THINNING OF TREMBLING ASPEN
(*POPULUS TREMULOIDES* MICHAUX) IN MANITOBA

BY

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ABSTRACT

Results of thinning trials in 11-, 14-, and 23-year-old trembling aspen stands in Manitoba 23 and 21 years later show that individual tree growth was markedly increased by thinning. By thinning up to 12 ft x 12 ft (3.6 x 3.6 m) spacing, the time required for trees to reach an average dbh of 9 in. (23 cm) can be reduced by about 20 years.

Although thinning to increase fibre production is not economical, thinning to produce sawlogs might pay, provided that precommercial thinnings could be carried out cheaply at the age of about 10 years.

RESUME

Les résultats d'essais d'éclaircie, effectués au Manitoba dans des peuplements de peupliers faux-tremble âgés de 11 et 14 et 23 ans, indiquent une augmentation significative dans l'accroissement des arbres. L'auteur rapporte que des éclaircies suffisantes pour produire des écartements de 12' x 12' (3.6 x 3.6 m) réduisent d'environ 20 ans l'âge normalement requis pour atteindre un dhp moyen de 9" (23 cm).

L'auteur croit que les éclaircies en vue d'accroître la production de fibres ne sont pas rentables. Par contre, pour produire des grumes, on pourrait effectuer des éclaircies, pourvu qu'elles soient faites à peu de frais lorsque le peuplement est âgé d'environ 10 ans.

TABLE OF CONTENTS

INTRODUCTION

Trembling aspen (*Populus tremuloides* Michaux) is one of the most abundant commercial tree species in the Prairie Provinces. By volume it accounts for about 13%, 30%, and 50% of the total forest resource in Manitoba, Saskatchewan, and Alberta, respectively (Gill 1960, Saskatchewan Department of Natural Resources 1959, Alberta Department of Lands and Forests 1961). Utilization of the species, however, particularly for lumber, has been very limited. One important reason for this is the high incidence of decay with advancing age (Gill 1960, Kirby et al. 1957, Thomas 1968).

The present minimum acceptable tree size for sawlogs is an 8-in. (20-cm) stump and 5-in. (13-cm) top; these dimensions are not reached until the stand is 60-70 years old. At that age 25% or more of the merchantable volume may have been lost through decay. If minimum commercial size can be reached at an age of 40 or 50 years by an increase in individual tree growth through thinning, decay losses could be kept at about 10-15%.

In 1948 and 1950 two thinning trials were initiated in Manitoba in 11-, 14-, and 23-year-old aspen stands with the objective to evaluate the effect of thinning on 1) individual tree growth and subsequent merchantable volume production, and 2) mean annual total cubic foot volume increment and production.

This report presents results to 1971. Intermediate results of the two trials were reported previously (Steneker 1964, 1966; Steneker and Jarvis 1966).

LOCATION AND DESCRIPTION OF STUDY AREAS

The study areas are located in the Turtle Mountain Forest Reserve and Riding Mountain National Park. Both areas are within the B18a Mixedwood Forest Section (Rowe 1972). The soils are grey-black and grey-wooded Luvisols, developed on calcareous till. Soil texture ranges from loam to clay loam. Species occurring in small amounts with the aspen are balsam poplar (*Populus balsamifera* L.), bur oak (*Quercus macrocarpa* Michaux), elm (*Ulmus americana* L.) and green ash (*Fraxinus pennsylvanica* Marsh. var. *subintegerrina* (Vahl.) Fern).

At Turtle Mountain Forest Reserve an 11-year-old aspen stand was selected for study. The number of trees per acre ranged from 3,000 to 4,000 (7,400-9,900 trees per ha), average diameter at breast height (dbh) was 2 in. (5 cm), and average height of dominant trees ranged from 19 to 26 ft (5.8-7.9 m).

At Riding Mountain National Park 14- and 23-year-old aspen stands were selected. Specifications for the 14-year-old stand were 6,000 trees per acre (14,800 trees per ha), 1.4 in. (3.6 cm) average dbh, and 19-25 ft (5.8-7.6 m) average dominant height; and for the 23-year-old stand were 2,200 trees per acre (5,400 trees per ha), 2.9 in. (7.4 cm) dbh and 41-44 ft (12.5-13.4 m) dominant height.

