

CLEAR CUTTING ALTERNATE STRIPS AND SCARIFYING IN WHITE SPRUCE-
TREMBLING ASPEN STANDS TO INDUCE WHITE SPRUCE REGENERATION,
MANITOBA AND SASKATCHEWAN

PROJECT MS-216

by

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FOREST RESEARCH LABORATORY

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INTRODUCTION

Surveys (Candy 1951) in white spruce- (Picea glauca (Moench) Voss) trembling aspen (Populus tremuloides Michx.) stands in the Mixedwood Forest Section of the Boreal Forest Region (Rowe 1959) have shown that white spruce reproduction in cut-over and burned-over stands as well as in undisturbed stands was in insufficient numbers to form future well-stocked stands. Later studies have revealed that lack of reproduction was due primarily to the absence of suitable seed beds (Rowe 1955); best seedbeds were found to be decayed wood, exposed mineral soil and humus.

As a follow-up to the previous work the Forestry Branch in cooperation with the Saskatchewan government began a number of trials in 1960 to determine on an operational basis whether mechanical scarification in conjunction with logging would result in adequate spruce regeneration. Strip clear cutting was employed to create a series of micro-climates.

This report brings together, in the form of case histories, the results of these trials.

CASE HISTORIES

Trial 1 - Riding Mountain Experimental Area, Manitoba

Location: Twp. 21, Rge. 19, Sec. 1, W.P.M. (See Figure 1)

Description: Trial 1 was carried out in an area about 40 acres in size which in 1961 supported a stand containing a total basal area of about 95 square feet per acre, half white spruce and half trembling aspen (Table 1). The terrain is gently rolling,

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parent soil materials are clay loam tills and sites vary from fresh to very moist but most of the area is in the fresh to moderately moist categories.

Work done: During the winter of 1961-62 all merchantable trees on alternate 2-chain-wide strips were logged. Trembling aspen on these strips were girdled during the summer of 1961. Stand data were obtained from a $\frac{1}{2}$ -chain-wide transect established down the middle of each uncut strip. In the fall of 1961, before logging, scarification was carried out on portions of each strip to be logged (see Figure 2). A D-6 crawler-type tractor with a straight blade was used. In 1962 a total of 630 milacre quadrats (213 in cut-over scarified conditions, 217 in cut-over unscarified conditions and 200 in uncut conditions) were established to assess regeneration. As well, 5 permanent observation transects were established to assess seedbed receptiveness in the years following treatment.

Results:

1. Occurrence and abundance of white spruce, other softwoods and hardwoods 1 year and 5 years after treatment are shown in Tables 2 and 3. As can be seen from these data, white spruce regeneration is abundant only on the cut-over scarified areas. Hardwoods are well represented on all areas.
2. The number of new germinants tallied each year to 1966 is shown in Table 4. The large number of new germinants tallied in 1965 shows that many seedbeds remain receptive for a least 4 years after treatment; observations indicate many are receptive for at least 7 or 8 years. The few cotyledons recorded in 1964 and 1966 reflects the very poor seed crops in 1963 and 1965¹.
3. Occurrence and abundance of white spruce seedlings by site for the various conditions are shown in Tables 5 and 6. Generally, stocking was good on fresh, moderately moist and moist sites; it was nil on very moist sites.
4. Abundance of white spruce seedlings by height class 5 years after treatment is shown in Figure 3. Seedlings larger than three inches were found only on the cut-over scarified areas.
5. Distribution of seed bed types and occurrence of white spruce regeneration on each is shown in Table 7. Of the various seed bed types recognized, mineral soil, humus, and decayed wood were obviously the best.

¹Annual seed crop records on file in the Winnipeg office; with reference to Internal Report MS-35 by G. R. Hennessey.

Comments:

As well as showing that seed bed preparation is essential for good white spruce regeneration, the results tend to indicate that the catch of seedlings in any one year is dependent upon the amount of seed produced the previous year.

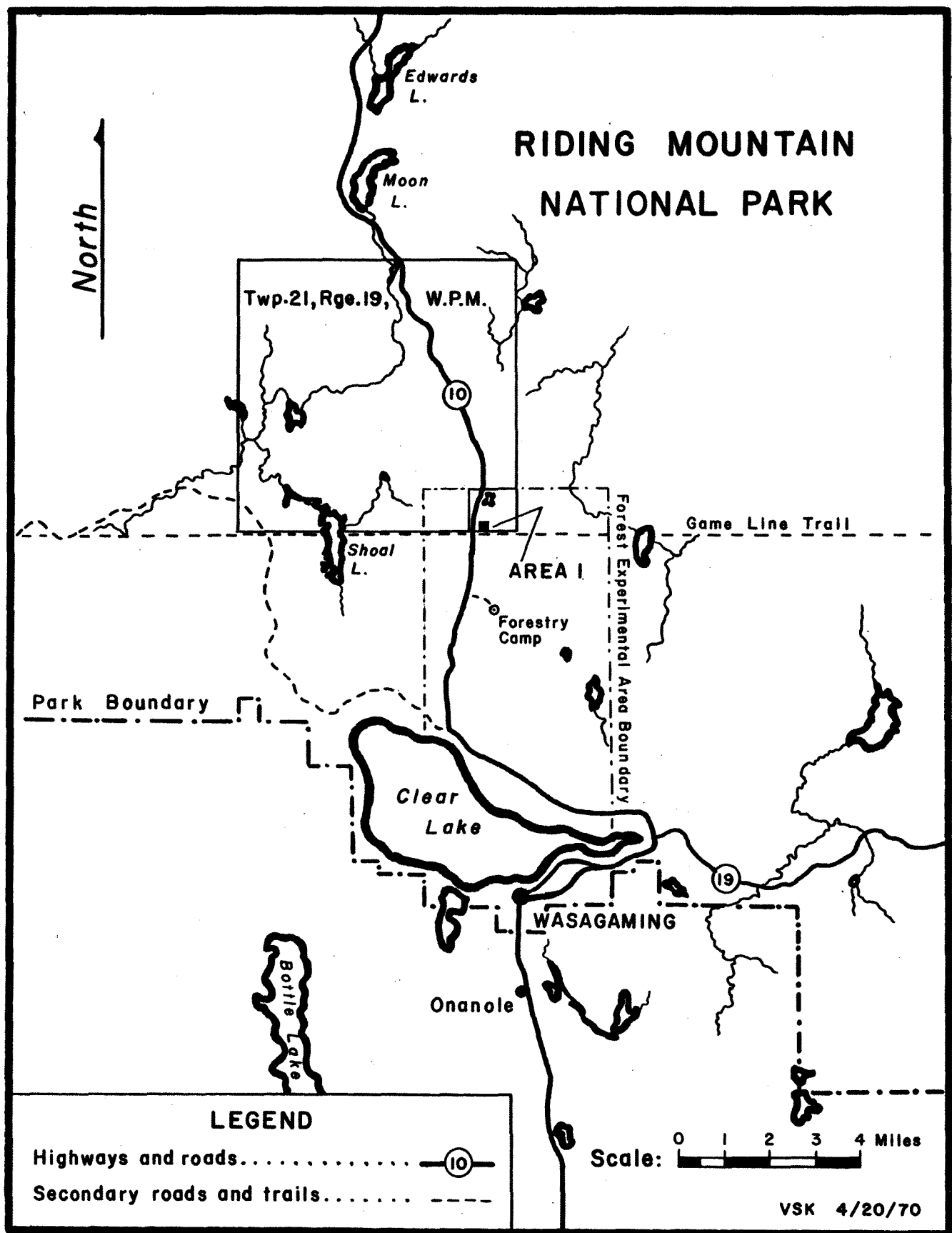


Figure 1. Location of Area 1, Project MS-216, Twp. 21, Rge. 19, Sec. 1, W.P.M.

TABLE 1
STAND TABLE AREA 1, UNCUT STRIPS
(basis: $\frac{1}{2}$ x 100 chains cruise tally)

D.B.H. (inches)	FIRST YEAR						FIFTH YEAR					
	White Spruce		Other Softwoods		Hardwoods		White Spruce		Other Softwoods		Hardwoods	
	Number of trees per acre	Basal area (sq.ft.)	Number of trees per acre	Basal area (sq.ft.)	Number of trees per acre	Basal area (sq.ft.)	Number of trees per acre	Basal area (sq.ft.)	Number of trees per acre	Basal area (sq.ft.)	Number of trees per acre	Basal area (sq.ft.)
1	33.8	.169			0.6	.003	29.6	.148			324.6	1.623
2	16.0	.352					25.8	.568			4.2	.092
3	9.0	.441					18.8	.921			0.2	.010
4	5.8	.505			0.4	.034	11.0	.957				
5	2.8	.381	0.2	.027	1.0	.136	7.6	1.034			0.6	.082
6	2.8	.549			0.6	.117	5.8	1.137			0.6	.118
7	2.0	.534			2.2	.587	2.8	.748	0.2	.053	1.0	.267
8	1.4	.489			2.8	.977	2.2	.768			1.6	.558
9	2.4	1.061			5.4	2.387	2.2	.972			4.6	2.033
10	1.6	.872			7.2	3.379	3.4	1.853			6.0	3.270
11	2.6	1.716			6.4	4.224	1.4	.924			5.6	3.696
12	1.6	1.256			7.2	5.652	3.0	2.355			8.4	6.594
13	2.2	2.028			9.4	8.667	2.4	2.213			8.0	7.376
14	2.8	2.993			4.2	4.490	1.8	1.924			6.4	6.842
15	4.0	4.908			3.6	4.417	4.8	5.890			4.6	5.644
16	3.8	5.305			2.0	2.791	3.2	4.467			2.6	3.630
17	2.2	3.467			1.8	2.837	2.2	3.467			1.8	2.837
18	2.2	3.887			1.4	2.473	2.8	4.948			2.2	3.887
19	2.0	3.938			0.4	.788	1.4	2.757			0.8	1.575
20	2.2	4.800			0.2	.436	2.2	4.800			0.4	.873
21	0.8	1.924					0.8	1.924			0.4	.962
22	1.4	3.696			0.2	.528	0.4	1.056			0.6	1.584
23	0.4	1.154			0.2	.577	0.8	2.308				
24	0.2	.628			0.2	.628	0.6	1.885				
25							0.2	.682			0.2	.682
26							0.2	.737				
27	0.2	.795										
ALL	106.2	47.848	0.2	.027	57.4	47.128	137.4	51.443	0.2	.053	385.4	54.235

