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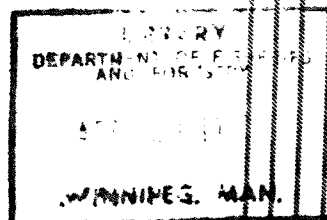
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FERTILIZATION OF UPLAND BLACK SPRUCE IN NORTHERN MANITOBA

Demonstration MS 030

by
L. D. Nairn

**FOREST RESEARCH LABORATORY
WINNIPEG, MANITOBA
INTERNAL REPORT MS-110**



**CANADIAN FORESTRY SERVICE
DEPARTMENT OF FISHERIES AND FORESTRY
MARCH, 1970**

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The forest fertilization trials in this report are being carried out by the Department of Fisheries and Forestry in cooperation with the Manitoba Department of Mines and Natural Resources as demonstrations of the possibilities of increasing merchantable yields of black spruce by the application of fertilizers.

ACKNOWLEDGEMENTS

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FERTILIZATION OF UPLAND BLACK SPRUCE IN
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INTRODUCTION

Forest fertilization studies in Sweden have shown that fertilization of coniferous stands by aircraft is both an economical and practical method of increasing forest productivity (Hagner, S. et al. 1966). With the increased demand for wood in northern Manitoba, the Manitoba Department of Mines and Natural Resources have expressed interest in the possibility of increasing merchantable yields of upland black spruce by the applications of fertilizers. Many stands in this area currently contain up to 10 merchantable cords per acre (4" d.b.h. and over) but these stands are overstocked, and stagnating with large numbers of trees just below merchantable size. It has been suggested that perhaps for a small short term investment, fertilizer might greatly increase merchantable volumes of these stands and make logging economically feasible.

In 1968 two demonstration areas were established. The first, near Sipiwesk Lake approximately seven miles southeast of Wabowden, was set out in the early spring and fertilizers applied during the last week of May, 1968. The second, approximately three miles south of Wanless, was set out in August and fertilizers applied during the period October 15-18, 1968. At Wanless, an additional fertilizer demonstration block was set out within a thinning experimental area that had been established by the province in 1966. The purpose of this latter demonstration is to assess the cost/benefit aspects of thinning compared to thinning and fertilizing. The thinned area is adjacent to the larger unthinned demonstration area, therefore a comparison can be made between thinning and fertilizing.

SIPIWESK LAKE DEMONSTRATION AREA

Description of area

The Sipiwesk Lake demonstration area is located in section 15, Tp. 68, Rge. 7, W.P.M. along the north side of the Sipiwesk Lake road, 15.0 miles east from the junction of the Thompson Highway #391 (Figure 1). This junction is approximately 11 miles southwest of Wabowden. The area is a dry upland site with a very thin humous layer. The soil is a well drained Orthic Grey Wooded soil developed on lacustrine clay. Soil analysis was carried out to a depth of 24 inches. The analysis indicated the top 6" of soil had a pH of 5.2 and contained 2.3 lbs. per acre nitrate nitrogen, 10.3 lbs. per acre available phosphorus, and 400 lbs. per acre of exchangeable K₂O.