METHODS

Within each selected stand a series of 0.2-acre (0.08-ha) permanent sample plots were established and subjected to the following thinning regimes:

Initial treatment	Number of sample plots (0.2 acre)[a]		
	stand age (years)		
	11 in 1948	14 in 1950	23 in 1950
12' x 12' spacing (3.6 m)		1	2[b]
10' x 10' " (3.0 m)		1	2[b]
8' x 8 ' " (2.4 m)		1[b]	2[b]
7' x 7' " (2.1 m)	1[b]		
5' x 5' " (1.5 m)	1[b]		
20' strip thinning (6 m)	1		
Control	1	1	2

[a] Plot size in the 14-year-old stand was 0.1 acre (0.04 ha).
[b] Plots subsequently thinned in 1965.

Thinning to spacing was approximate. Residuals were left as evenly distributed as possible while leaving the required number of trees per plot. The 20-ft (6-m) strip thinning in the 11-year-old stand involved the removal of all trees in 20-ft wide strips with the strips 20 ft apart.

The objective of the thinning in 1965 was to maintain the increased growth rate that resulted from the first thinning. Thinning intensities in 1965 were based on other aspen thinning results on the prairies (Steneker and Jarvis 1966), which indicated the required basal area levels for maximum net basal and total cubic foot volume increment at various ages (Table 1). By 1965 these levels of stocking had either been reached or surpassed on the more lightly thinned plots (Tables 2 and 3).

In the 1965 thinning the 7 ft x 7 ft and 5 ft x 5 ft thinned plots in the 11-year-old stand (28 years old in 1965) were thinned back

TABLE 1. Average basal area of undisturbed upland aspen stands in Manitoba and Saskatchewan and basal area per acre giving maximum basal area increment, by age (After Steneker and Jarvis 1966)

Stand age (years)	Basal area of undisturbed stands (sq ft)	Basal area giving maximum b. a. increment (sq ft)
10	44	28
20	86	48
30	104	67
40	114	84
50	122	101

to 53 and 60 sq ft (4.8 and 5.4 m^2) respectively. The 8 ft x 8 ft thinned plot in the 14-year-old stand (29 years old in 1965) was thinned back to 63 sq ft (5.7 m^2), and the 8 ft x 8 ft, 10 ft x 10 ft and 12 ft x 12 ft thinned plots in the oldest stand (38 years old in 1965) were thinned back to 90, 78 and 58 sq ft (8.1, 7.0, and 5.2 m^2) respectively. Stand statistics per acre for all plots to 1971 are given in Tables 2 and 3.

Most stems removed in the 1965 thinnings were 4 in. (10 cm) dbh or larger and it is assumed that this thinning paid for itself.

RESULTS

VOLUME INCREMENT

In all three stands plot data showed considerable differences in net mean annual total cubic foot volume increment (MAI) before thinning (Figure 1), presumably the result of site differences between plots and/or genetic differences between trees of different plots. However, treatment effects were still apparent.

TABLE 2. Stand Data Per Acre to 1971 for Sample Plots at Turtle Mountain

	Number of trees at age							Basal area (sq ft) at age							Total volume (cu ft)[a] at age						
	11		16	23	28		34	11		16	23	28		34	11		16	23	28		34
Treatment	BT	AT			BT	AT		BT	AT			BT	AT		BT	AT			BT	AT	
7' x 7'	3,085	805	740	680	585	230	225	62	16	47	81	101	53	78	951	248	821	1,798	2,442	1,349	2,139
5' x 5'	3,280	1,470	1,430	1,125	855	335	335	54	32	73	107	114	60	86	800	474	1,322	2,328	2,770	1,509	2,271
20' strips	4,240	2,260	1,905	1,440	930	930	730	65	33	55	82	90	90	98	937	475	879	1,612	1,849	1,849	2,216
Control[b]	2,740	2,740	2,240	1,425	980	980	845	44	44	71	88	98	98	110	655	655	1,256	1,877	2,326	2,326	2,768
Control	60	60	65	55	50	50	55	15	15	19	22	24	24	28	238	238	343	596	720	720	641

a Interpolated volume tables 1944. Dominion Forest Service, Miscellaneous Series #3.

b The control plot contained some trees other than aspen.

