MULTIPLE THINNING IN FOURTEEN-YEAR-OLD POPLAR, PORCUPINE PROVINCIAL FOREST, SASKATCHEWAN

Project MS-155

by
G. A. Steneker

FOREST RESEARCH LABORATORY
WINNIPEG, MANITOBA
INFORMATION REPORT MS-X-17

FORESTRY BRANCH
DEPARTMENT OF FISHERIES AND FORESTRY
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INTRODUCTION

In Manitoba and Saskatchewan early investigations on the thinning of trembling aspen[1] stands involved stands 30 or more years old. In most instances additional growth on residual trees as a result of a single thinning was small or results were inconclusive. Experiments, both in Canada and the Lake States (Bickerstaff 1946, Zehngraff 1947), have indicated that thinning should be started before age 30.

At every age of a stand there is a stocking density that will promote optimum growth either in terms of volume production or increment on individual trees. Such densities cannot readily be determined from single thinning treatments. However their determination is essential for the intensive management of aspen forests.

The requirement for data showing the effect of a range of thinning intensities at concessive stages in the development of a stand from an early age on were met in a multiple thinning experiment established by the Forestry Branch in 1951 in a 14-year-old trembling aspen stand in the Porcupine Provincial Forest, Saskatchewan. The purpose of the experiment was to determine for each age in the development of the stand, what density promotes the best growth in terms of individual tree increment and stand volume production. Results to 1962 were reported by Steneker[2] and were incorporated in a report on aspen thinning in Manitoba and Saskatchewan (Steneker 1966). This report presents results to 1967.

+ JARVIS

LOCATION AND DESCRIPTION OF EXPERIMENTAL AREA

The experimental area is situated in Sec. 21, Twp. 36, Rge. 32, WPM in the Porcupine Provincial Forest. It is in the B18[a] Forest Section of the Boreal Forest Region (Rowe 1959).

The area is located on a morainic plain characterized by gently to strongly rolling (5° to 10°) topography with elevations ranging from about 1,800 to 2,000 feet above sea level. The soil is a till which varies in

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[1] See Appendix I for botanical names

[2] Winnipeg, 63-MS-27

texture from sandy loam to clay loam. In 1951 the order of abundance of the more prominent species of minor vegetation was found to be -

Shrubs - hazel nut, pin cherry, prickly rose, high-bush cranberry, snowberry

Herbs - wild sarsaparilla, cream-coloured vetch, American vetch, tall lungwort, violet spp., star-flowered Solomon's seal, aster spp., palmate-leaved colts-foot

Grasses - wild rye spp., sedge spp.

A few balsam poplars were present in the stand.

At time of treatment the stand was 14 years old; it had developed after a fire in 1937. Diameters ranged from one to three inches and stocking varied from about 2,000 to 4,500 trees per acre. Height of dominant aspen ranged from 24 to 34 feet. Stand statistics are given in Appendix II and III.

METHODS

Treatments

Fourteen 1/5-acre plots (with 33-foot surrounds), as similar as possible with regard to stocking, were established and two were assigned to each of the following treatments:

1. Control - no thinning; two plots which had stand density indexes (SDI) of 186 and 183 respectively (Mulloy 1943).

2. Thinned -(a) two plots to be thinned back at five-year intervals to an SDI of 120% of that of the controls in 1951
   (b) as for (a) but 100 per cent
   (c) as for (a) but 80 per cent
   (d) as for (a) but 70 per cent
   (e) as for (a) but 60 per cent
   (f) as for (a) but 50 per cent

Measurements

(a) 1951

Before thinning all trees $\geq$ 0.5 inches d.b.h. were numbered with paint and tallied by species to the nearest one-tenth inch. Height and diameter measurements were taken on six standing trees in each one-inch diameter class on each plot. Height was also measured for cut trees. Height-diameter curves were prepared for each plot.

(b) 1957, 1962, 1967

In 1957, 1962 and 1967 diameters of all living and dead trees were measured to the nearest one-tenth inch. On each plot the heights of five trees in each one-inch diameter class were measured. Wherever possible,

trees measured for height in 1951 were remeasured for height in 1957, 1962 and 1967. Height-diameter curves were prepared for each plot.

Thinning 1951, 1957, 1962 and 1967

After measurement the plots were thinned to their designated densities. In this operation efforts were made to achieve regular spacing. Wherever possible, small trees, malformed trees and balsam poplars were removed, while large-sized trembling aspen were favoured. Numbers and size of trees removed in the thinning were recorded. After the thinning in 1951 maps showing the positions of trees were prepared for all plots.

In 1962 sites on all plots were examined. Site information is presented in Appendix IV.

In the results thinning intensities have been expressed in terms of residual basal area rather than stand density index, since basal area is a more convenient measure of stocking. The relationship between basal area and stand density index after thinning in 1951, 1957, 1962 and 1967 is shown for all sample plots in Figure 1. The graphs indicate that with increasing age, a stand kept at a specific stand density index, will show an increase in basal area.