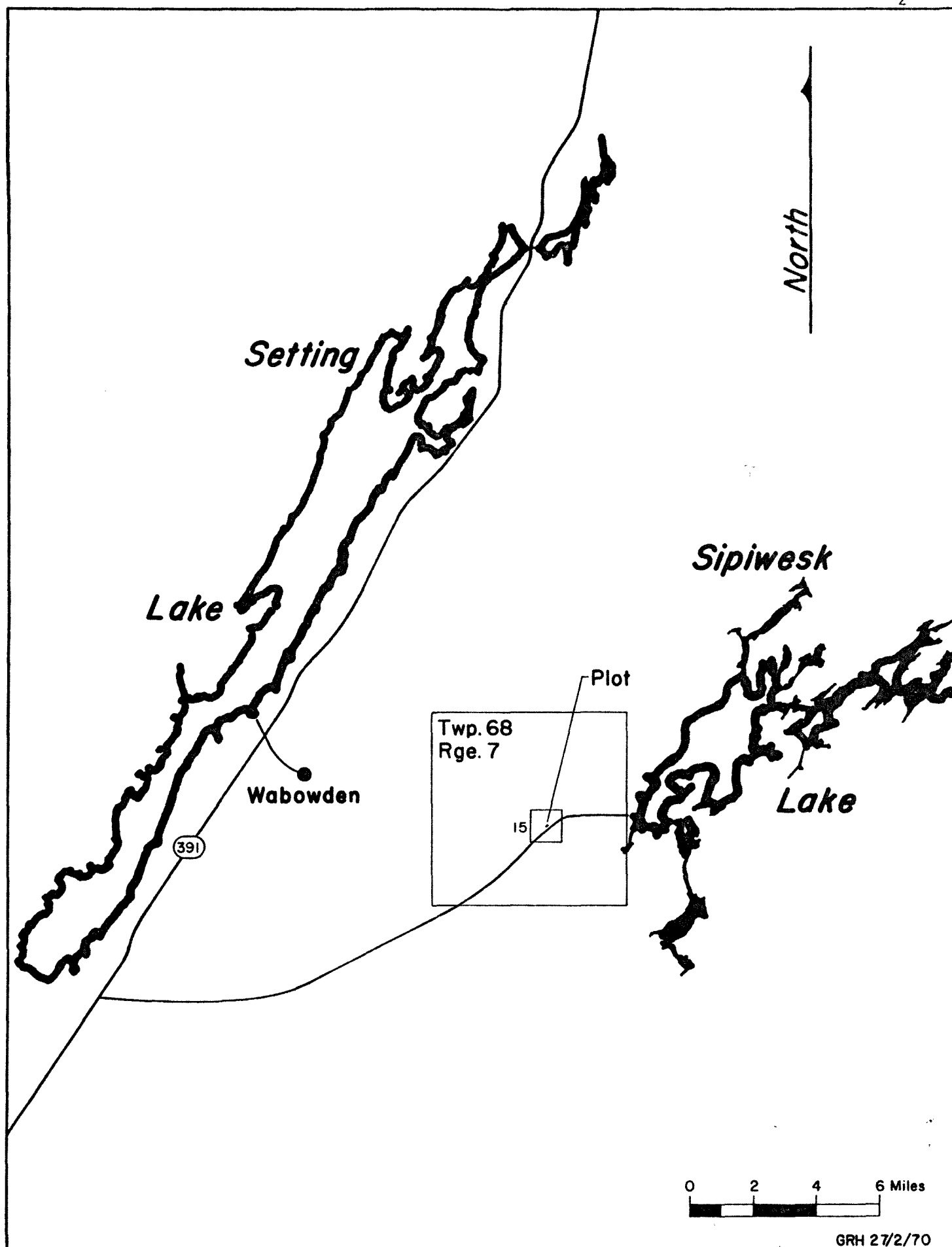


Fig.1 Fertilization Demonstration Area, Sipiweesk Lake, Manitoba

The stand was heavily stocked with 2,500 stems per acre comprised of 90 per cent black spruce, 7 per cent trembling aspen, and 3 per cent jack pine. The distribution of stems per acre and basal area per acre by diameter classes and species is shown in Table 1. This stand was apparently of fire origin, 70 years old and the average height of the dominant black spruce was 45 feet. There was no understory and ground vegetation was a carpet of shallow moss. The terrain is fairly level, sloping very gently to the northwest.

Annual radial increment has been steadily declining in the larger spruce trees over the past 15 to 20 years. This decline is also evident in the upper portions of the stem in the average size trees of the stand (Figure 2). Analysis of current years spruce needles taken in the upper portion of the crowns show 0.99 per cent nitrogen, 0.21 per cent phosphorus and 0.71 per cent potassium.