TABLE 3. Stand Data per Acre to 1971 for Sample Plots at Riding Mountain

Treatment	Number of trees at age						Basal area (sq ft) at age						Total volume (cu ft)[a] at age					
	23		33	38		44	23		33	38		44	23		33	38		44
	BT	AT		BT	AT		BT	AT		BT	AT		BT	AT		BT	AT	
12' x 12'	2,365	300	300	290	190	190	97	26	71	87	59	87	1,986	580	1,873	2,455	1,662	2,738
12' x 12'	1,965	300	295	280	190	190	95	28	69	80	58	80	1,895	593	1,801	2,141	1,554	2,330
10' x 10'	2,645	435	425	405	270	265	106	36	93	105	77	104	2,065	765	2,408	2,861	2,133	3,112
10' x 10'	2,250	435	420	400	320	310	75	33	84	96	80	103	1,796	693	2,160	2,530	2,100	2,964
8' x 8'	1,700	680	615	530	370	350	92	56	114	114	89	107	1,793	1,132	2,964	3,087	2,389	2,997
8' x 8'	1,665	680	640	575	400	380	92	53	115	119	91	112	1,792	1,087	2,974	3,175	2,458	3,061
Control	2,490	2,490	1,470	1,090	1,090	865	127	127	159	164	164	177	2,706	2,706	4,069	4,562	4,562	5,351
Control	2,730	2,730	1,650	1,110	1,110	955	131	131	166	159	159	178	2,631	2,631	4,214	4,191	4,191	5,127
							Stand age											
	14		24	29		35	14		24	29		35	14		24	29		35
12' x 12'	5,970	300	260	250	250	240	70	6	29	40	40	58	907	83	459	729	729	1,242
10' x 10'	6,670	440	410	350	350	340	55	9	40	46	46	62	714	119	640	803	803	1,290
8' x 8'	5,270	680	630	560	400	400	71	20	75	85	62	84	990	296	1,424	1,767	1,311	2,001
Control	6,050	6,050	3,060	2,050	2,050	1,540	55	55	103	104	104	111	712	712	1,685	1,914	1,914	2,263

[a] Interpolated volume tables 1944. Dominion Forest Service, Miscellaneous Series #3.

Data to 1971 for the Turtle Mountain stand (Fig. 1a) show that MAI (based on standing volume + thinnings) was not much affected by treatment except for the strip thinning, which resulted in a marked increment drop, presumably because of incomplete utilization of the site. The control plot did show a drop in increment during the last few years due to high tree mortality. Although thinning to 7 ft x 7 ft at age 11 (residual basal area of 17 sq ft or 1.4 m^2) caused a slight drop in increment, subsequent increment was comparable to the other plots. Culmination of MAI on the control plot appears to have occurred by age 30, whereas MAI for the two thinned plots may still not have maximized by age 34.

In the youngest Riding Mountain stand (Fig. 1b) thinning to 10 ft x 10 ft and 12 ft x 12 ft at age 14 caused a marked drop in MAI. Under these regimes basal areas per acre were reduced to 9 and 6 sq ft (0.8 and 0.5 m^2) respectively. At that age residual stocking was too low to attain all the potential volume increment. The effect of thinning on these plots was still apparent 15 years after treatment, although by 1971 at age 35 MAI approached that on the control plot. Culmination of MAI on the control plot appears to have occurred at age 25. On the thinned plots no distinct culmination of MAI could as yet be observed by age 35.

The older stand at Riding Mountain (thinned at age 23) showed little difference in MAI between thinned plots (Fig. 1c). Although a drop in increment occurred after thinning to a 12 ft x 12 ft spacing, by age 44 in 1971 MAI on all thinned plots was quite similar. Culmination of MAI on the control plots occurred at age 30. However, by age 44 no maximum increment value was yet apparent on the thinned plots.

Although the oldest (44-year-old) stand had produced the greatest amount of material 8 in. (20 cm) dbh and larger, no prediction could be made at what age MAI for this material would culminate. MAI to age 33 ranged from 12 cu ft (0.3 m^3) for the 12 ft x 12 ft thinning to 1.5 cu ft (0.04 m^3) for the control plots and at age 44 from 60 cu ft (1.7 m^3) to 42 cu ft (1.2 m^3) respectively. Substantial further increases in increment before culmination are indicated.