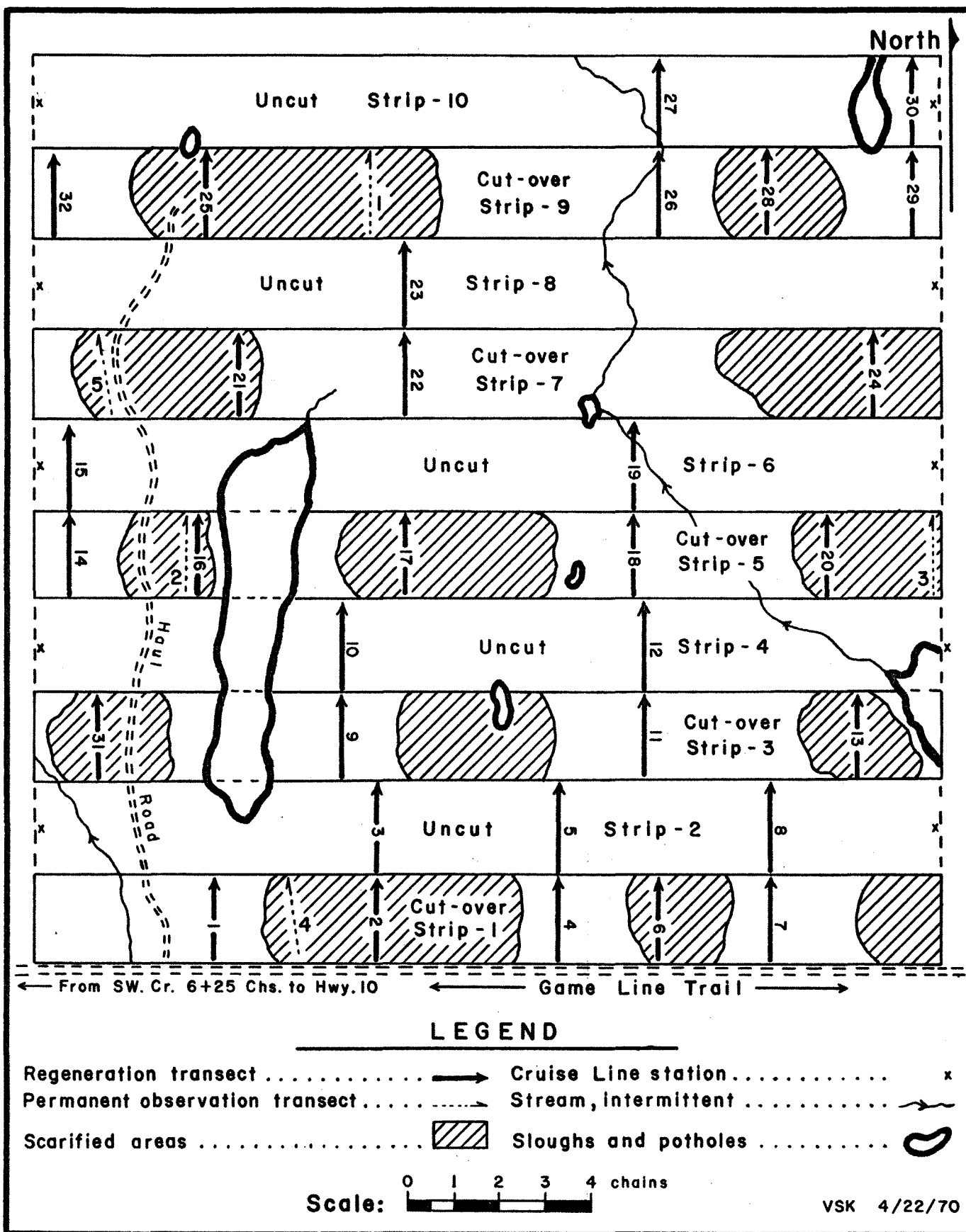


Figure 2. Sketch of Area 1 showing cut-over strips, scarified areas and location of various sample plots.

TABLE 2
PER CENT QUADRATS STOCKED TO WHITE SPRUCE, OTHER SOFTWOODS AND HARDWOODS; AREA 1

Condition	FIRST YEAR							FIFTH YEAR						
	Basis number of quadrats	White Spruce		Other Softwoods		Hardwoods		Basis number or quadrats	White Spruce		Other Softwoods		Hardwoods	
		Regener- ation %	Advance growth %	Regener- ation %	Advance growth %	Regener- ation %	Advance growth %		Regener- ation %	Advance growth %	Regener- ation %	Advance growth %	Regener- ation %	Advance growth %
Cut and scarified	213	69	1	0	0	- ¹	51	211	44	0	3	-	-	77
Cut not scarified	217	1	5	0	0	-	54	214	2	5	0	-	-	52
Uncut	200	2	7	0	0	-	63	200	3	6	0	-	-	45
Average	630	24	4	0	0	-	56	625	17	4	1	-	-	58

¹ All hardwood regeneration classed as advance growth.

TABLE 3

NUMBER OF WHITE SPRUCE, OTHER SOFTWOODS AND HARDWOOD STEMS PER ACRE, AREA 1

Condition	Number of list quadrats	FIRST YEAR						FIFTH YEAR					
		White Spruce		Other Softwoods		Hardwoods		White Spruce		Other Softwoods		Hardwoods	
		Regener-	Advance	Regener-	Advance	Regener-	Advance	Regener-	Advance	Regener-	Advance	Regener-	Advance
		ation	growth	ation	growth	ation	growth	ation	growth	ation	growth	ation	growth
		Number	per acre	Number	per acre	Number	per acre	Number	per acre	Number	per acre	Number	per acre
Cut and scarified	39	5,641	0	0	0	-	2,538	4,616	-	26	-	-	8,205
Cut not scarified	42	0	71	0	0	-	1,643	95	24	-	-	-	1,928
Uncut	40	75	125	0	0	-	2,325	0	75	-	-	-	1,025
Average	121	1,843	66	0	0	-	2,157	1,521	33	8	-	-	3,653

TABLE 4

NUMBER OF NEW GERMINANTS TALLIED ANNUALLY ON PERMANENT OBSERVATION
 TRANSECTS 1962 TO 1966, AREA 1

Transect number	Total Area (sq.ft.)	Number of New Germinants				
		1962	1963	1964	1965	1966
1	228	61	25	0	13	0
2	207	75	5	1	42	0
3	237	136	10	4	31	0
4	197	37	5	0	3	0
5	154	36	12	1	22	2
All	1,023	345	57	6	111	2
Number per acre		14,697	2,428	266	4,729	85

TABLE 5
PER CENT STOCKING WHITE SPRUCE REGENERATION BY SITE, AREA 1

Condition	Per Cent Stocking First Year				Per Cent Stocking Fifth Year			
	Site				Site			
	Fresh	Moder- ately moist	Moist	Very moist	Fresh	Moder- ately moist	Moist	Very moist
Cut and scarified	68 ⁽¹⁶⁶⁾ ¹	69 ⁽²⁶⁾	76 ⁽²¹⁾	_(0)	47 ⁽¹⁶⁶⁾	33 ⁽²⁴⁾	38 ⁽²¹⁾	_(0)
Cut not scarified	1 ⁽¹³⁰⁾	2 ⁽⁵⁵⁾	0 ⁽³²⁾	_(0)	3 ⁽¹²⁹⁾	0 ⁽⁵⁴⁾	0 ⁽³¹⁾	_(0)
Uncut	2 ⁽¹⁰²⁾	2 ⁽⁵²⁾	0 ⁽¹⁵⁾	0 ⁽³¹⁾	0 ⁽¹⁰²⁾	10 ⁽⁵²⁾	7 ⁽¹⁵⁾	0 ⁽³¹⁾
Average	29 ⁽³⁹⁸⁾	15 ⁽¹³³⁾	24 ⁽⁶⁸⁾	0 ⁽³¹⁾	21 ⁽³⁹⁷⁾	10 ⁽¹³⁰⁾	13 ⁽⁶⁷⁾	0 ⁽³¹⁾

¹ Figures in brackets represent number of quadrats.

