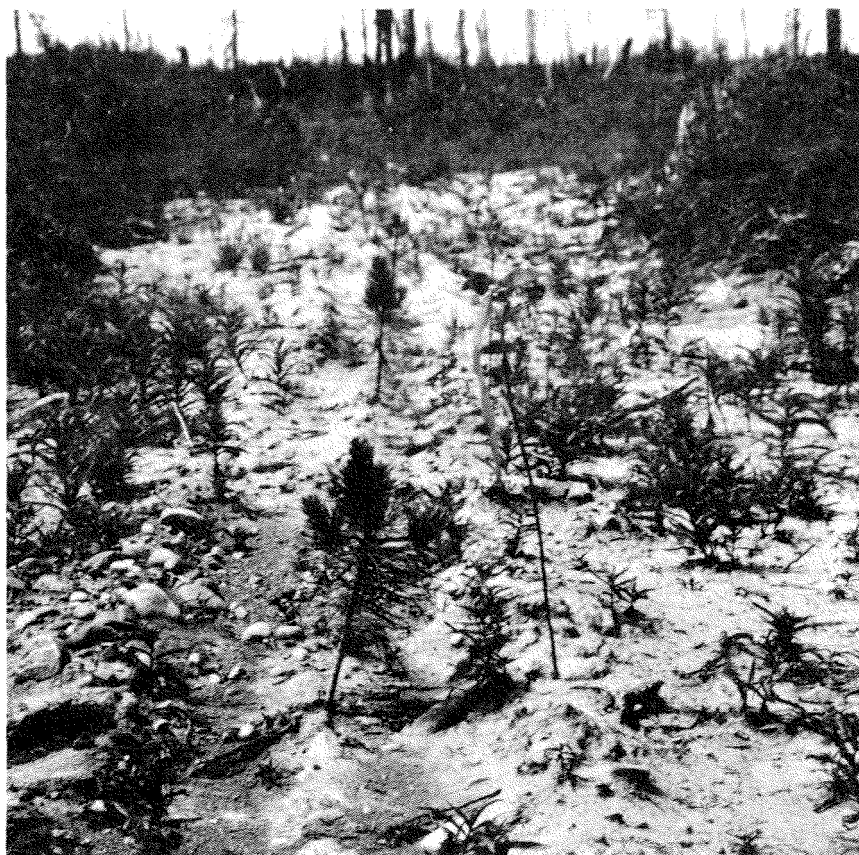


(9) Sparse vegetational competition.



(10) Drought killed seedling in a plantation with sparse competition.

APPENDIX IX (Continued)



Froning, K.

1972. An appraisal of recent plantations  
in forests of the Prairie  
Provinces.

Information Report NOR-X-31; 83 p.;  
Northern Forest Research Centre,  
Canadian Forestry Service,  
Department of the Environment,  
Edmonton, Alberta  
T6H 3S5

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Copies of this publication (if still in stock) may be  
obtained from:

Information Officer,  
Northern Forest Research Centre,  
Canadian Forestry Service,  
Department of the Environment,  
5320 - 122 Street,  
Edmonton, Alberta, Canada.  
T6H 3S5