VOLUME PRODUCTION

Total cubic foot volume production data (standing volume + thinning) to 1971 (Table 4) still reflect initial standing volumes at time of treatment (Table 3). Consequently, the effect of thinning is obscured. However, some differences in production can be attributed to treatment. The 44-year-old stand at Riding Mountain shows a slightly higher production to 1971 following the 10 ft x 10 ft than the 12 ft x 12 ft thinning (4,819 to 4,578 cu ft or 135 to 128 m^3), although initial volumes in 1950 were comparable. The 35-year-old stand at Riding Mountain showed a loss in total production as a result of thinning to 10 ft x 10 ft and 12 ft x 12 ft, although judging from Fig. 1, production losses may disappear within a few years. Strip thinning caused a marked drop in production, whereas thinning to 5 ft x 5 ft and 7 ft x 7 ft resulted in production gains of almost 15%.

Production to 1971 of material 4 in. (10 cm) dbh and larger, as with total production, does not show any clear treatment effect except for reduced production after strip thinning.

Production to 1971 of material 8 in. (20 cm) dbh and larger reflects the effect of thinning on diameter increment. In the 44-year-old

TABLE 4. Volume Production (Cu Ft) Including Thinnings to 1971 by Stands and Treatments

Stand age in 1971	Treatment	Number of plots	Volume (cu ft)		
			Total	≥4" dbh	≥8" dbh
44	12' x 12'	2	4,578	3,537	2,618
	10' x 10'	2	4,819	3,680	2,472
	8' x 8'	2	4,420	3,826	1,874
	Control	2	5,239	5,214	1,820
35	12' x 12'	1	2,066	1,242	248
	10' x 10'	1	1,885	1,290	-
	8' x 8'	1	3,151	2,451	-
	Control	1	2,263	1,514	-
34	7' x 7'	1	3,935	3,268	1,604
	5' x 5'	1	3,859	3,452	811
	20' strips	1	2,678	2,102	207
	Control	1	3,409	3,260	780

stand, production had increased by about 45% from 1,820 to 2,618 cu ft (51 to 73 m^3). The two younger stands also showed increases, although an insufficient number of trees had passed the 8-in. (20-cm) diameter limit to make meaningful comparisons.

DIAMETER INCREMENT

Thinning increased the diameter increment of all residual trees regardless of size. For illustration, tree increment data for the older Riding Mountain stand have been presented (Figure 2).

Strip thinning did not produce any apparent stimulation of diameter increment, even in those trees close to the edge (Figure 3).

Figure 4 shows the average diameter of selected dominant trees in two stands from the time of treatment to 1971. Trees with an average dbh of 4 in. (10 cm) in 1950 in the 23-year-old stand at Riding Mountain, thinned to a spacing of 12 ft x 12 ft, reached an average dbh of 9 in. (23 cm) in 1971 at age 44. Similar-sized dominants on the control plots reached an average dbh of 6.4 in. (16 cm). If growth trends for the unthinned plots were projected at current rates, these trees would not reach an average of 9 in. (23 cm) dbh until an age of about 65, or 20 years later.

Increment trends for the Turtle Mountain stand also indicate a difference of about 20 years between trees reaching an average of 9 in. (23 cm) dbh on thinned and control plots. The difference of 20 years, particularly for the Riding Mountain stand, is conservative because it is assumed that the unthinned trees will maintain their growth rate over the next 20 years.

DISCUSSION AND CONCLUSIONS

Although results are confounded by differences between plots in initial stand volume and tree size, and although there were few or no replications, some general conclusions can be drawn:

1. Mean annual total volume increment (MAI) in the unthinned stands culminated at age 25 to 30. Thinning appears to prolong culmination age by a few years.

2. Thinning stimulated the diameter increment of all tree sizes, confirming results by Zehngraff (1949) and Zasada (1952).

3. Thinning to 12 ft x 12 ft spacing in the 23-year-old stand and to 10 ft x 10 ft and 12 ft x 12 ft spacings in the 14-year-old stand was too severe and caused marked losses in MAI and subsequent losses in total cubic foot volume production to ages 44 and 35 respectively.

4. Cubic foot volume production of material 8 in. (20 cm) dbh and larger was markedly increased by thinning.

If the anticipated end product from poplar stands is fibre or pulp, thinnings would be unjustified. Gain in fibre production will be in the form of anticipated mortality. This material will generally be of small size and low value and its removal will be uneconomical.