TABLE 6

NUMBER OF WHITE SPRUCE REGENERATION PER ACRE BY SITE, AREA 1

Condition	Number Per Acre First Year				Number Per Acre Fifth Year			
	Site				Site			
	Fresh	Moder- ately moist	Moist	Very moist	Fresh	Moder- ately moist	Moist	Very moist
Cut and scarified	5,355 ⁽³¹⁾ ¹	6,000 ⁽⁵⁾	8,000 ⁽³⁾	- ⁽⁰⁾	3,806 ⁽³¹⁾	12,000 ⁽⁵⁾	667 ⁽³⁾	- ⁽⁰⁾
Cut not scarified	0 ⁽²⁷⁾	0 ⁽¹⁰⁾	0 ⁽⁵⁾	- ⁽⁰⁾	148 ⁽²⁷⁾	0 ⁽¹⁰⁾	0 ⁽⁵⁾	- ⁽⁰⁾
Uncut	100 ⁽²⁰⁾	0 ⁽¹⁰⁾	0 ⁽³⁾	0 ⁽⁷⁾	0 ⁽²⁰⁾	0 ⁽¹⁰⁾	0 ⁽³⁾	0 ⁽⁷⁾
Average	2,154 ⁽⁷⁸⁾	1,200 ⁽²⁵⁾	2,182 ⁽¹¹⁾	0 ⁽⁷⁾	1,564 ⁽⁷⁸⁾	2,400 ⁽²⁵⁾	182 ⁽¹¹⁾	0 ⁽⁷⁾

¹Numbers in brackets equal number of list quadrats.

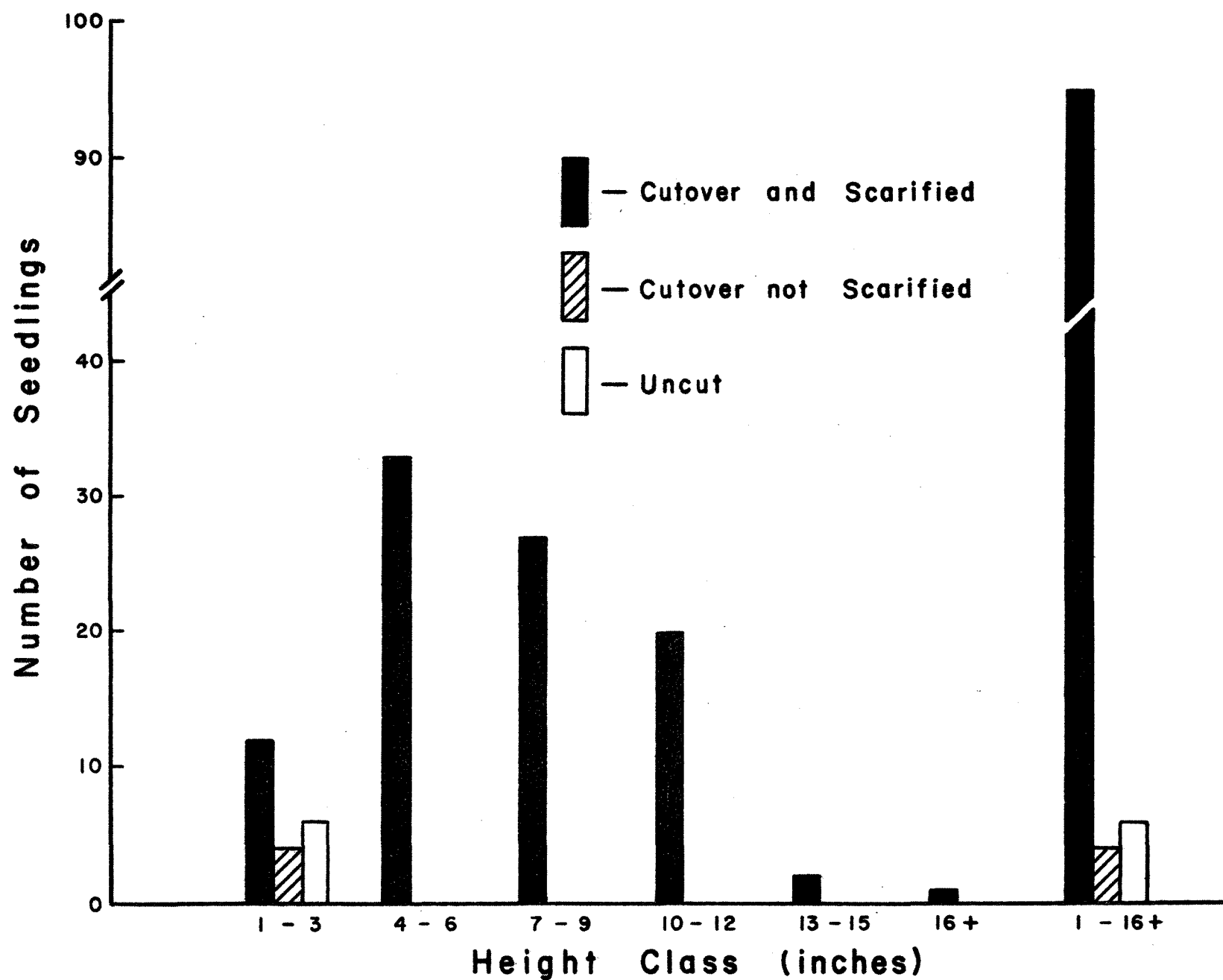


Figure 3. Number of white spruce seedlings (excluding cotyledons) by height class, five years after treatment, Area I. (Basis: tallest seedling on each stocked quadrat).

TABLE 7
DISTRIBUTION OF SEEDBED TYPES AND OCCURRENCE OF WHITE SPRUCE SEEDLINGS,
1 YEAR AND 5 YEARS AFTER TREATMENT, AREA 1

Type of seedbed	Per Cent Occurrence of Seedbed Types and White Spruce Seedlings								
	Cut-over Scarified Areas basis: 213 quadrats			Cut-over Unscarified Areas basis: 217 quadrats			Uncut Areas basis: 200 quadrats		
	Seedbeds	Seedlings		Seedbeds	Seedlings		Seedbeds	Seedlings	
		1st year	5th year		1st year	5th year		1st year	5th year
Litter	23	0	3	89	0	0	84	0	0
Grass	0	-	-	4	0	0	11	0	0
Feathermoss	0	-	-	2	0	0	0	-	-
F-horizon	1	5	1	0	-	-	0	-	-
Humus	13	23	10	0	-	-	0	-	-
Mineral soil	42	59	82	0	-	-	0	-	-
Mixture (organic + mineral)	4	12	1	0	-	-	0	-	-
Debris	15	0	3	0	-	-	0	-	-
Slash	1	0	0	0	-	-	0	-	-
Decayed wood	1	1	0	5	100	100	5	100	100
All	100	100	100	100	100	100	100	100	100

Trial 2 - Montreal Lake, Saskatchewan

Location: Twp. 67, Rge. 24, Sec. 29, W.2 Mer. (See Figure 4)

Description: Trial 2 was carried out on an area about 10 acres in size. In 1960 this area supported a stand containing a white spruce basal area of 66 square feet per acre; the basal area of other softwoods and hardwoods was 26 and 72 square feet per acre respectively (Table 8). The terrain is gently rolling, parent soil materials are clay loam tills, and sites vary from fresh to moist. Most of the area is in the fresh and moderately moist categories.

Work done: Alternate 2-chain-wide strips were clear cut during the winter of 1960-1961. Any remaining hardwoods on the cut-over areas were girdled during the summer of 1961. In August 1962 portions of the cut-over strips were scarified (Figure 5) using a TD-14 tractor equipped with a Saskatchewan fire-line plow.

In May 1963 a total of 572 white spruce seedlings were planted (192 on cut-over scarified areas, 190 on cut-over unscarified areas and 190 on uncut areas).

In July a total of 615 milacre quadrats (213 on cut-over and scarified areas, 196 on cut-over unscarified areas and 200 on uncut areas) were established to assess regeneration. Also five 1/5-acre plots were established in the uncut strips to supply stand data.

Results:

1. Occurrence and abundance of white spruce, other softwood and hardwood reproduction 1 year and 5 years after treatment are shown in Tables 9 and 10. White spruce reproduction is best on the cut-over scarified areas; balsam fir and hardwood reproduction is about the same on all areas.
2. Occurrence and abundance of white spruce regeneration by site are shown in Tables 11 and 12. Spruce stocking is best on fresh sites, poorest in moist sites and intermediate on moderately moist sites.
3. Abundance of white spruce seedlings by height class is shown in Figure 6. Seedlings on the cut-over scarified areas are more numerous and larger than those on the other conditions.
4. Distribution of seedbed types and occurrence of seedlings on the various seed beds is given in Table 13. Scarification was poor and only 29 per cent of the areas designated for treatment were actually scarified. Nevertheless the information shows that mineral soil, humus and decayed wood seed beds are necessary for good results.

5. Per cent survival of white spruce transplants five years after planting on the cut-over scarified, cut-over unscarified, and uncut areas along with average height of survivors is shown in Table 14. Survival has been good on all conditions but height growth was best on cut-over scarified areas, intermediate on cut-over unscarified areas and poorest on uncut areas.
6. Per cent survival of transplants by planting site is shown in Table 15. Survival has been good on all conditions.