Methods

The area layout consists of 20 plots in a randomized complete block design with four replicates. Each block contains five plots with each of the five treatments randomized within the block (Figure 3).

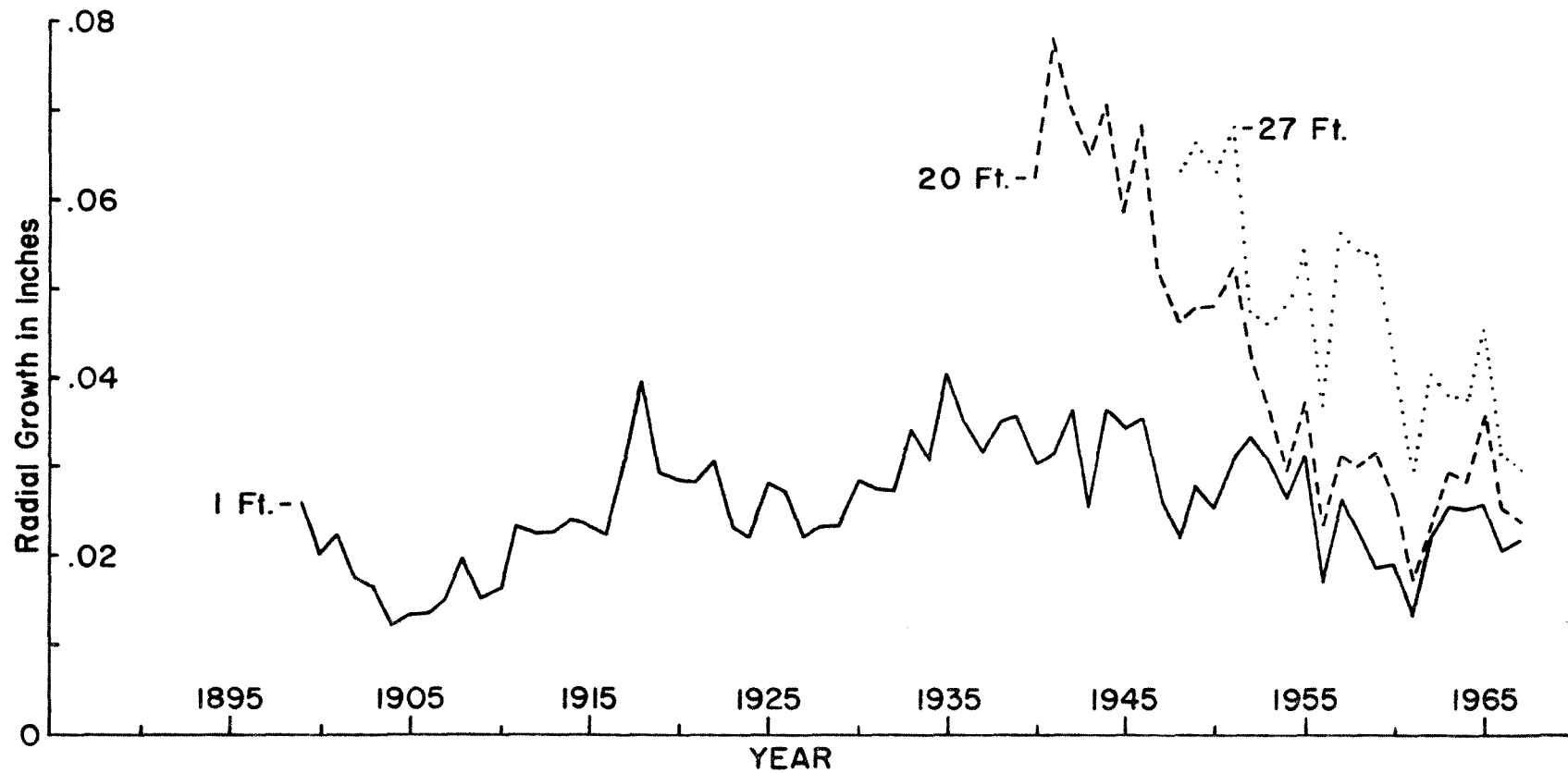
Each plot consists of (1) an inner tree study plot 40 ft. x 40 ft., (2) an area 80 ft. x 80 ft. to be fertilized within and surrounding the study plots and (3) a 10 foot buffer zone between plots and blocks to prevent contamination between treatments of adjacent plots. From available literature on root lengths and considering the density of the stand it was assumed that 20 feet should be an adequate distance to extend the fertilized area around the study trees. Including the buffer zone, this provides a minimum buffer distance of 30 feet between the study trees of one plot and the treatment area of adjacent plots.