RESULTS

Diameter Increment

Thinning resulted in an increase in diameter increment of individual trees on the various plots. To illustrate this, the diameter increment of those trees in the largest diameter class in 1951 (3-inch d.b.h. class) which were still present in 1967, was plotted over treatment (Figure 2). Initial and final tree sizes together with period increment are shown in Table 1. Figure 1 indicates that periodic diameter increment had increased as a result of thinning and that increment tended to increase with thinning intensity. A range in increment is shown from 2.45 inches on the unthinned control plots to 3.50 inches on the most heavily thinned plots.

The number of trees above specific diameters in 1967 have been listed (Table 2) to show the influence of thinning intensity on the production of large-sized trees. Although there is a tendency for the more heavily thinned plots to have a greater number of large-sized trees, there apparently is still an influence of the original size class distribution before thinning in 1951. To illustrate this, the numbers of trees 3 inches in d.b.h. and larger in 1951 and 6 inches d.b.h. and larger in 1967 were plotted over treatment in 1951 (Figure 3). The relatively high values of the 50 and 100 per cent SDI plots and the low values of the 60 per cent of SDI plots in 1951 were still apparent in 1967. However, thinning has had its influence on size distribution. This is apparent from the size distribution for 1967 which indicates, in contrast to the 1951 distribution, a trend towards a greater number of large-sized trees in the heavier than in the lighter thinned plots.

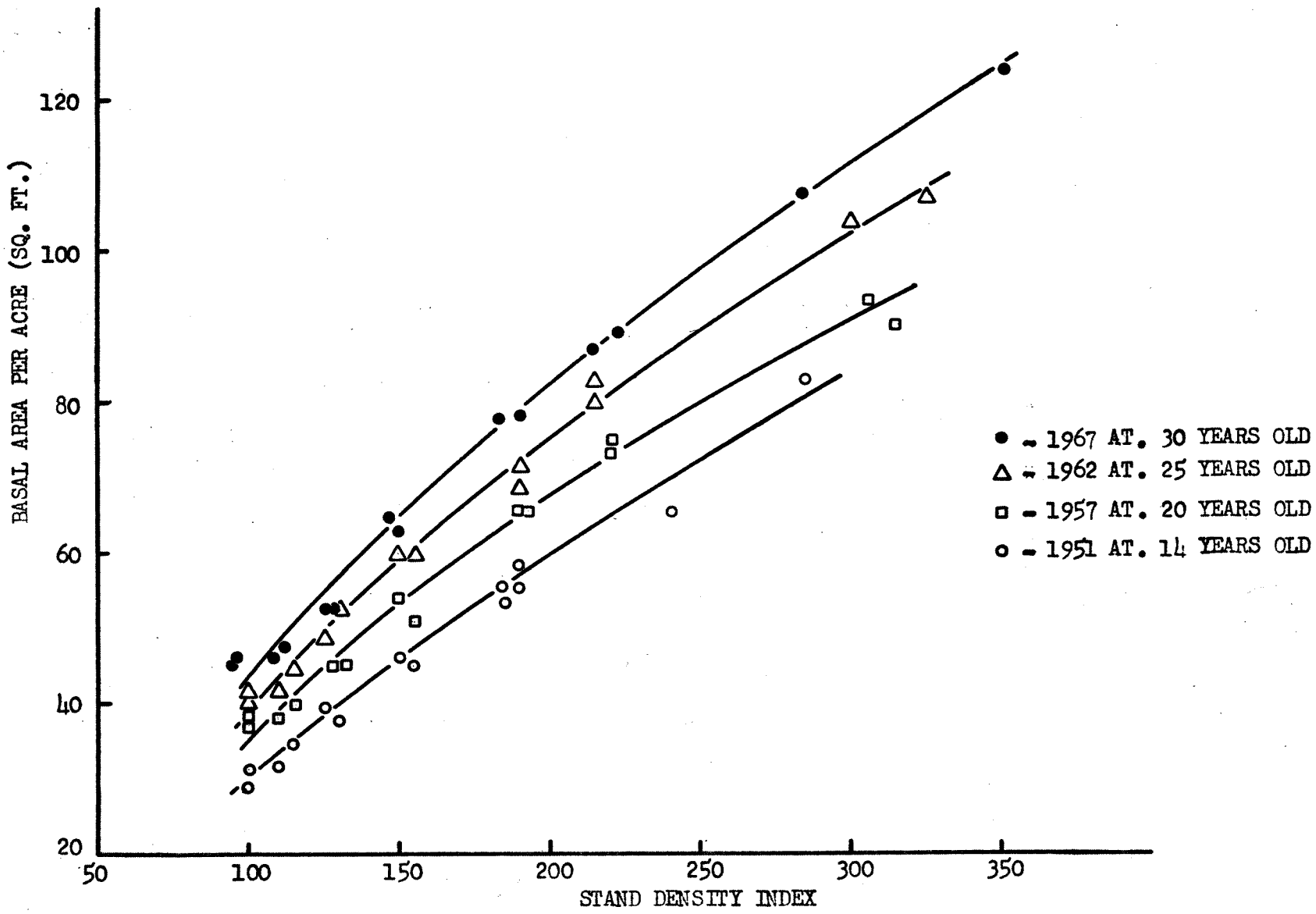

FIGURE 1. BASAL AREA PER ACRE AFTER THINNING RELATED TO STAND DENSITY INDEX IN 1951, 1957, 1962, AND 1967 (FOURTEEN SAMPLE PLOTS)