Comments:

Stocking to white spruce on the cut-over scarified areas is poorer on Area 2 than on Area 1. This is believed to be a result of poor scarification. The operator did not cover nearly as much of each area designated for treatment as he should have. Furthermore, on the portions actually scarified he plowed too deeply creating deep furrows and high ridges which are not good seed beds. Many seedlings in the furrows died as a result of flooding or burial by alluvium; many in the ridges died of drought and many on the sides of the ridges died as a result of soil erosion away from around their roots.

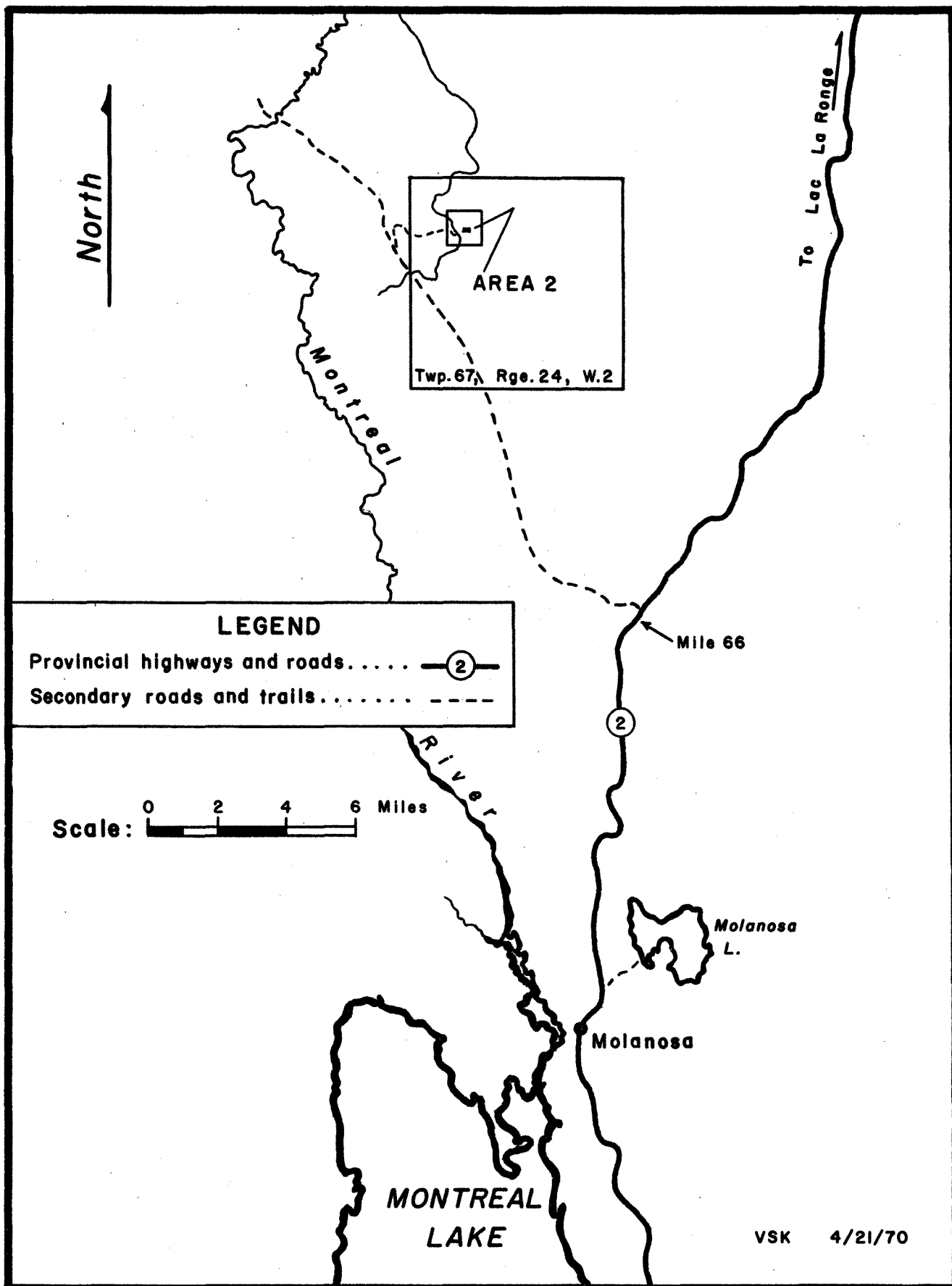


Figure 4. Location of Area 2, Project MS-216, Twp. 67, Rge. 24, Sec. 29, W.2 Mer.

TABLE 8
STAND TABLE, AREA 2, UNCUT STRIPS
(basis - 5, 1/5-acre P.S.P.'s)

D.B.H. (inches)	FIRST YEAR						FIFTH YEAR					
	White Spruce		Other Softwoods		Hardwoods		White Spruce		Other Softwoods		Hardwoods	
	Number of trees per acre	Basal area per acre (sq.ft.)	Number of trees per acre	Basal area per acre (sq.ft.)	Number of trees per acre	Basal area per acre (sq.ft.)	Number of trees per acre	Basal area per acre (sq.ft.)	Number of trees per acre	Basal area per acre (sq.ft.)	Number of trees per acre	Basal area per acre (sq.ft.)
1	61	.305	129	.645	7	.035	63	.315	144	.720	17	.085
2	33	.726	58	1.276	3	.066	35	.770	61	1.342	1	.022
3	13	.637	27	1.323			19	.931	31	1.519	2	.098
4	11	.957	12	1.044	1	.087	9	.783	20	1.740	2	.174
5	7	.952	13	1.768	5	.680	7	.952	11	1.496	3	.408
6	8	1.568	14	2.744	6	1.176	4	.784	20	3.920	4	.784
7	2	.534	6	1.602	8	2.136	3	.801	6	1.602	10	2.670
8	4	1.396	10	3.490	9	3.141	3	1.047	5	1.745	8	2.792
9	3	1.326	5	2.210	13	5.746	5	2.210	4	1.768	9	3.978
10	2	1.090	5	2.725	19	10.353	3	1.635	1	.545	19	10.355
11	8	5.280	2	1.320	15	9.900	5	3.300	2	1.320	11	7.260
12	6	4.710	1	.785	15	11.775	9	7.065	2	1.570	15	11.775
13	8	7.376	1	.922	11	10.142	6	5.532			13	11.986
14	4	4.276	3	3.207	5	5.345	4	4.276	3	3.207	7	7.483
15	2	2.454	1	1.227	6	7.362	2	2.454			2	2.454
16	2	2.792			1	1.396	2	2.792	1	1.396	3	4.188
17	4	6.304			2	3.152	4	6.304			3	4.728
18	3	5.301					3	5.301				
19	1	1.969					1	1.969				
20	4	8.728					4	8.728				
21	1	2.405					2	4.810				
22	2	5.280					4	10.560				
All	187	66.366	287	26.288	126	72.492	197	73.319	311	23.890	129	71.240

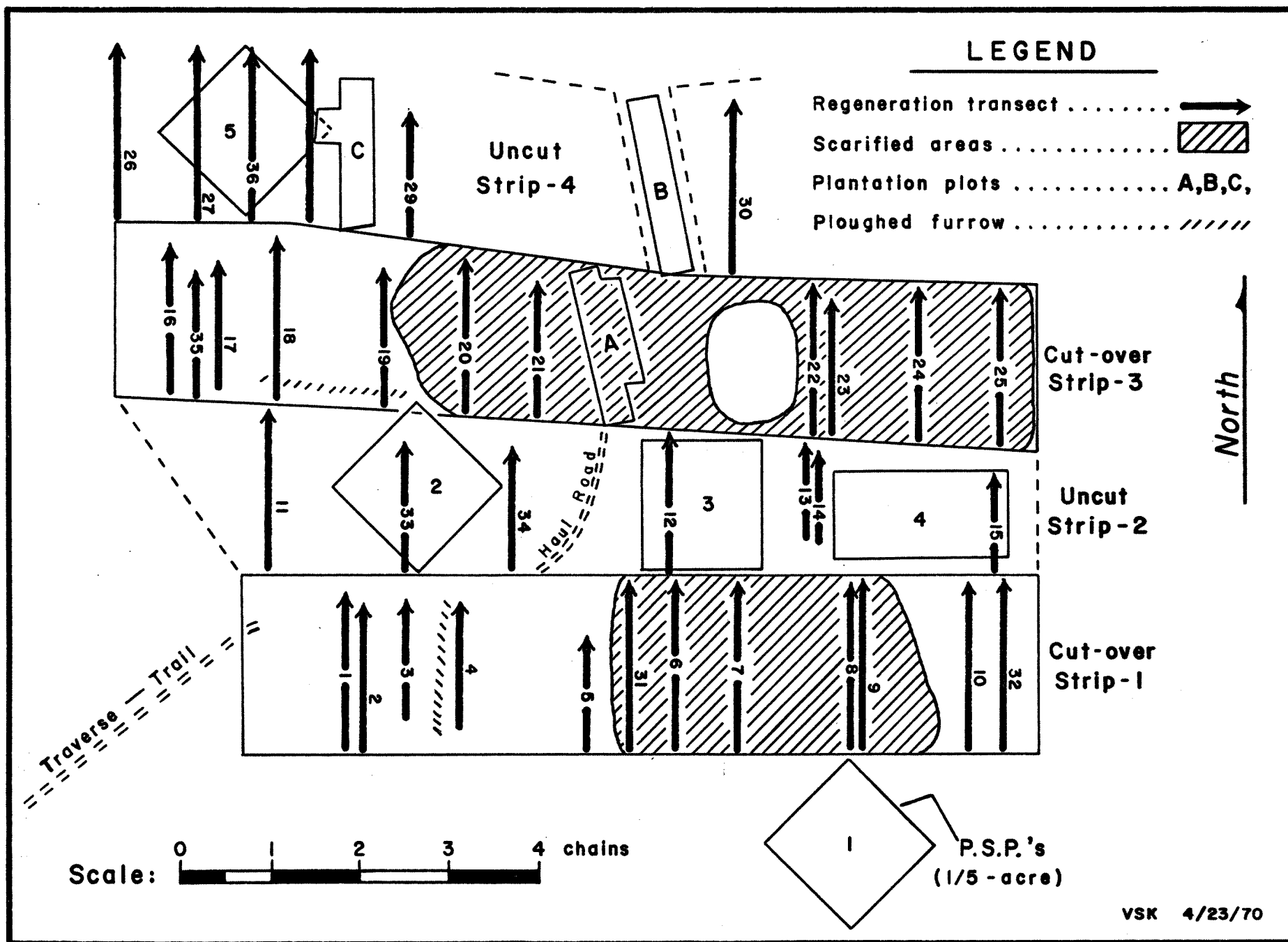


Figure 5. Sketch of Area 2 showing cut-over strips, scarified areas and location of various sample plots.