If the objective of thinning is to produce large-sized trees for lumber in a shorter period of time, thinning could be given consideration. The initial cost of thinning must then be recovered through a final gain in merchantable volume. Present growth data indicate a 45% gain in production of material 8 in. (20 cm) dbh and larger to age 44. Diameter increment data further suggest that an average diameter of dominant trees of 9 in. (23 cm) will be obtained at least 20 years sooner on the thinned than on the control plots.

Recent experience with precommercial thinning (Bella 1974) would indicate that aspen stands 10 years or under could be thinned relatively quickly using a brush saw. Cost per acre would depend on stand age, tree size, and stand density, but would likely be under 8 man-hours per acre. Trees could be thinned to a spacing of at least 10 ft x 10 ft on average sites and 12 ft x 12 ft on good sites. In Bella's study (1974), tree increment subsequent to thinning maintained itself well and the beneficial effect of the second thinning on residual trees was not marked. Therefore, subsequent thinnings should only be considered if they can pay for themselves, possibly at an age of about 35 years.

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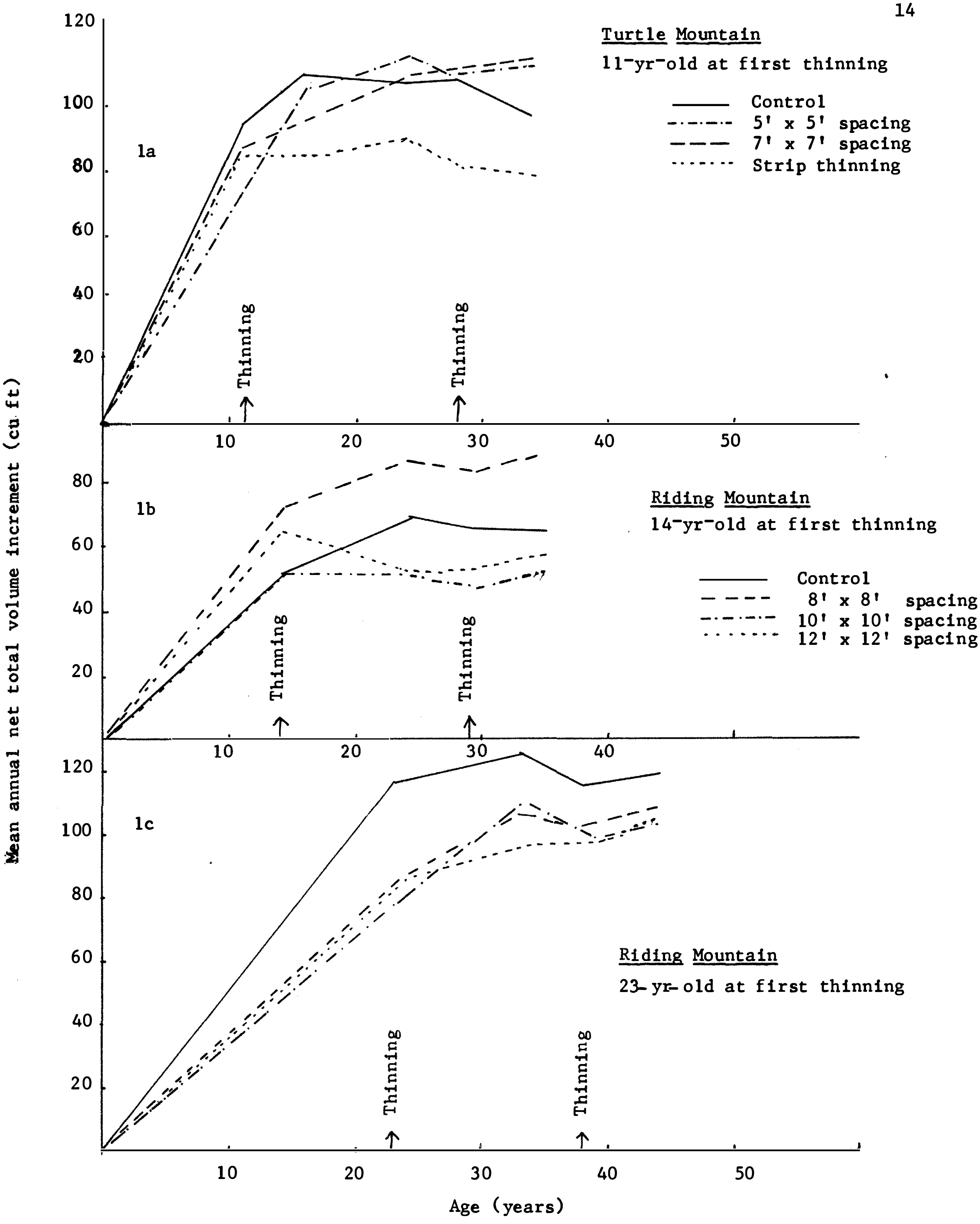