The plots were set out using a right angle prism, with a maximum acceptable closing distance of 3 inches being adhered to on the 40 ft. x 40 ft. study plots. The corners of the study plots were permanently marked with aluminum stakes. All dead trees within the study plots were either felled or blazed. All living trees within the study plots 0.6 inches or larger were measured to the nearest 0.1 inches d.b.h. by diameter tape. The location of each measurement was initially marked with a paint crayon and subsequently painted. The number of trees and basal area by species for each plot is shown in Table 2. Height measurements were taken on five representative trees on each plot. In addition to the above 4 block plus 20 plot layout one additional similar plot was set out to test the effects of a very high (700 lbs. nitrogen per acre) application of fertilizer. This plot is designated as 700N.

Treatments

The following five treatments were applied to the five plots in each of the four blocks as shown in Table 2:

Figure 2. Radial growth of a black spruce tree 3.5 inches d.b.h. and 41 feet in height from the Sipiwesk Lake demonstration area. Radial growth is shown for the 1-foot, 20-foot, and 27-foot levels.



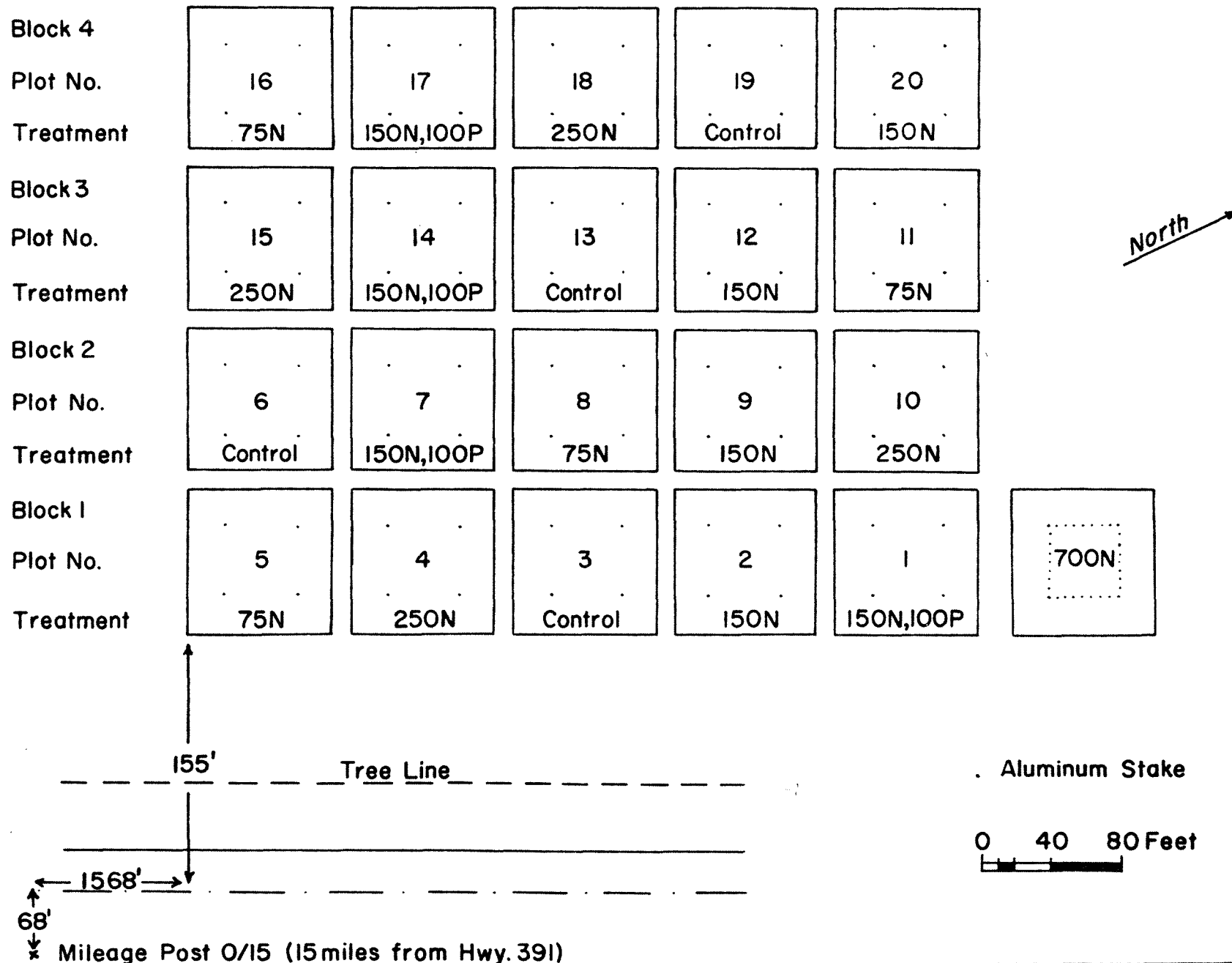


Fig.3 Fertilization Demonstration Area, Sipiwesk Lake, Manitoba

Treatment Per AcreCommercial Fertilizer Specification

Control

75 lbs. nitrogen (N)

UREA (46-0-0)

150 lbs. N

UREA (46-0-0)

150 lbs. N + 100 lbs. P₂O₅

UREA (46-0-0) + Triple Super Phosphate (0-46-0)

250 lbs. N

UREA (46-0-0)

Plot number 700N was treated with 700 lbs. of nitrogen per acre using UREA. All fertilizer was applied using a heavy duty "Cyclone" seeder. Preliminary trials showed that an ideal width of spread and rate of application would be obtained on the 80 ft. x 80 ft. plots by subdividing each plot with string lines every 13.3 feet starting at 6.7 feet from the boundary. The predetermined amount of fertilizer for each treatment was weighed out at the site using a double beam platform scale.

All dead branches were cleared from the trees along the string lines to enable the man applying the fertilizer to concentrate in maintaining a steady pace and an even width of spread of fertilizer (13.3 ft.). The application was made in two passes with the direction of travel on the second pass being opposite to that of the first application. With experience the operator could set the rate of flow of fertilizer for each treatment so that at the end of the second pass there would be less than a handful of fertilizer to distribute on the plot.

WANLESS DEMONSTRATION AREA

Description of area

The Wanless demonstration area is located in section 31, Tp. 59, Rge. 26, W.P.M. along the east side of highway no. 10, 3.1 miles south of the Wanless post office (Figure 4). The area is located on an imperfectly drained Solonchic soil developed on glacial till. There is a thin humous layer. Soil analysis of the top 6 inches of soil showed a pH of 5.4 and contained 1.1 lbs. per acre nitrate nitrogen, 14.0 lbs. per acre available phosphorus and 740 lbs. per acre exchangeable K₂O.

This stand was also heavily stocked with 2,300 stems per acre comprised of 65 per cent black spruce, 28 per cent jack pine and 7 per cent trembling aspen. The distribution of stems per acre and basal area per acre by diameter classes and species is shown for the unthinned area in Table 3 and the thinned area in Table 4. The stand is fire origin, 65-75 years old with the average height of the dominant black spruce being 48 ft. The understory vegetation is scattered willow and alder over a carpet of moss. The terrain is level.

Annual radial increment has been declining over the past ten years (Figure 5). Analysis of black spruce needles from the upper crown show 1.11 per cent nitrogen, 0.12 per cent phosphorus and 0.46 per cent potassium. Jack pine needles contained 1.34 per cent N, 0.15 per cent P, and 0.30 per cent K.