TABLE 9

PER CENT QUADRATS STOCKED TO WHITE SPRUCE, OTHER SOFTWOODS AND HARDWOODS, AREA 2

Condition	FIRST YEAR							FIFTH YEAR						
	Basis - number of quadrats	White Spruce		Other Softwoods		Hardwoods		Basis - number of quadrats	White Spruce		Other Softwoods		Hardwoods	
		Regener- ation %	Advance growth %	Regener- ation %	Advance growth %	Regener- ation %	Advance growth %		Regener- ation %	Advance growth %	Regener- ation %	Advance growth %	Regener- ation %	Advance growth %
Cut and scarified	213	49	4	20	19	- ¹	26	208 ²	29	7	3	20	-	50
Cut not scarified	196	4	15	1	19	-	49	170 ²	4	13	1	18	-	50
Uncut	206	2	14	1	46	-	20	206	7	14	4	38	-	34
Average	615	19	11	8	28	-	31	584	14	11	3	27	-	42

¹ All hardwood regeneration classed as advance growth.² A total of 31 quadrats were accidentally destroyed.

TABLE 10
NUMBER OF WHITE SPRUCE, OTHER SOFTWOODS AND HARDWOOD STEMS PER ACRE, AREA 2

Condition	FIRST YEAR							FIFTH YEAR						
	Basis - number of quadrats	White Spruce		Other Softwoods		Hardwoods		Basis - number of quadrats	White Spruce		Other Softwoods		Hardwoods	
		Regener-	Advance	Regener-	Advance	Regener-	Advance		Regener-	Advance	Regener-	Advance	Regener-	Advance
		ation	growth	ation	growth	ation	growth		ation	growth	ation	growth	ation	growth
		Number	per acre	Number	per acre	Number	per acre		Number	per acre	Number	per acre	Number	per acre
Cut and scarified	41	1,951	73	610	122	-	1,073	37 ¹	1,243	54	27	216	-	1,919
Cut not scarified	35	38	314	0	457	-	1,228	29 ¹	69	241	0	103	-	1,310
Uncut	39	26	102	26	1,821	-	333	39	128	128	26	1,385	-	615
Average	115	713	156	226	800	-	870	105	505	133	19	610	-	1,267

¹ A total of 10 list quadrats were accidentally destroyed.

TABLE 11

PER CENT STOCKING WHITE SPRUCE REGENERATION BY SITE, AREA 2

Condition	Number Per Acre First Year			Number Per Acre Five Years After		
	Site			Site		
	Fresh	Moderately moist	Moist	Fresh	Moderately moist	Moist
Cut and scarified	64(104) ¹	48(64)	22(45)	41(103) ²	23(61) ²	11(44) ²
Cut not scarified	2(99)	6(97)	_(0)	2(91) ²	5(79) ²	_(0)
Uncut	3(160)	0(24)	0(22)	8(160)	4(24)	9(22)
Average	19(363)	20(185)	15(67)	16(354)	12(164)	11(66)

¹ Figures in brackets represent number of quadrats.

² A total of 31 quadrats were accidentally destroyed.

TABLE 12

NUMBER OF WHITE SPRUCE REGENERATION PER ACRE BY SITE, AREA 2

Condition	Number Per Acre First Year			Number Per Acre Five Years After		
	Site			Site		
	Fresh	Moderately moist	Moist	Fresh	Moderately moist	Moist
Cut and scarified	2,667 ⁽¹⁸⁾ ¹	1,923 ⁽¹³⁾	700 ⁽¹⁰⁾	2,118 ⁽¹⁷⁾ ¹	818 ⁽¹¹⁾ ¹	111 ⁽⁹⁾ ¹
Cut not scarified	56 ⁽¹⁸⁾	0 ⁽¹⁷⁾	- ⁽⁰⁾	125 ⁽¹⁶⁾ ¹	0 ⁽¹³⁾ ¹	- ⁽⁰⁾
Uncut	30 ⁽³³⁾	0 ⁽²⁾	0 ⁽⁴⁾	152 ⁽³³⁾	0 ⁽²⁾	0 ⁽⁴⁾
Average	725 ⁽⁶⁹⁾	781 ⁽³²⁾	500 ⁽¹⁴⁾	652 ⁽⁶⁶⁾	346 ⁽²⁶⁾	77 ⁽¹³⁾

¹Figures in brackets represent number of list quadrats.

²A total of 10 list quadrats were destroyed accidentally.

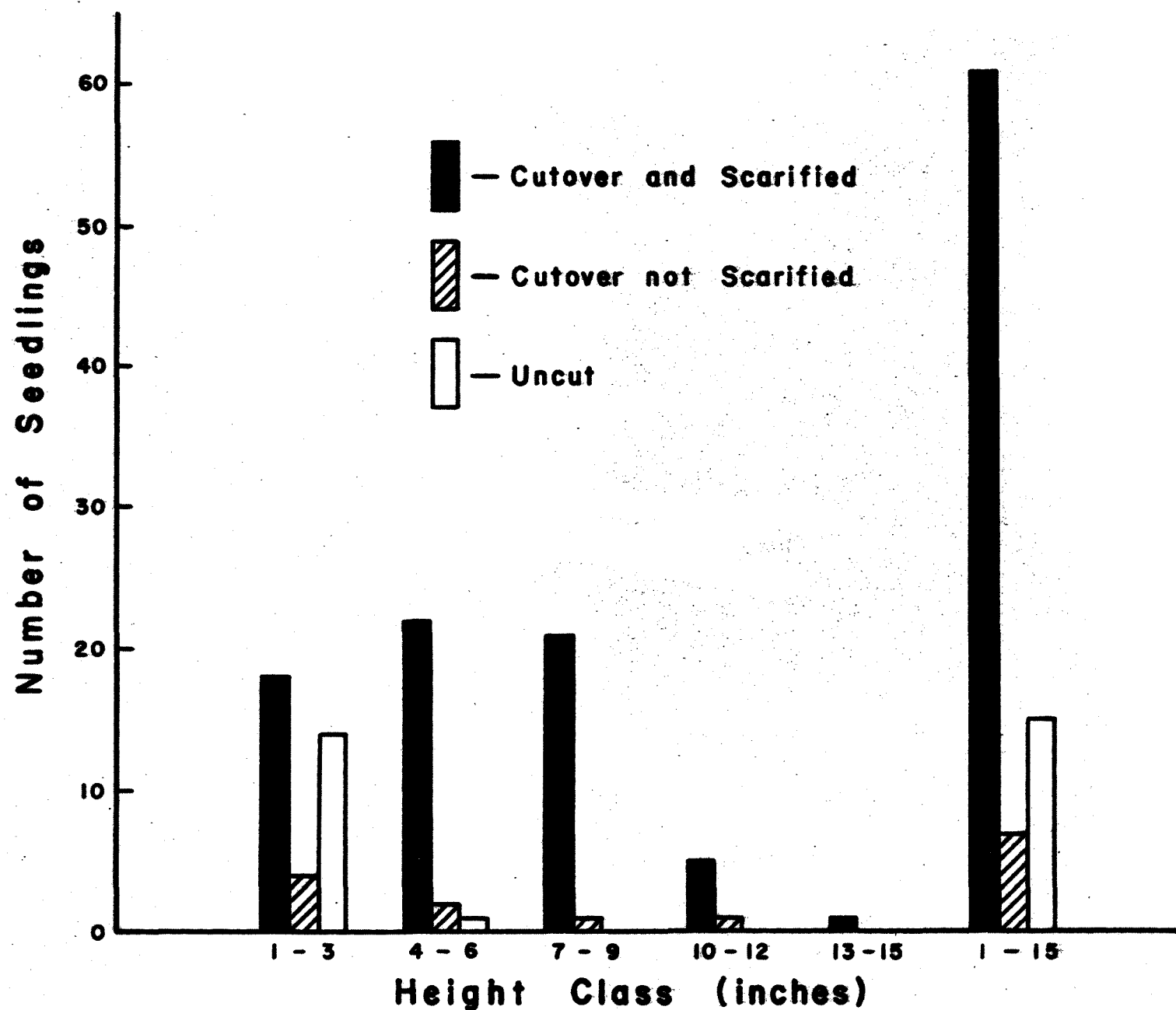


Figure 6. Number of white spruce seedlings (excluding cotyledons) by height class, five years after treatment, Area 2. (Basis: tallest seedling on each stocked quadrat).