FIGURE 1. Mean annual net total volume (cu ft) increment in relation to age and treatment for the stands at Turtle Mountain and Riding Mountain.

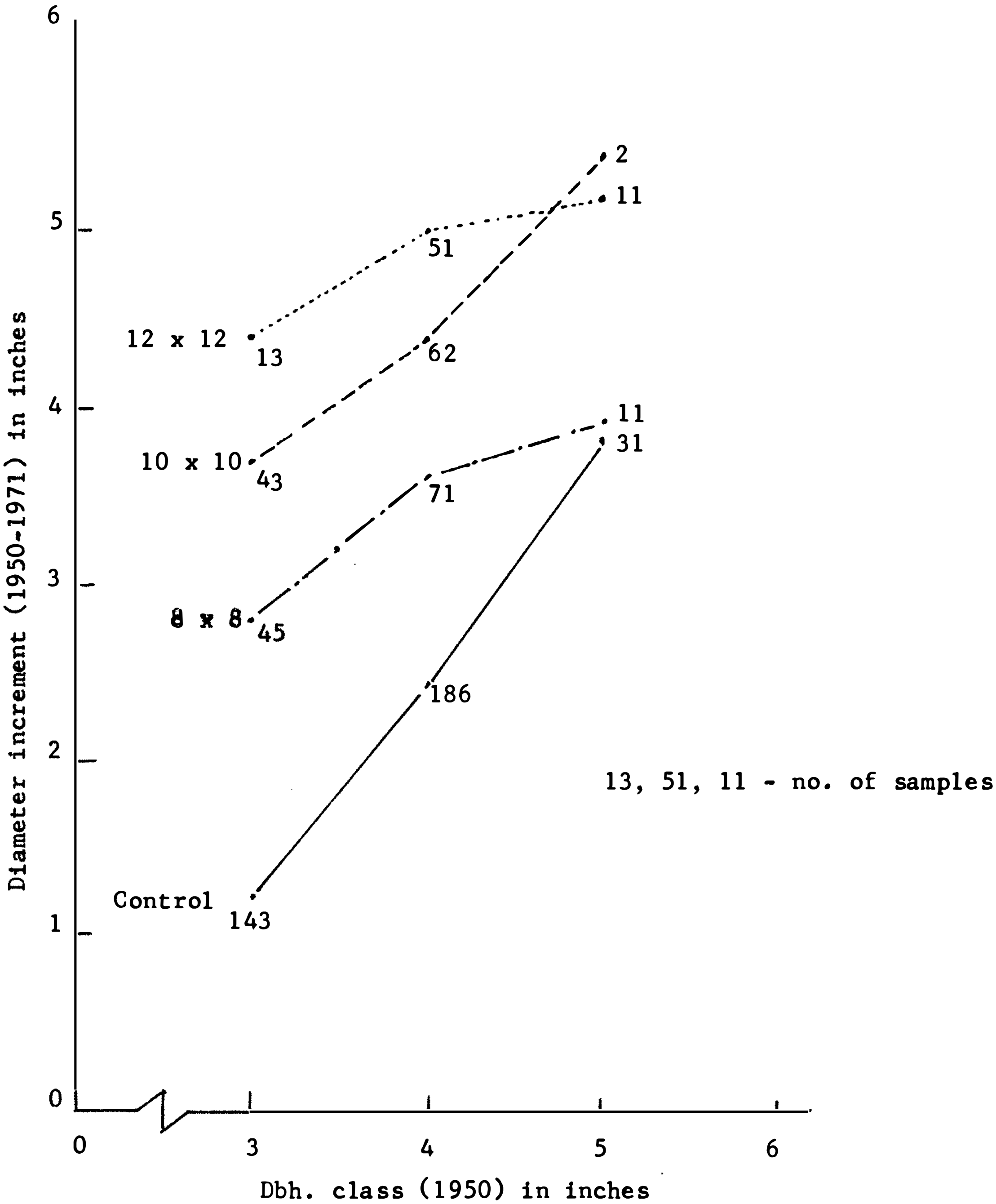

FIGURE 2. Diameter increment (1950-1971) in relation to dbh class in 1950 after thinning to different spacings in the 23-year-old aspen stand at Riding Mountain National Park.