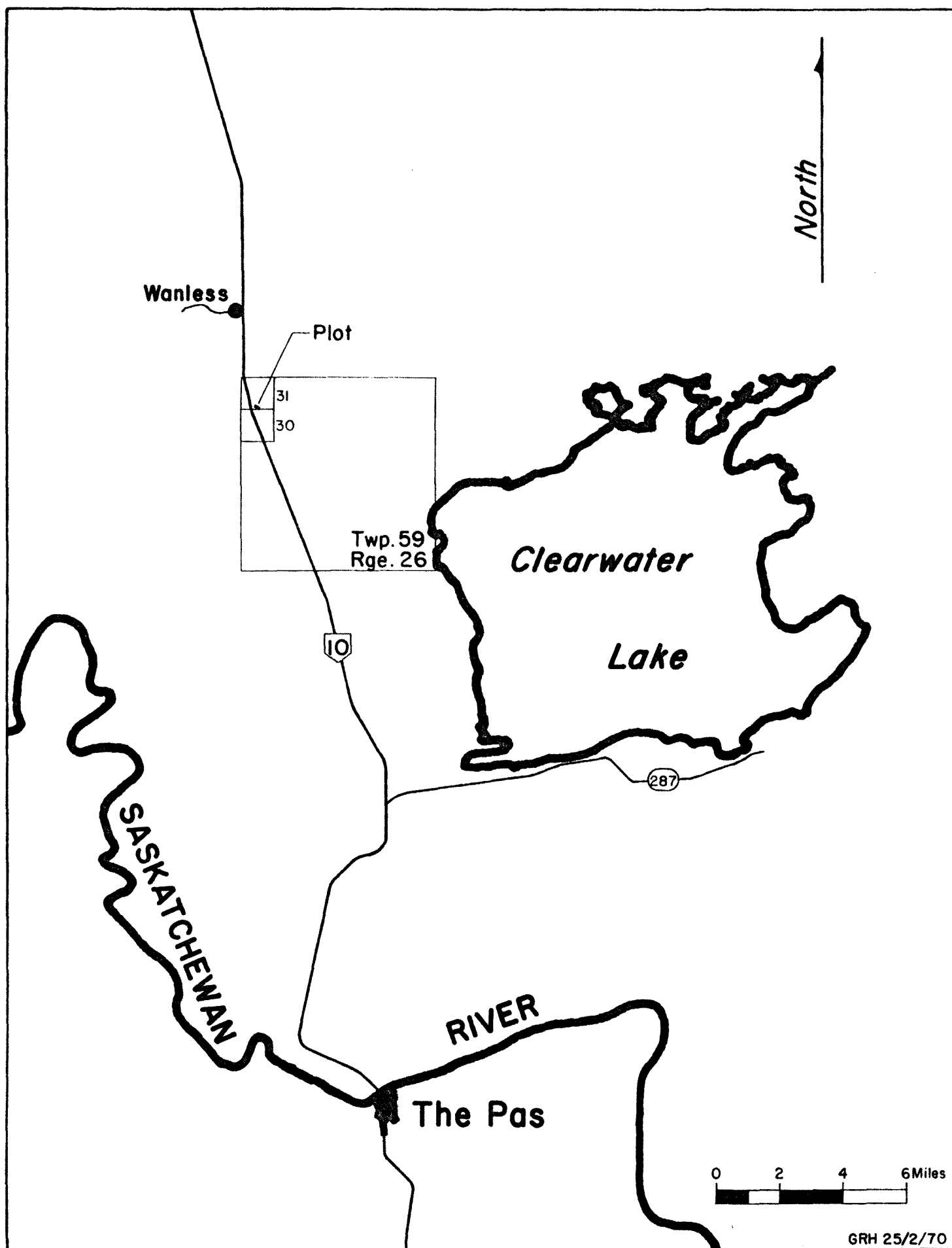
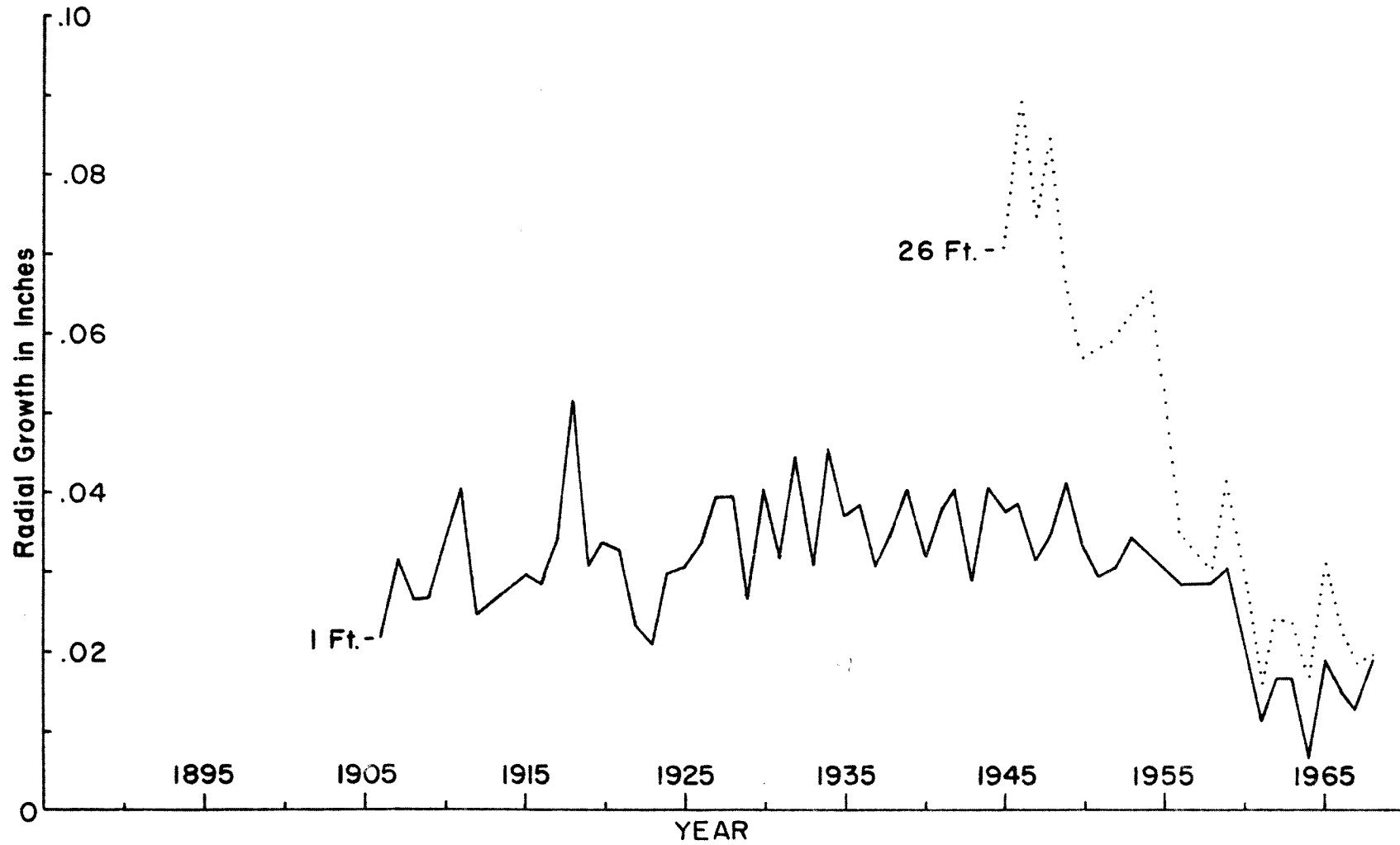