TABLE 13

DISTRIBUTION OF SEEDBED TYPES AND OCCURRENCE OF WHITE SPRUCE SEEDLINGS,

1 YEAR AND 5 YEARS AFTER TREATMENT, AREA 2

Type of seedbed	Per Cent Occurrence of Seedbed Types and White Spruce Seedlings										
	Cut-over scarified areas basis: 1st yr. 213 quadrats ¹				Cut-over unscarified areas basis: 1st yr. 196 quadrats ²				Uncut areas basis: 206 quadrats		
	Seedbeds		Seedlings		Seedbeds		Seedlings		Seedbeds	Seedlings	
	1st year	5th year	1st year	5th year	1st year	5th year	1st year	5th year		1st year	5th year
Litter	31	32	3	4	62	65	11	0	64	20	7
Grass	0	0	-	-	3	3	0	0	0	-	-
Feather moss	4	4	1	1	15	14	11	33	23	0	13
F-horizon	1	1	11	0	1	0	11	-	0	-	-
Humus	3	4	14	2	0	0	-	-	0	-	-
Mineral soil	18	17	36	69	1	1	34	17	1	20	7
Mixture (organic + mineral soil)	9	8	27	21	1	1	11	17	0	-	-
Debris	25	25	1	0	2	1	0	0	0	-	-
Slash	7	7	0	-	12	12	0	0	9	0	0
Decayed wood	2	2	7	3	3	3	22	33	3	60	73
All	100	100	100	100	100	100	100	100	100	1100	100

¹Five quadrats were accidentally destroyed.²Twenty-six quadrats were accidentally destroyed.

TABLE 14
PER CENT SURVIVAL AND AVERAGE HEIGHT WHITE SPRUCE
PLANTATIONS ON AREA 2, 1963 TO JULY 1967

Planting site	Number planted May 1963	<u>Per Cent Survival</u>			<u>Average Height(inches)</u>		
		July 1963	August 1964	July 1967	July 1963	August 1964	July 1967
Cut-over scarified	192	99	92	89	11.1	13.5	32.1
Cut-over not scarified	190	100	84	75	12.3	14.1	23.2
Uncut	190	99	93	88	7.6	9.3	15.0

TABLE 15

PER CENT SURVIVAL WHITE SPRUCE TRANSPLANTS BY PLANTING SITE
AFTER 5 GROWING SEASONS, AREA 2

Planting Site	<u>Cut-over Scarified Areas</u>		<u>Cut-over Unscarified Areas</u>		<u>Uncut Areas</u>	
	Number planted 1963	Survival after 5 years (%)	Number planted 1963	Survival after 5 years (%)	Number planted 1963	Survival after 5 years (%)
Litter	57	93	153	72	147	89
F-horizon	1	100	0	-	0	-
Humus	0	-	1	100	0	-
Mineral soil	62	84	30	87	0	-
Overturnd sod	58	88	0	-	1	100
Debris	13	100	5	100	1	0
Feather moss	0				39	82
Decayed wood	1	100	1	0	2	100
All	192	89	190	75	190	88

Trial 3 - Carrot River, Saskatchewan

Location: Twp. 51, Rge. 7, Sec. 2, W.2 Mer. (Figure 7).

Description: Trial 3 was carried out on an area about 45 acres in size. In 1963 it supported a stand with a total basal area of about 131 square feet per acre. Of this total 105 square feet were white spruce and the remainder was hardwoods (Table 16). The terrain was gently undulating to flat and parent soil material was a silty clay loam. Sites varied from fresh to very moist but most of the area was fresh or moderately moist.

Work done: All merchantable white spruce on alternate 2-chain-wide strips were logged during the winter of 1963-64. Unmerchantable spruce and hardwoods on the logged strips were felled during the summer of 1964 and pushed to the edges of the strips with a bulldozer. Portions of the cut-over strips were then scarified (Figure 8).

In 1965 a total of 615 permanent milacre quadrats (209 in cut-over scarified areas, 215 on cut-over unscarified areas and 191 on uncut areas) were established to assess regeneration. At the same time 8 1/5-acre plots were established in the uncut strip to obtain stand information.

Results:

1. Occurrence and abundance of white spruce and hardwood reproduction 1 year and 5 after treatment are shown in Tables 17 and 18. White spruce reproduction is the most abundant on the cut-over scarified areas. Hardwood reproduction on cut-over scarified and unscarified areas is greater than in the uncut stands.
2. Occurrence and abundance of white spruce regeneration by site are shown in Tables 19 and 20. Five years after treatment the ranking of sites in order of their suitability for spruce regeneration is fresh (best), moderately moist, moist and very moist (poorest). Scarified seedbeds on very moist sites in many instances after 5 years have remained nonproductive due to flooding and high water tables. The scalping action of the straight blade on these sites has tended to create potholes; and after 5 years is evident by the dominance of cattail (*Typha latifolia* L.) vegetation (see Figure 9).
3. Abundance of white spruce seedlings by height class is shown in Figure 10. Seedlings on the cut-over scarified areas are more numerous (with exception of the 3-inch class) and larger than those on the other conditions.
4. Distribution of seedbed types and occurrence of white spruce regeneration on each is shown in Table 21. As on the other areas mineral soil, humus, mixture (organic and mineral soil) and decayed wood were the best seedbeds.

Comments:

After 5 years suitable seedbeds on cut-over scarified areas are well stocked to white spruce regeneration; with the exception of prepared seedbeds on the very moist sites. Stocking on the cut-over unscarified areas was better than expected. This was due to the fact that when the felled hardwoods and unmerchantable spruce were being bulldozed off the strips some seedbeds were inadvertently created by the bulldozer. Regeneration in the uncut stands had increased due to a greater abundance of cotyledonous seedlings that were present at the end of 5 years. However, most of these seedlings were small and weak; and past observations have indicated that they are not likely to persist on this condition.

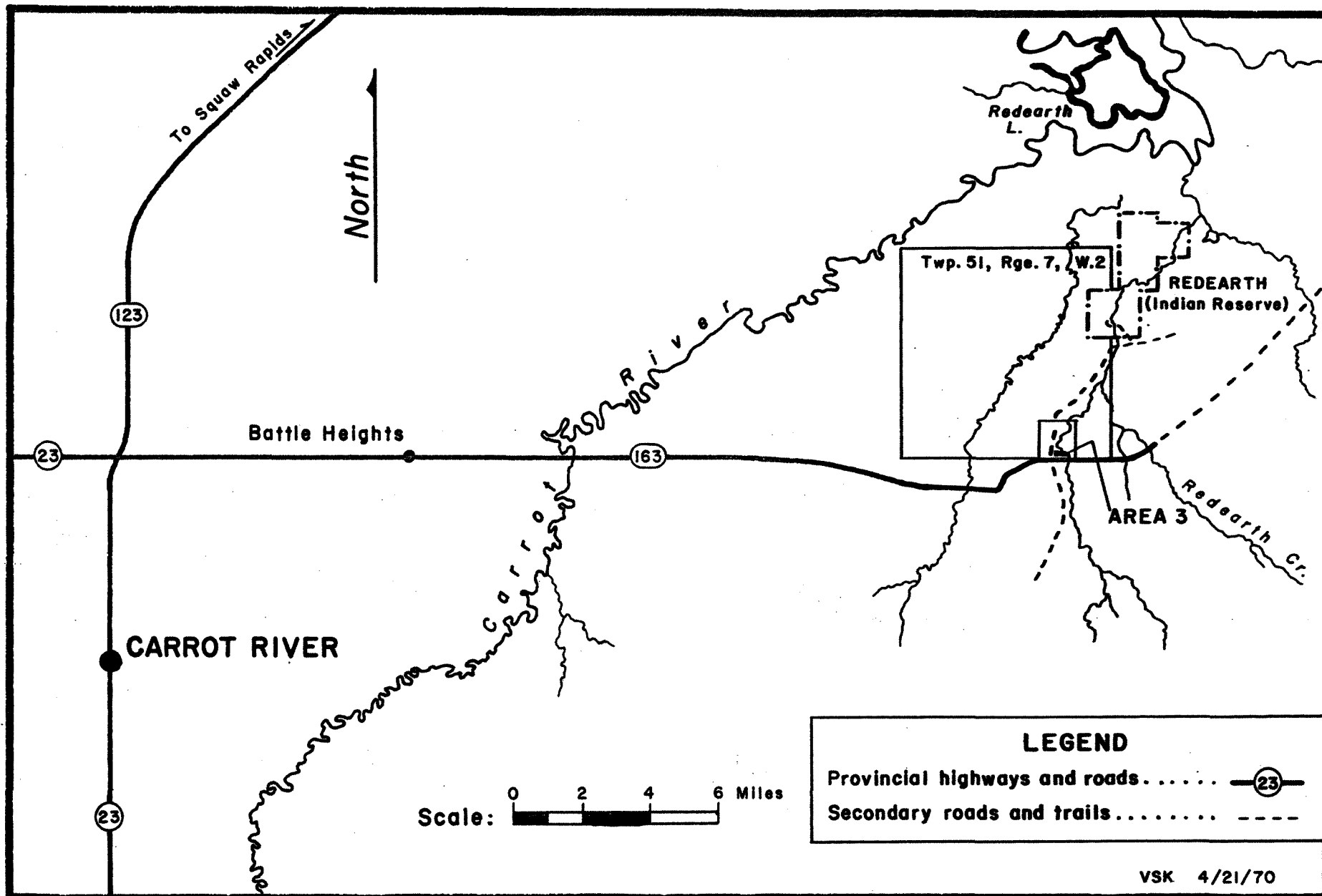


Figure 7. Location of Area 3, Project MS-216, Twp. 51, Rge. 7, Sec. 2, W.2. Mer.