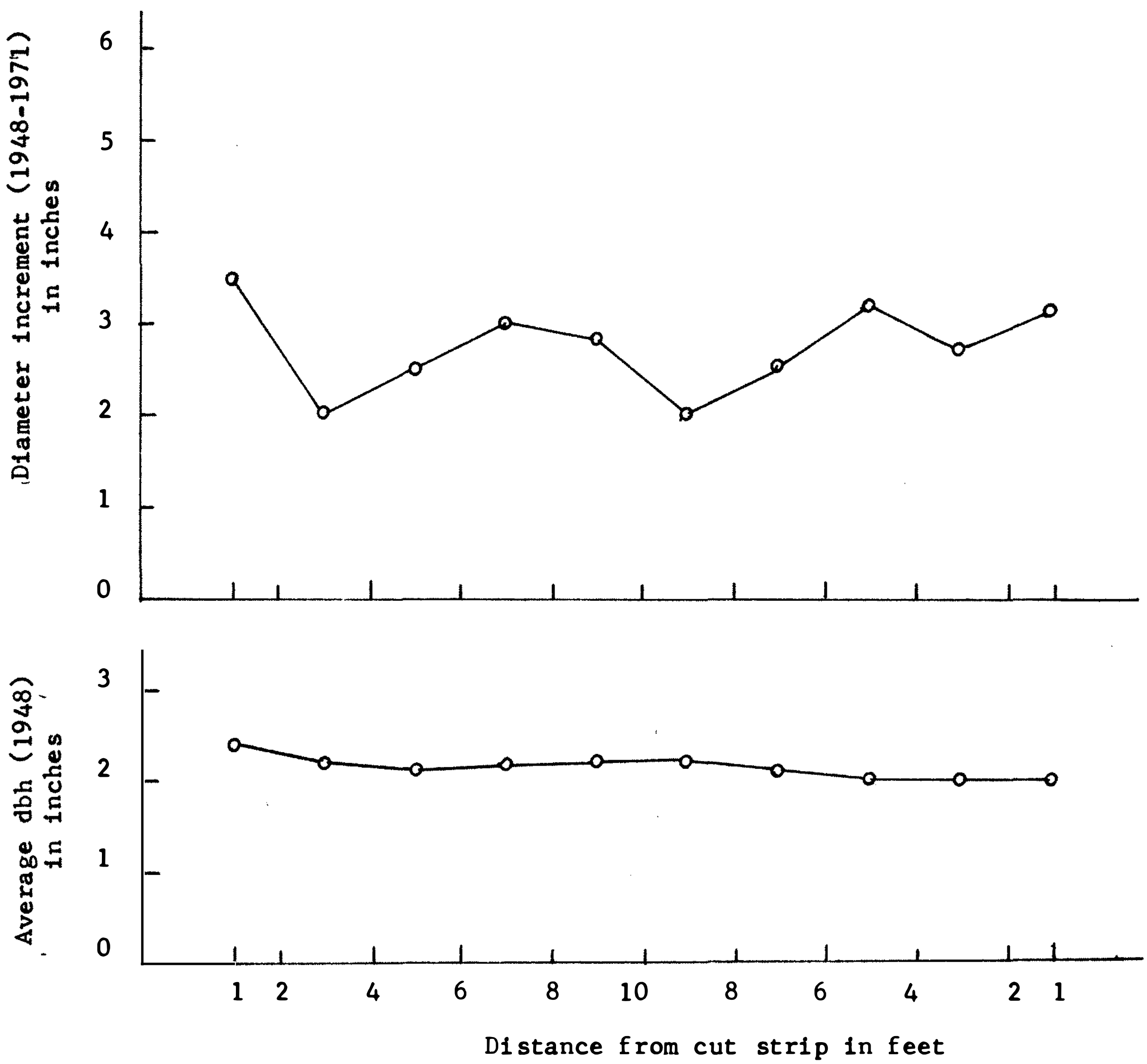

FIGURE 3. Initial diameter at breast height in 1948 and diameter increment (1948-1971) of trees across a 20-foot strip on the strip-thinned plot at Turtle Mountain Forest Reserve.