Fig.4 Fertilization Demonstration Area, Wanless, Manitoba

Figure 5. Radial growth of a spruce tree 4.1 inches d.b.h. and 41 feet in height from the Wanless demonstration area. Radial growth is shown for the 1-foot and 26-foot levels.



Methods

The area layout consists of a randomization of five treatments replicated four times. It was not possible to set out the randomized complete block design as carried out at Sipiwesk Lake due to the small area of the stand and frequently occurring openings in the stand together with the necessity of selecting plots with similar stand density. Essentially 28 plots were laid out in order to select 20 plots to be used in the demonstration (Figure 6). The demonstration for the thinned area consists of one block of six plots wherein three treatments are replicated twice (Figure 6).

The individual plot size and buffer areas are the same as for the Sipiwesk Lake area. The number of trees and basal area by species for each plot is shown in Table 2. Height measurements were taken on five representative trees on each plot.

Treatments

The five treatments are again the same as for the Sipiwesk Lake area, namely: (1) control (2) 75N (3) 150N (4) 150N + 100 P₂O₅ (5) 250N (Table 5). The method of application was also identical. In the thinning plots only three treatments were used, namely: (1) control, (2) 75N and (3) 150N (Table 6).

The general data of the thinned area is given in the Manitoba Dept. of Mines and Natural Resources, Silvicultural Report N.W. 66-1. Briefly, the following statistics are taken from this report:

1. Six acres thinned by 3-man crew using axe and power saw.
2. Stems per acre: before thinning = 1,900, after thinning = 1,125
3. Average spacing: 5.9 feet.
4. Per cent stems removed: 41%.
5. Cost per acre: \$40.91.

FUTURE WORK

All plots will be checked annually for tree mortality. Foliage analysis will be carried out annually for N, P, and K for each treatment in both locations.

Core samples were taken from all plots in the Sipiwesk Lake area in the fall of 1969. A preliminary report will be prepared on radial growth following two growing seasons since fertilization at Sipiwesk Lake.

All plots will be remeasured following five growing seasons since application of fertilizer, i.e. Sipiwesk Lake in 1972 and Wanless in 1973.

Final assessment of growth will be made when radial growth has returned to pre-fertilization levels (probably 1974 or 1975). Assessment will be made from gross tree measurements and analysis of radial growth within individual sample trees.