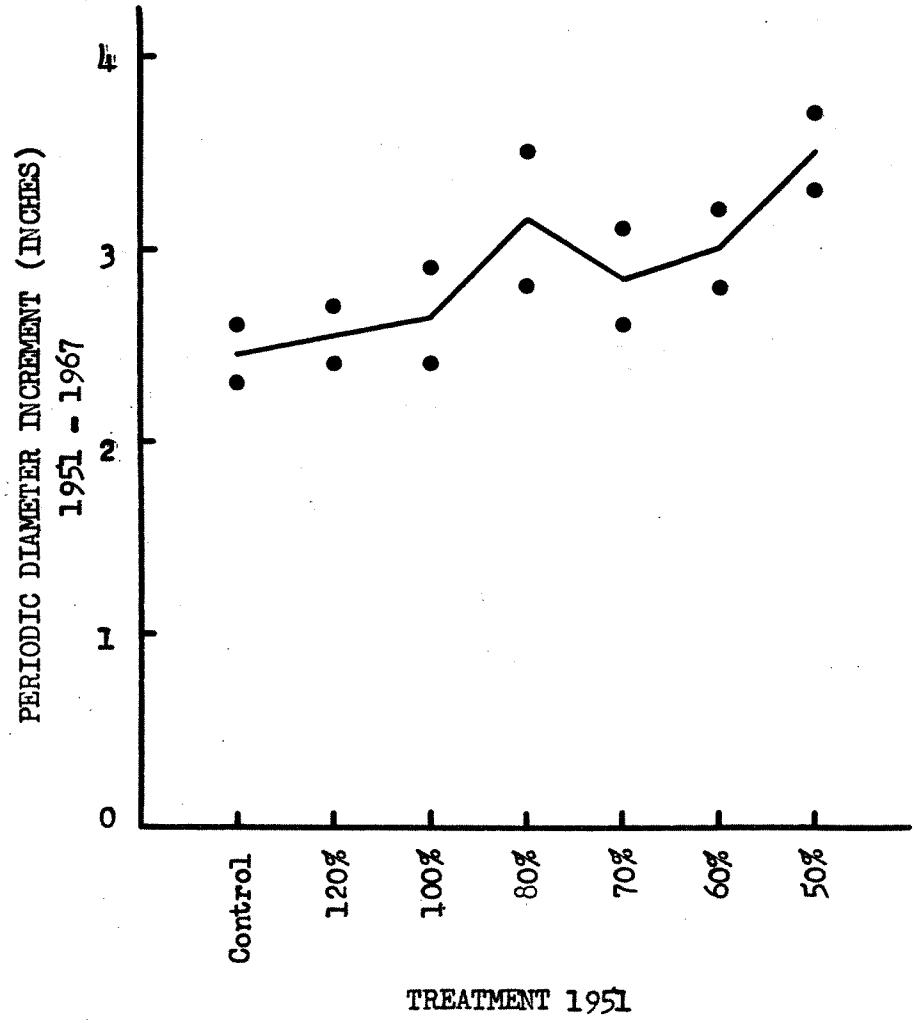

FIGURE 2. PERIODIC DIAMETER INCREMENT (1951-1967) OF 1951's 3-inch CLASS TREES IN RELATION TO TREATMENT. (FOURTEEN SAMPLE PLOTS)

TABLE 1

PERIOD DIAMETER INCREMENT (1951 - 1967) OF THE LARGEST 1951 DBH CLASS IN RELATION TO TREATMENT

Treatment in 1951	Plot No.	No. of Trees	Dbh.		Periodic Increment
			1951	1967	
Control	11	11	2.8	5.1	2.3
	6	21	2.8	5.4	2.6
120% of SDI	3	48	2.8	5.2	2.4
	10	54	2.7	5.4	2.7
100% of SDI	9	87	2.8	5.2	2.4
	1	32	2.7	5.6	2.9
80% of SDI	13	22	2.7	5.5	2.8
	2	36	2.8	6.3	3.5
70% of SDI	5	9	2.7	5.8	3.1
	14	32	2.8	5.4	2.6
60% of SDI	8	10	2.8	6.0	3.2
	7	14	2.8	5.6	2.8
50% of SDI	12	26	2.9	6.2	3.3
	4	30	2.8	6.5	3.7