TABLE 16
STAND TABLE, AREA 3, UNCUT STRIPS
(basis - 8 1/5-acre P.S.P.'s)

D.B.H. (inches)	FIRST YEAR				FIFTH YEAR			
	White Spruce		Hardwoods		White Spruce		Hardwoods	
	Number of trees per acre	Basal area per acre (sq. ft.)	Number of trees per acre	Basal area per acre (sq. ft.)	Number of trees per acre	Basal area per acre (sq. ft.)	Number of trees per acre	Basal area per acre sq. ft.
1	0.6	.003	18.1	.090			395.0	1.975
2	0.6	.013	7.5	.165	0.6	.013	25.6	.563
3	4.4	.216	1.9	.093	3.1	.152	8.8	.431
4	2.5	.218			4.4	.383	1.2	.104
5	6.2	.843			3.8	.517		
6	6.2	1.215			4.4	.862		
7	10.0	2.670	1.2	.320	7.5	2.002		
8	6.2	2.164	1.2	.419	5.0	1.745		
9	10.0	4.420	1.2	.530	7.5	3.315		
10	10.6	5.777	1.9	1.035	8.8	4.796	0.6	.327
11	9.4	6.204	2.5	1.650	10.6	6.996	0.6	.396
12	7.5	5.888	2.5	1.962	8.1	6.358	1.9	1.492
13	13.1	12.078	3.1	2.858	14.4	13.277	3.1	2.858
14	11.2	11.973	3.1	3.314	13.8	14.752	2.5	2.672
15	6.9	8.466	3.8	4.663	6.9	8.466	3.1	3.804
16	7.5	10.470	1.2	1.675	7.5	10.470	2.5	3.490
17	6.9	10.874	2.5	3.940	5.0	7.880	3.8	5.989
18	4.4	7.775	1.2	2.120	2.5	4.418	0.6	1.060
19	1.2	2.363			2.5	4.922		
20	1.9	4.146	0.6	1.309	1.2	2.618	0.6	1.309
21					0.6	1.443		
22	0.6	1.584			0.6	1.584		
23	1.2	3.462			0.6	1.731		
24	1.2	3.770			1.9	5.970		
All	130.3	106.592	53.4	26.143	121.3	104.670	449.9	26.470

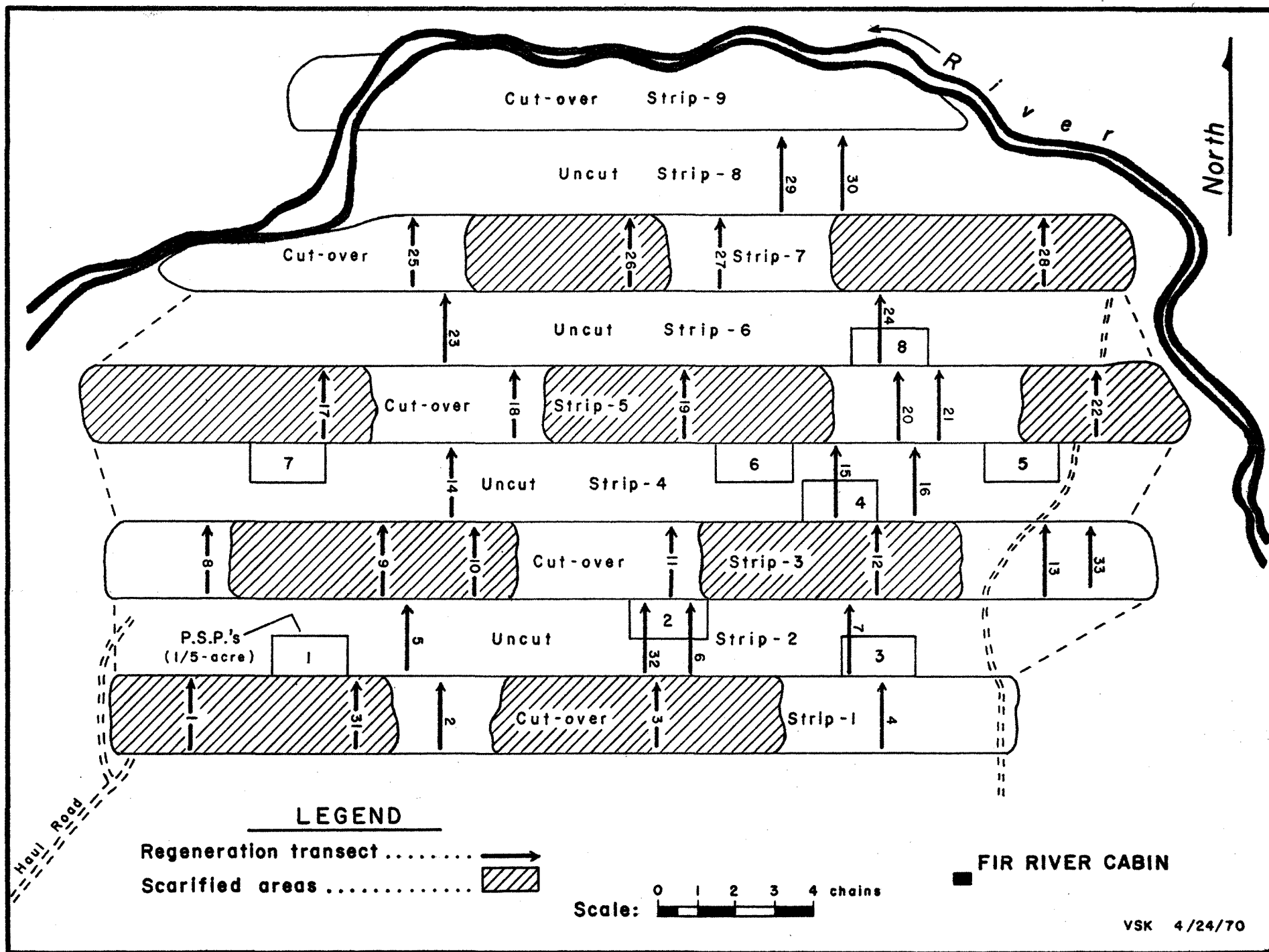


Figure 8. Sketch of Area 3 showing cut-over strips, scarified areas and location of various sample plots.

TABLE 17
PER CENT QUADRATS STOCKED TO WHITE SPRUCE AND HARDWOODS,
AREA 3

Condition	Number of quadrats	FIRST YEAR				FIFTH YEAR			
		White Spruce		Hardwoods		White Spruce		Hardwoods	
		Regener- ation %	Advance growth %	Regener- ation %	Advance growth %	Regener- ation %	Advance growth %	Regener- ation %	Advance growth %
Cut and scarified	209	82	0	- ¹	13	75	-	-	55
Cut not scarified	215	41	3	-	65	30	3	-	76
Uncut	191	20	16	-	35	45	15	-	40
All	615	48	6	-	38	50	5	-	55

¹ All hardwoods classed as advance growth.

TABLE 18
NUMBER WHITE SPRUCE AND HARDWOOD STEMS PER ACRE,
AREA 3

Condition	Number of list quadrats	FIRST YEAR				FIFTH YEAR			
		White Spruce		Hardwoods		White Spruce		Hardwoods	
		Regener-	Advance	Regener-	Advance	Regener-	Advance	Regener-	Advance
		ation	growth	ation	growth	ation	growth	ation	growth
		Number per acre		Number per acre		Number per acre		Number per acre	
Cut and scarified	40	18,275	0	-	225	24,400	-	-	2,575
Cut not scarified	41	1,146	0	-	3,780	1,585	0	-	2,707
Uncut	36	444	361	-	1,250	3,167	278	-	667
All	117	6,786	111	-	1,786	9,872	85	-	2,034

TABLE 19

PER CENT STOCKING TO WHITE SPRUCE REGENERATION BY SITE,

AREA 3

Condition	Per Cent Stocking First Year				Per Cent Stocking Fifth Year			
	Site				Site			
	Fresh	Moderately moist	Moist	Very moist	Fresh	Moderately moist	Moist	Very moist
Cut and scarified	95 ⁽⁷⁷⁾ ¹	96 ⁽⁵⁶⁾	89 ⁽²⁸⁾	40 ⁽⁴⁸⁾	90 ⁽⁷⁷⁾	95 ⁽⁵⁶⁾	57 ⁽²⁸⁾	39 ⁽⁴⁸⁾
Cut not scarified	38 ⁽⁸⁹⁾	42 ⁽⁹⁰⁾	50 ⁽²⁶⁾	30 ⁽¹⁰⁾	22 ⁽⁸⁹⁾	36 ⁽⁹⁰⁾	38 ⁽²⁶⁾	30 ⁽¹⁰⁾
Uncut	0 ⁽³⁹⁾	22 ⁽⁹¹⁾	28 ⁽⁴³⁾	39 ⁽¹⁸⁾	8 ⁽³⁹⁾	49 ⁽⁹¹⁾	65 ⁽⁴³⁾	56 ⁽¹⁸⁾
All	52 ⁽²⁰⁵⁾	47 ⁽²³⁷⁾	52 ⁽⁹⁷⁾	37 ⁽⁷⁶⁾	45 ⁽²⁰⁵⁾	56 ⁽²³⁷⁾	58 ⁽⁹⁷⁾	41 ⁽⁷⁶⁾

¹Numbers in brackets represent number of quadrats.