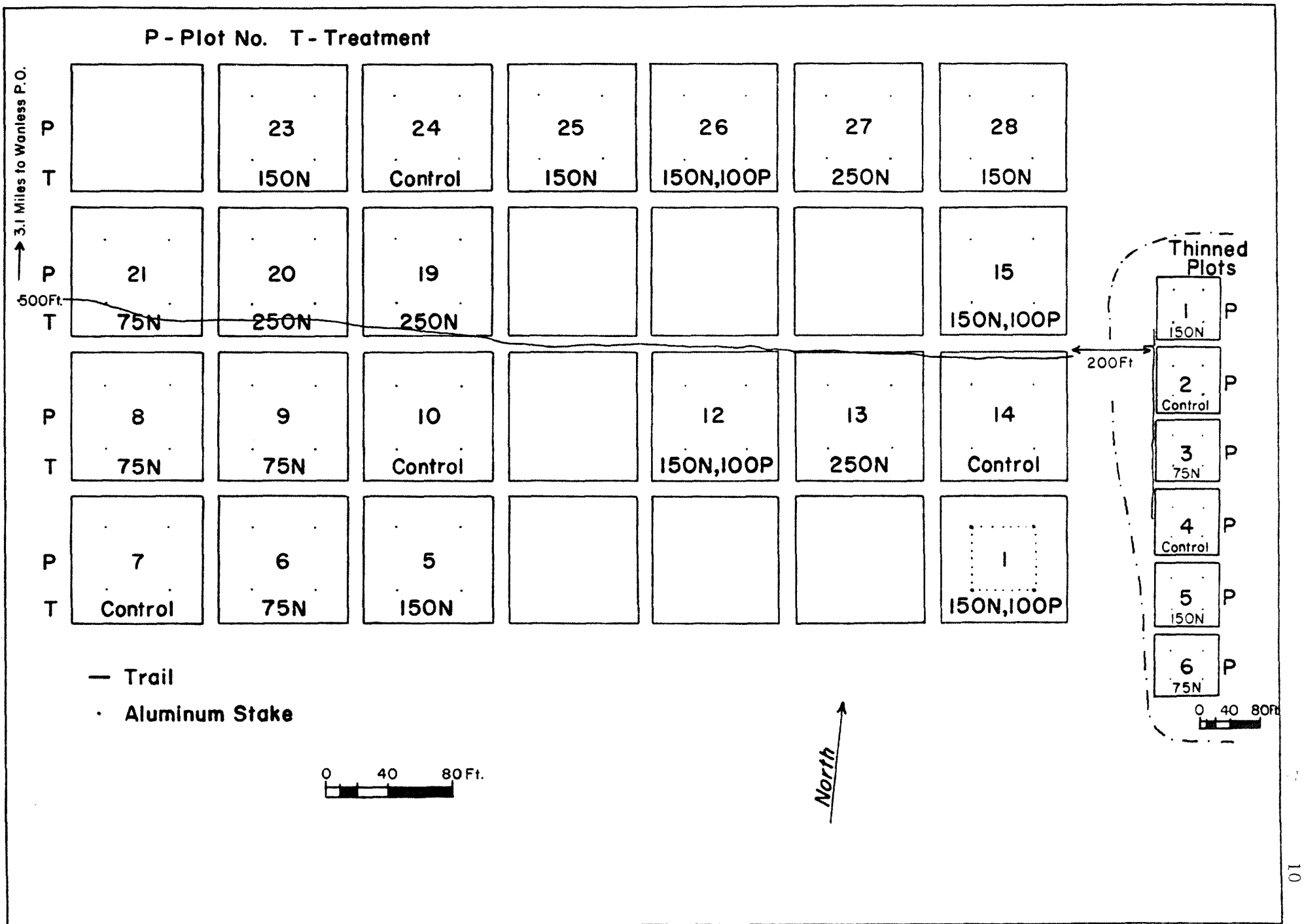


Fig.6 Fertilization Demonstration Area, Wanless, Manitoba

REFERENCES

- Hagner, S. et al. 1966. Timber production by forest fertilization.
Sveriges Scogsvforb. Tidskr. 64(2):103-171.

Table 1

Distribution of stems per acre and basal area per acre by diameter classes and species in the Sipiwesk Lake demonstration area, June 2, 1968.

Species Dia.class d.b.h.	Black Spruce		Jack Pine		Aspen	
	Stems/ acre	BA/ acre (sq.ft.)	Stems/ acre	BA/ acre (sq.ft.)	Stems/ acre	BA/ acre (sq.ft.)
1"	530	3.516	-	-	-	-
2"	388	9.014	-	-	-	-
3"	369	18.531	3	0.143	50	2.785
4"	460	41.232	30	2.750	64	5.691
5"	377	51.325	33	4.461	41	5.528
6"	110	21.461	14	2.570	11	2.078
7"	27	7.038	11	3.012	3	0.677
8"	8	2.853	5	1.854	-	-
9"	-	-	-	-	-	-
Totals	2269	154.972	96	14.790	169	16.759

GRAND TOTAL ALL SPECIES

Stems per acre = 2534

Basal area per acre = 186.521 sq. ft.

Table 2

Number of trees, basal area, and treatment for each plot in the Sipiwek Lake demonstration area.

Plot No.	Treatment	Black Spruce (per plot)		Jack Pine (per plot)		Aspen (per plot)		Totals per plot	
		No. trees	BA (sq.ft.)	No. trees	BA (sq.ft.)	No. trees	BA (sq.ft.)	No. trees	BA (sq.ft.)
Block 1	1 150N+100P ₂₀₅	84	5.256	8	1.180	-	-	92	6.436
	2 150N	83	6.677	-	-	14	1.690	97	8.367
	3 Control	62	5.070	3	0.331	11	1.638	76	7.039
	4 250N	101	7.193	5	0.613	3	0.403	109	8.209
	5 75N	73	7.398	2	0.211	-	-	75	7.609
Block 2	6 Control	85	5.665	-	-	7	0.542	92	6.207
	7 150N+100P ₂₀₅	94	5.402	-	-	1	0.115	95	5.517
	8 75N	105	7.702	3	0.925	2	0.417	110	9.044
	9 150N	67	5.030	11	1.699	5	0.578	83	7.307
	10 250N	83	5.098	7	0.957	-	-	90	6.057
Block 3	11 75N	123	7.164	3	0.380	-	-	126	7.554
	12 150N	98	6.181	7	1.083	5	0.361	110	7.625
	13 Control	112	6.186	5	0.572	2	0.217	119	6.975
	14 150N+100P ₂₀₅	108	6.414	-	-	3	0.252	111	6.666
	15 250N	58	4.668	-	-	4	0.292	62	4.960
Block 4	16 75N	33	4.019	8	1.681	6	0.402	47	6.102
	17 150N+100P ₂₀₅	37	3.435	1	0.351	31	2.743	69	6.493
	18 250N	102	5.677	5	0.740	4	0.276	111	6.693
	19 Control	75	6.120	-	-	26	2.397	101	8.517
	20 150N	83	4.126	2	0.156	-	-	85	4.282
700N	700N	116	5.091	3	0.360	-	-	119	5.451