TABLE 2

DISTRIBUTION OF TREES BY 1 - INCH

DIAMETER CLASSES IN 1967

Treatment in 1951	Plot No.	Number of Trees per Acre Above:							
		1"	2"	3"	4"	5"	6"	7"	8"
Control	11	1985	1970	1410	695	220	25		
	6		1225	1115	740	360	60		
120% Of SDI	3		1090	1080	875	405	40		
	10		1040	1015	820	435	80	5	
100% of SDI	9			765	740	490	95		
	1		800	785	685	380	125	10	
80% of SDI	13			675	615	390	75	10	5
	2		560	555	535	405	180	20	
70% of SDI	5		555	550	535	395	55	10	
	14			525	520	375	80		
60% of SDI	8			465	450	330	70	5	
	7			465	455	305	70		
50% of SDI	12					320	225	30	
	4				300	275	205	80	10

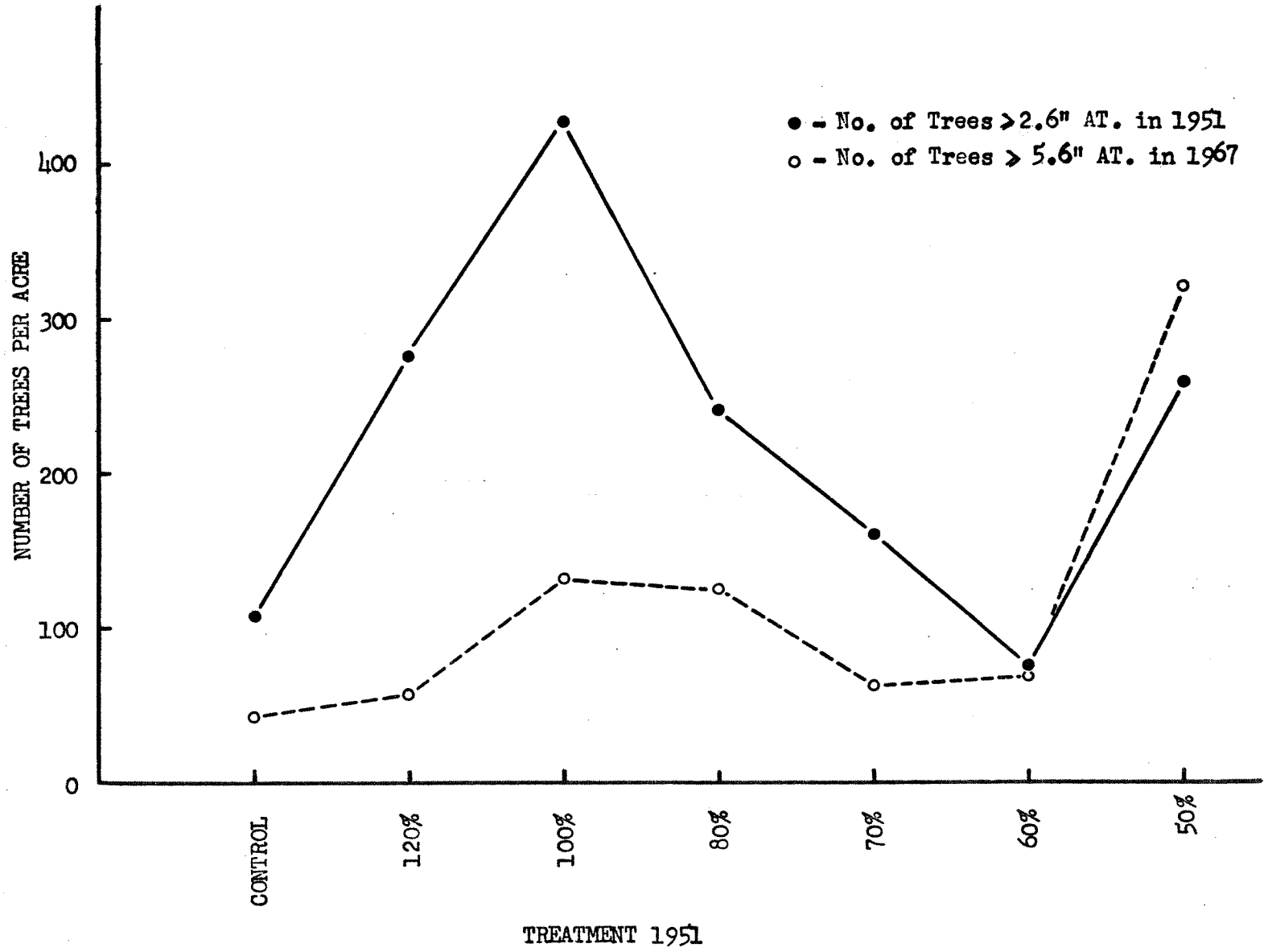

FIGURE 3. LARGE SIZE TREE DISTRIBUTION BY TREATMENT IN 1951 AFTER THINNING AND IN 1967

Height Increment

Data for average height increment of dominant trees by treatment over the period 1951-1962 are shown in Table 3. They indicate that no apparent relation exists between height increment and thinning intensity.