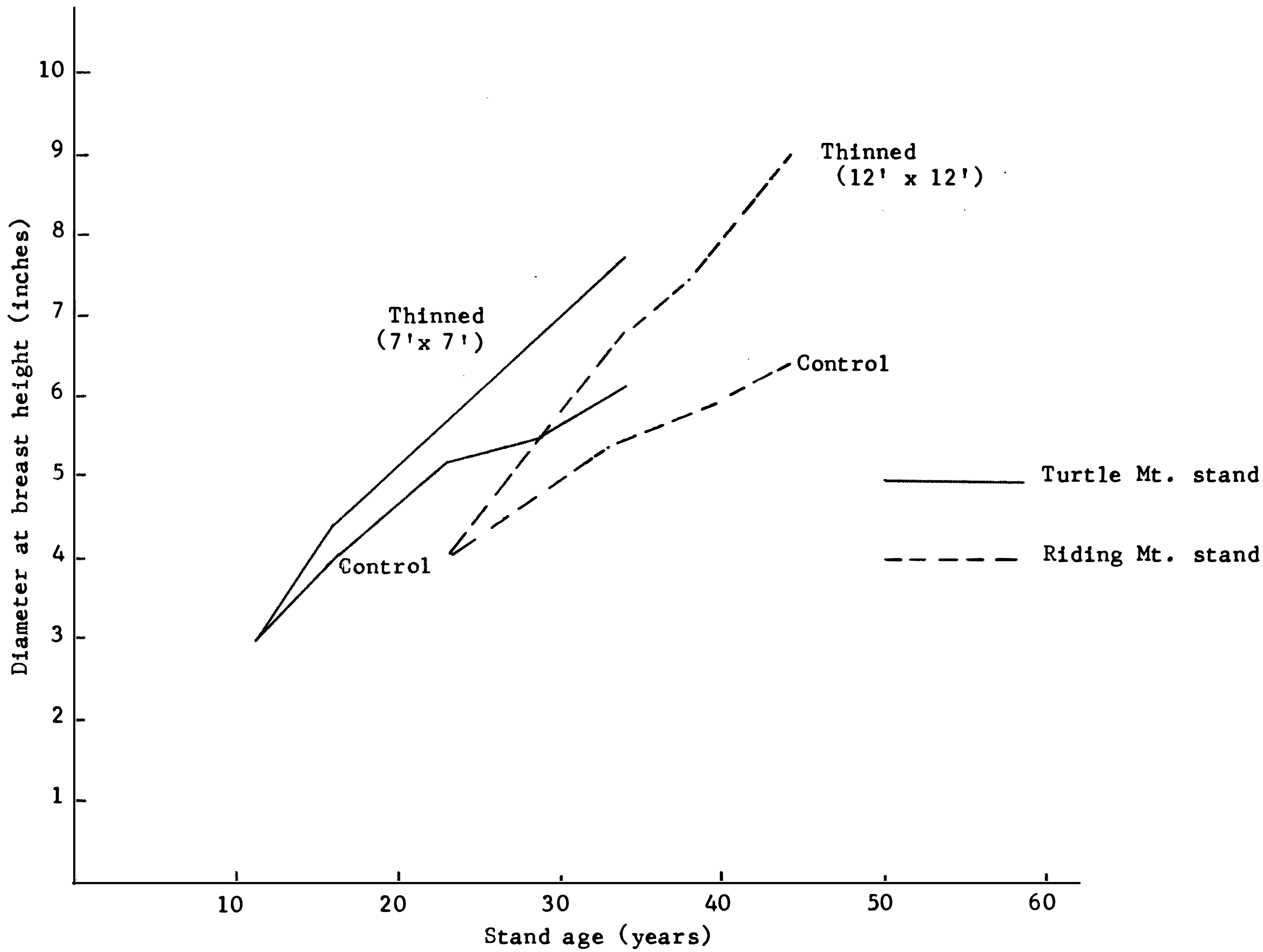

FIGURE 4. Average diameter at breast height of dominant trees to 1971 on thinned and control plots at Riding Mountain and Turtle Mountain.