Table 3

Distribution of stems per acre and basal area per acre by diameter classes and species in the Wanless (unthinned) demonstration area, August 14, 1968

<u>Species</u> Dia.class d.b.h.	Black Spruce		Jack Pine		Aspen	
	Stems/ acre	BA/ acre (sq.ft.)	Stems/ acre	BA/ acre (sq.ft.)	Stems/ acre	BA/ acre (sq.ft.)
1"	256	1.831	-	-	-	-
2"	366	8.589	-	-	1	0.046
3"	399	20.773	45	2.502	29	1.491
4"	437	39.222	99	8.856	48	4.103
5"	275	37.444	99	13.817	26	3.455
6"	82	15.801	84	16.724	7	1.295
7"	10	2.345	39	10.483	4	1.188
8"	3	0.868	5	2.000	1	0.524
9"	-	-	-	-	1	0.562
Totals	1828	126.873	371	54.382	117	12.664

GRAND TOTAL ALL SPECIES

Stems per acre = 2316

Basal area per acre = 193.919 sq. ft.

Table 4

Distribution of stems per acre and basal area per acre by diameter classes and species in the Wanless (thinned) demonstration area.

Species Dia. class d.b.h.	Black Spruce		Jack Pine	
	Stems/ acre	BA/ acre (sq.ft.)	Stems/ acre	BA/ acre (sq.ft.)
1"	-	-	-	-
2"	41	1.143	-	-
3"	209	11.208	9	0.490
4"	390	35.882	18	1.711
5"	318	44.363	36	5.177
6"	77	15.686	45	9.102
7"	23	5.962	41	11.598
8"	-	-	9	3.317
9"	-	-	-	-
Totals	1058	114.244	158	31.395

GRAND TOTAL ALL SPECIES

Stems per acre = 1216

Basal area per acre = 145.639 sq.ft.

Table 5

Number of trees, basal area, and treatment for each plot in the Wanless (thinned) demonstration area.

Plot No.	Treatment	Black Spruce (per plot)		Jack Pine (per plot)		Aspen (per plot)		Totals per plot	
		No. trees	BA (sq.ft.)	No. trees	BA (sq.ft.)	No. trees	BA (sq.ft.)	No. trees	BA (sq.ft.)
1	150N+100P ₂₀₅	83	5.100	12	1.418	3	0.157	98	6.675
5	150N	40	3.269	15	2.424	4	0.797	59	6.490
6	75N	75	5.670	4	0.273	5	0.623	84	6.566
7	Control	99	4.723	18	1.977	6	0.411	123	7.111
8	75N	85	4.857	11	2.130	10	1.018	106	8.005
9	75N	45	4.698	17	2.397	1	0.126	63	7.221
10	Control	66	4.830	5	0.926	4	0.484	75	6.240
12	150N+100P ₂₀₅	92	6.953	8	1.183	9	0.860	109	8.996
13	250N	97	5.394	13	2.544	1	0.083	111	8.021
14	Control	75	5.818	9	1.420	1	0.079	85	7.317
15	150N+100P ₂₀₅	51	4.136	15	2.399	9	0.496	75	7.031
19	250N	60	5.028	3	0.345	1	0.075	64	5.448
20	250N	36	2.720	16	3.161	5	1.329	57	7.210
21	75N	40	3.748	16	3.357	5	0.822	61	7.927
23	150N	34	2.324	29	3.579	-	-	63	5.903
24	Control	69	5.552	12	1.158	9	0.841	90	7.551
25	150N	95	5.952	13	1.141	6	0.512	114	7.605
26	150N+100P ₂₀₅	81	4.425	15	2.199	4	0.340	100	6.964
27	250N	62	4.123	23	3.272	1	0.083	86	7.478
28	150N	57	3.840	20	2.737	2	0.167	79	6.744

Table 6

Number of trees, basal area, and treatment for each plot in the Wanless (thinned) demonstration area.

Plot No.	Treatment	Black Spruce (per plot)		Jack Pine (per plot)		Totals per plot	
		No. trees	BA (sq.ft.)	No. trees	BA (sq.ft.)	No. trees	BA (sq.ft.)
1	150N	42	4.813	2	0.325	44	5.138
2	Control	26	3.491	10	1.901	36	5.392
3	75N	39	4.577	9	2.000	48	6.577
4	Control	45	4.730	6	1.049	51	5.779
5	150N	26	2.943	3	0.850	29	3.793
6	75N	53	4.625	5	0.772	58	5.397