Basal Area and Volume Increment and Mortality

Basal area and total volume increment per acre for the period 1962-1967 were plotted over residual basal area per acre in 1962 (Figure 4). The distribution of the individual plot data indicates that a residual basal area in 1962 of about 80 square feet produced maximum periodic increment over the subsequent five-year period. It was previously reported[3] that maximum period basal area and volume increment after thinning at age 14 and 20 resulted from a reduction in basal area to about 65 and 70 square feet respectively. This, together with the results now reported suggest that with increasing age, maximum periodic increment is obtained at relatively higher basal areas.

The lower periodic increment between 1962 and 1967 in stands thinned more heavily than the apparent optimum is probably due to inadequate stocking, while the lower increment in less heavily thinned stands may be due in part to mortality over the 5-year period. Highest mortality occurred on the control plots while on the thinned plots mortality by volume averaged about one per cent (Table 4). Mortality occurred principally in the smaller diameter classes. Particularly on the unthinned plots, mortality among the smallest trees was almost 100 per cent as a result of natural thinning.

Hypoxylon pruinatum (Klotsche) Cke. caused some mortality. No relationship was observed between the incidence of canker and thinning intensity. Furthermore canker did not seem to be limited to any particular size class.

Total and Merchantable Volume Production to 1967

Data for total (cubic feet) and merchantable (cords) volume production to 1967 are presented in Figure 5. Except for the unthinned and most heavily thinned plots, total volume production showed a decline with increase in thinning intensity. Thinning to 120 per cent of the SDI of the controls in 1951 gave maximum total production, since this thinning intensity maintained the plots at basal area levels providing maximum periodic increment. This basal area ranged from about 65 square feet at age 14 in 1951 to about 80 square feet at age 25 in 1962.

Data for merchantable volume production (Figure 5) reflect the production of large-sized trees to 1967, the latter still being partly a reflection of tree size distribution in 1951 (Figure 3).

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[3] Winnipeg, 63-MS-27

TABLE 3

AVERAGE PERIODIC HEIGHT INCREMENT

1951 - 1962

Treatment in 1951	Basis. (No. of Trees)	Height Increment (feet)
Control	20	16
120% of SDI	20	15
100% of SDI	10	14
80% of SDI	20	15
70% of SDI	13	17
60% of SDI	19	15
50% of SDI	10	14