TABLE 20
NUMBER WHITE SPRUCE REGENERATION PER ACRE BY SITE,
AREA 3

Condition	Number Per Acre First Year				Number Per Acre Fifth Year			
	Site				Site			
	Fresh	Moderately moist	Moist	Very moist	Fresh	Moderately moist	Moist	Very moist
Cut and scarified	25,812 ⁽¹⁶⁾ ¹	20,500 ⁽¹⁰⁾	16,250 ⁽⁴⁾	4,800 ⁽¹⁰⁾	40,062 ⁽¹⁶⁾	26,600 ⁽¹⁰⁾	9,750 ⁽⁴⁾	3,000 ⁽¹⁰⁾
Cut not scarified	941 ⁽¹⁷⁾	1,529 ⁽¹⁷⁾	1,000 ⁽⁵⁾	0 ⁽²⁾	1,470 ⁽¹⁷⁾	1,647 ⁽¹⁷⁾	2,400 ⁽⁵⁾	(0) ⁽²⁾
Uncut	0 ⁽⁷⁾	5 ⁽¹⁷⁾	11 ⁽⁹⁾	0 ⁽³⁾	1,571 ⁽⁷⁾	2,765 ⁽¹⁷⁾	6,111 ⁽⁹⁾	333 ⁽³⁾
All	10,725 ⁽⁴⁰⁾	5,364 ⁽⁴⁴⁾	4,500 ⁽¹⁸⁾	3,200 ⁽¹⁵⁾	16,925 ⁽⁴⁰⁾	7,750 ⁽⁴⁴⁾	5,889 ⁽¹⁸⁾	2,067 ⁽¹⁵⁾

¹Numbers in brackets equal number of list quadrats.



Left: Close-up view; note presence of cattail vegetation.



Right: General view showing extent of cattail vegetation in strip 5.

Figure 9. Non productive scalped seedbeds on a cut-over very moist site five years after treatment, Area 3.

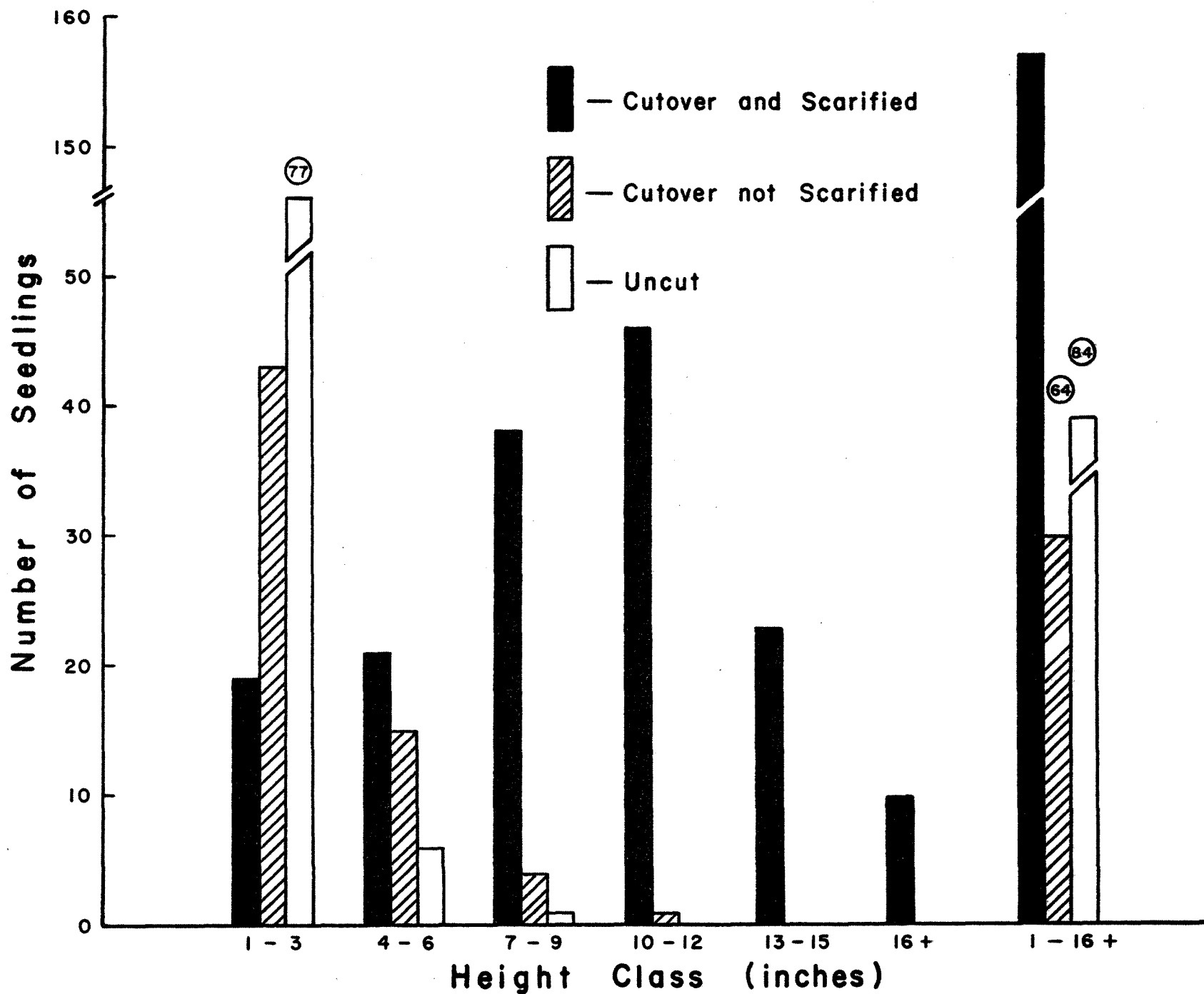


Figure 10. Number of white spruce seedlings (excluding cotyledons) by height class, five years after treatment, Area 3. (Basis: tallest seedling on each stocked quadrat).

TABLE 21
DISTRIBUTION OF SEEDBED TYPES AND OCCURRENCE OF WHITE SPRUCE SEEDLINGS,
1 YEAR AND 5 YEARS AFTER TREATMENT, AREA 3

Type of Seedbed	Per Cent Occurrence of Seedbed Types and White Spruce Seedlings								
	Cut-over Scarified Areas basis: 209 quadrats			Cut-over Unscarified Areas basis: 215 quadrats			Uncut areas basis: 191 quadrats		
	Seedbeds	Seedlings		Seedbeds	Seedlings		Seedbeds	Seedlings	
		1st year	5th year		1st year	5th year		1st year	5th year
Litter	0	-	-	74	2	8	86	5	20
Grass	0	-	-	4	0	-	2	0	0
F-horizon	2	3	3	0	-	-	0	-	-
Humus	8	20	18	1	20	11	0	-	-
Mineral soil	73	63	71	2	7	12	0	-	-
Mixture (organic + mineral soil)	2	1	2	6	22	13	2	2	7
Debris	14	6	5	3	2	0	0	-	-
Slash	0	-	-	3	0	-	3	0	0
Decayed wood	1	7	1	7	48	56	7	93	73
All	100	100	100	100	100	100	100	100	100

DISCUSSION AND CONCLUSIONS

Results from these trials have demonstrated that mechanical seed bed preparation in partially cut mixedwood stands on mesic sites in the Mixedwood Forest Section will provide favourable habitats for white spruce regeneration. The catch of seedlings in any given year will depend upon the seed source available and in the amount of seed produced the previous year.

Of the two types of equipment used to make seedbeds (the Saskatchewan fire-line plow and the straight bulldozer blade) the bulldozer blade is the better tool to use. Practically all seedbeds made by it, especially mineral soil, humus and mixtures of mineral soil and organic materials, are suitable and remain receptive for a number of years. On the other hand piles of debris created when dumping the blade are poor seedbeds because they dry out too quickly.

Because tractor operators have a tendency to plow too deep, the resulting furrows and ridges created by the Saskatchewan fire-line plow are generally not good seedbeds. The furrows collect water which in turn drowns seedlings; the high ridges dry out too quickly so seedlings die of drought; and the steep sloping sides of the furrow erode so that seedlings which may have become established on the slopes are eventually washed from the soil and others in the furrows are covered with alluvium.

Results from Area 2 show that cut-over areas can also be regenerated by planting. For best survival and development, planting sites should be scarified before transplants are set out.

It is evident from the results of all areas that treatments to obtain regeneration either naturally from seed or artificially by planting, should be restricted to the fresh, moderately moist and moist sites. Also, the amount of regeneration obtained will depend directly upon the thoroughness of the scarification and the amount of area actually treated.

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