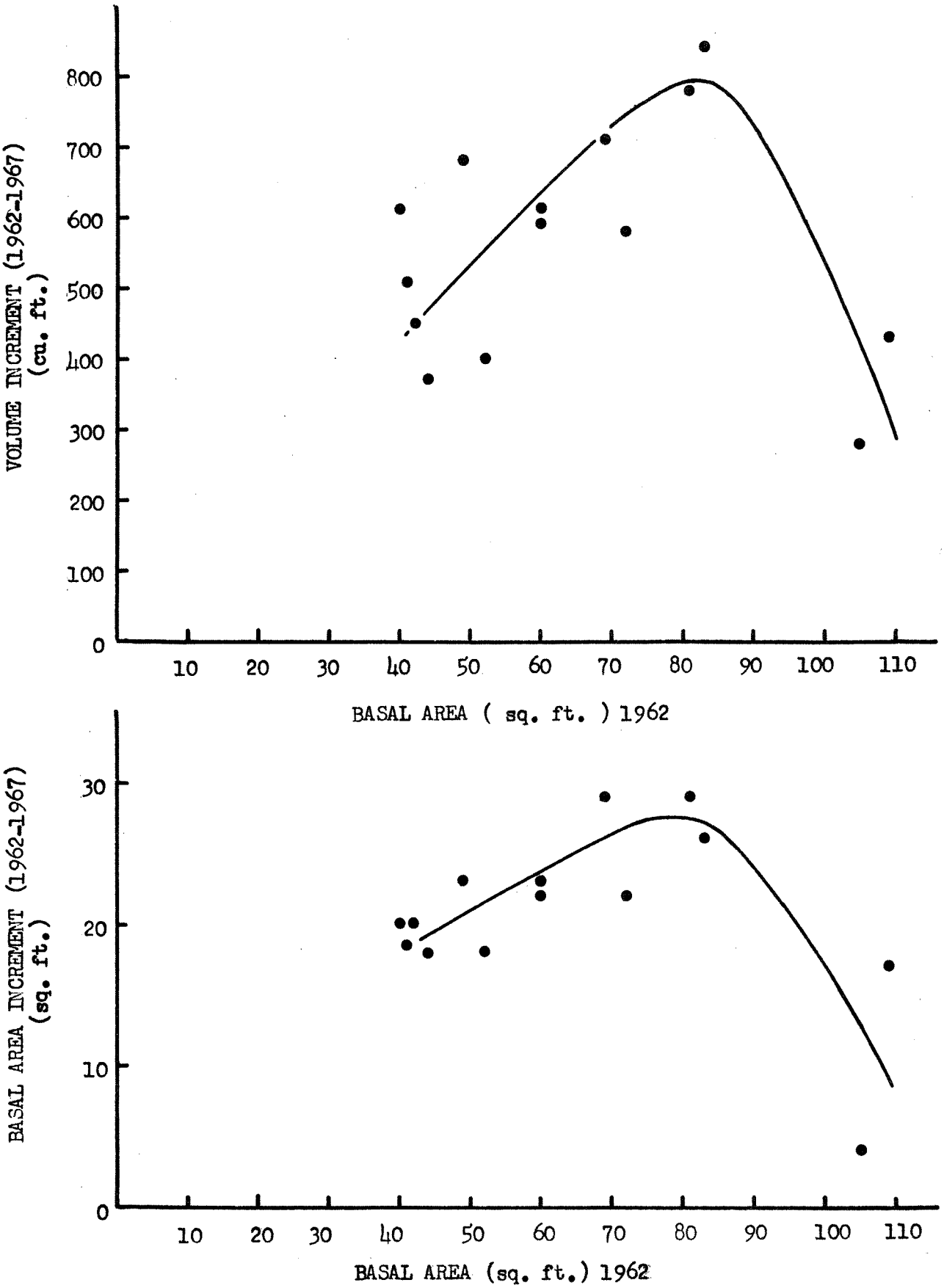

FIGURE 4. PERIODIC NET BASAL AREA (SQ. FT.) AND TOTAL VOLUME (CU. FT.) INCREMENT PER ACRE (1962-1967) IN RELATION TO BASAL AREA PER ACRE AFTER THINNING IN 1962.

TABLE 4

MORTALITY (CU. FT.) PER ACRE BY TREATMENTS

OVER THE PERIOD 1962 - 1967

Treatment in 1951	Mortality 1962-1967 (cu. ft.)	% of Standing Volume in 1967
Control	195	8.5
120% of SDI	39	1.6
100% of SDI	28	1.3
80% of SDI	18	1.1
70% of SDI	0	0.0
60% of SDI	6	0.5
50% of SDI	20	1.5

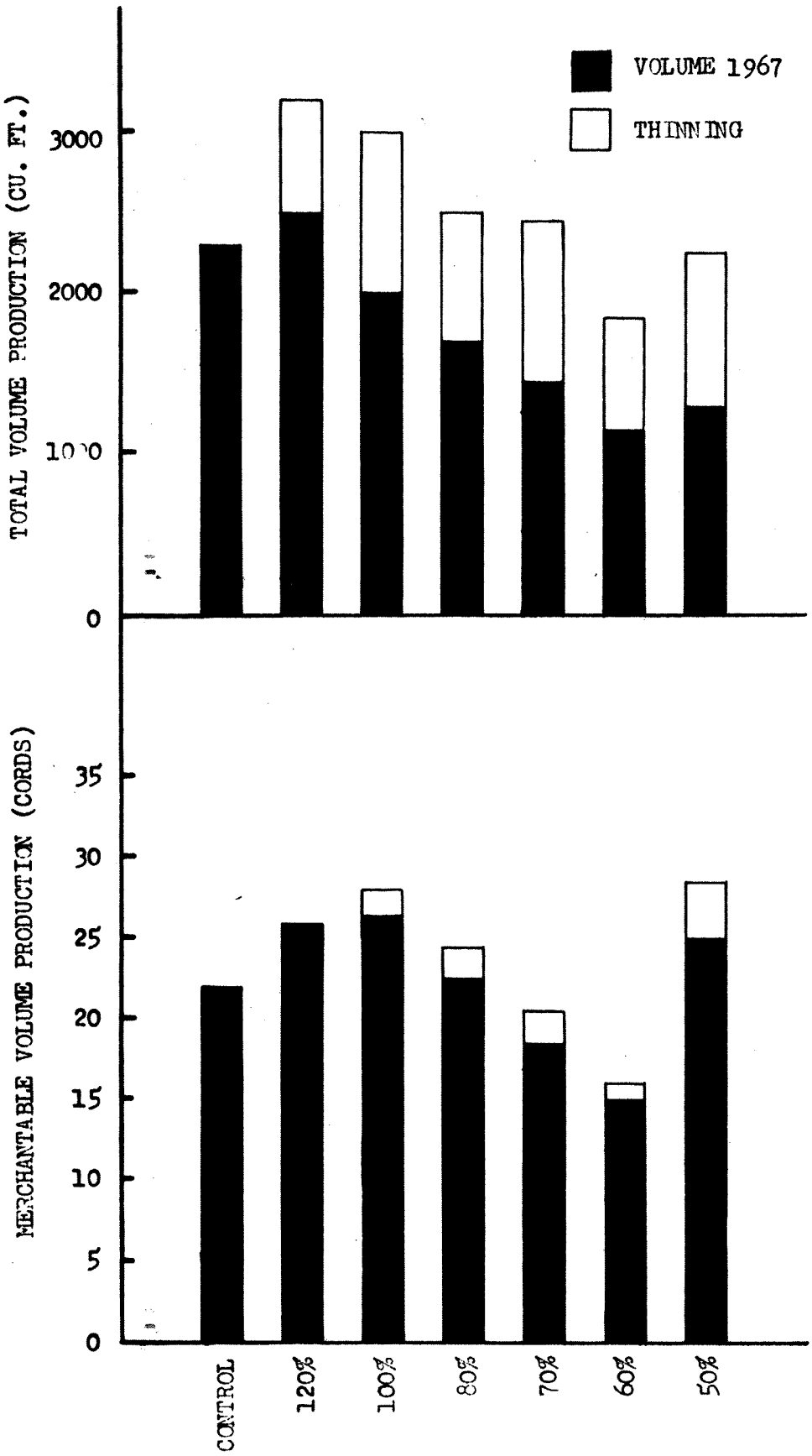

FIGURE 5. TOTAL AND MERCHANTABLE VOLUME PRODUCTION PER ACRE TO 1967 BY TREATMENTS.

DISCUSSION AND CONCLUSIONS

The main objective of this thinning experiment was to determine levels of growing stock at various stages in the rotation that would provide for maximum volume production and optimum increment on individual trees.

Results do not differ substantially from those to 1962. Rate of diameter growth increased with an increase in thinning intensity, while a response to thinning was observed even in the largest trees. Previous results had shown that basal area and volume increment drop markedly when residual basal area is lower than about 60 square feet per acre at age 14. Results to 1967 indicate that such losses in increment occur with residual basal area levels below about 75 square feet at age 25.

Results indicate that the level of stocking required to give maximum volume production is higher than that required to give maximum diameter increment on individual trees.

Stand data, 16 years after treatment, still show the influence of original tree size distribution in 1951. Size distribution in 1951 could be a reflection of site differences between the plots and/or a reflection of genetic differences between the stands on the different sample plots.

SUMMARY

In 1951 the Forestry Branch began a multiple thinning experiment in a 14-year-old trembling aspen-balsam poplar stand in the Porcupine Provincial Forest. Fourteen 1/5-acre permanent sample plots were established. Two plots, with stand density indices of 183 and 186, were chosen for controls and were not thinned. The remaining plots, two for each treatment, were thinned to 120, 100, 80, 70, 60 and 50 per cent of the stand density indices of the unthinned plots in 1951. Under a 5-year thinning cycle, all plots except the controls were thinned in 1957, 1962 and 1967 back to their SDI after thinning in 1951.

Results to 1967 show that:

1. The diameter increment of even the largest trees increased as a result of thinning.

2. For the periods 1951-1957, 1957-1962 and 1962-1967, basal areas giving maximum periodic basal area and volume increment were about 65, 75 and 80 square feet respectively.

3. The production of large-sized trees and merchantable volume production to 1967 was still influenced by initial diameter distribution on the plots after thinning in 1951.

RECOMMENDATIONS

Five-year thinning and remeasurements should be continued at least to 1972. If results at that time do not differ substantially from those in 1962 and 1967, the project should be closed.

REFERENCES

Bickerstaff, A. 1946. The effect of thinning upon the growth and yield of aspen stands. Canada Dept. Mines and Resources, Land, Parks and Forests. Forestry Branch, Dom. For. Serv., Silv. Res. Note No. 80.

Hills, G.A. 1952. The classification and evaluation of site for forestry. Ont. Dept. Lands and Forests, Div. Res., Res. Report 24, 41 pp.

Mulloy, G.A. 1943. A practical measure of stock density in white and red pine stands. For. Chron. 19(2):108-118.

Rowe, J.S. 1959. Forest regions of Canada. Canada Dept. Northern Affairs and National Resources, Forestry Branch, Bull. No. 123.

Steneker, G.A. and J.M. Jarvis. 1966. Thinning in trembling aspen stands, Manitoba and Saskatchewan. Dept. of Forestry Publication #1140.

Zehngraff, P. 1947. Possibilities of managing aspen. United States Dept. Agric. For. Serv., Lake States For. Exp. Sta., Aspen Report No. 21.

APPENDIX I

List of Botanical Names

American vetch	Vicia americana Muhl.
Aster spp.	Aster spp.
Balsam poplar	Populus balsamifera L.
Cream-coloured vetch	Lathyrus ochroleucus Hook.
Hazel nut	Corylus cornuta Marsh.
High-bush cranberry	Viburnum opulus L.
Palmate-leaved coltsfoot	Petasites palmatus (Ait.) A. Gray
Pin cherry	Prunus pennsylvanica L.
Prickly rose	Rosa acicularis Lindl.
Sedge spp.	Carex spp.
Snowberry	Symphoricarpus albus (L.) Blake
Star-flowered Solomon's seal	Smilacina stellata (L.) Desf.
Tall lungwort	Mertensia paniculata (Ait.) G. Don.
Trembling aspen	Populus tremuloides Michx.
Violet spp.	Viola spp.
Wild rye spp.	Elymus spp.
Wild sarsaparilla	Aralia nudicaulis L.

APPENDIX II

NUMBER OF TREES PER ACRE, DOMINANT HEIGHT, AND STAND DENSITY INDEX IN 1951, 1957, 1962, AND 1967

Treatment in 1951	Plot No.	Number of Trees per Acre								Height of 100 Largest Trees in 1951 (ft.)	Stand Density Index							
		1951		1957		1962		1967			1951		1957		1962		1967	
		BT**	AT	BT	AT	BT	AT	BT	AT		BT	AT	BT	AT	BT	AT	BT	AT
Control	11	3620	-	3025	-	2355	-	1985	-	24	186	-	316	-	326	-	350	-
	6	3215	-	2575	-	1690	-	1225	-	25	183	-	303	-	299	-	282	-
120% Of SDI	3	4545	4545	3545	1545	1505	1105	1090	800	30	285	285	364	222	278	223	276	216
	10	3760	3760	3145	1610	1510	1075	1040	770	30	238	238	323	222	279	227	275	223
100% of SDI	9	*	2005	1910	1080	1065	765	765	580	34	260	190	284	191	244	190	238	190
	1	3515	2120	1920	1105	1005	830	800	605	28	239	188	280	188	221	189	228	188
80% of SDI	13	3220	1940	1800	925	945	680	675	470	28	181	153	241	153	199	156	204	152
	2	3470	1715	1490	865	745	580	560	400	28	218	151	228	151	186	150	193	150
70% of SDI	5	3105	1955	1920	795	795	555	555	385	26	178	127	225	128	182	127	174	127
	14	2190	1530	1445	745	730	525	525	380	29	150	132	220	132	174	131	170	130
60% of SDI	8	2335	1510	1455	720	705	465	465	315	25	133	109	191	109	161	110	150	109
	7	2725	1605	1430	745	710	475	465	340	24	157	114	198	114	156	114	148	113
50% of SDI	12	*	1045	975	495	485	320	320	225	28	196	98	172	98	145	99	136	102
	4	*	980	930	465	465	310	300	215	29	227	98	173	99	144	99	134	100

* No data available

** Before Thinning, After Thinning

APPENDIX III

BASAL AREA AND TOTAL VOLUME PER ACRE

IN 1951, 1957, 1962, AND 1967

Treatment in 1951	Plot No.	Basal Area per Acre (sq. ft.)								Total Volume (cu. ft.)							
		1951		1957		1962		1967		1951		1957		1962		1967	
		BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
Control	11	54	-	91	-	109	-	126	-	570	-	1385	-	1962	-	2396	-
	6	56	-	94	-	105	-	109	-	620	-	1500	-	1929	-	2208	-
120% of SDI	3	84	84*	113	75	103	81	110	88	930	930*	1735	1250	2016	1675	2454	1984
	10	66	66*	101	74	99	83	110	91	730	730*	1560	1225	1914	1647	2490	2078
100% of SDI	9	**	59	96	66	92	69	98	79	**	705	1600	1165	1867	1486	2198	1776
	1	74	56	94	66	86	72	94	79	840	655	1560	1121	1532	1296	1874	1610
80% of SDI	13	58	46	78	51	77	60	83	63	645	525	1100	750	1375	1082	1673	1292
	2	66	46	80	54	73	60	82	65	740	535	1165	820	1371	1124	1736	1410
70% of SDI	5	52	40	81	45	68	49	72	53	555	460	1140	655	1225	880	1558	1152
	14	46	38	73	45	67	52	70	53	515	450	1060	680	1197	936	1333	1043
60% of SDI	8	39	32	63	38	61	42	62	46	420	350	855	555	1045	762	1216	913
	7	48	35	66	40	59	44	61	47	520	395	925	580	970	727	1100	867
50% of SDI	12	**	31	63	38	59	41	60	44	**	375	950	575	1024	710	1217	895
	4	**	29	62	37	58	40	60	45	**	355	950	580	1086	788	1401	1076

* - No Thinning was Carried Out in 1951

** - No Data Available

APPENDIX IV

Site Information

Plot Number	Parent Material	Moisture Regime *	Texture
1	alluvium	4	clay-loam
2	till	3-4	clay-loam
3	till	3	clay-loam
4	till	3-6	clay-loam
5	till	5	stony silt loam
6	alluvium over till	4	silty clay
7	till	3	clay-loam
8	alluvium over till	4	silty clay
9	till	4	clay-loam
10	till	4-5	clay-loam
11	till	3-5	clay-loam
12	alluvium	6	silty loam
13	till	4-6	stony clay-loam
14	till	3	clay-loam

*after Hills (1952)