

SCARIFYING CUTOVER JACK PINE STANDS WITH BARRELS AND ANCHOR CHAINS,
MANITOBA AND SASKATCHEWAN
Demonstrations MS 031 and MS 032

by

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The treatments described in this report are being carried out by the Department of Fisheries and Forestry as operational-scale demonstrations of promising regeneration techniques for cutover jack pine stands in cooperation with the Forestry Branch and the Central Region of the Saskatchewan Department of Natural Resources, the Prince Albert Pulp Co. of Prince Albert, Saskatchewan, and the Operations Branch of the Manitoba Department of Mines and Natural Resources.

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INTRODUCTION

Shark-finned barrel scarifiers (Figure 1) designed by the Ontario Department of Lands and Forests have been found to be superior to other types of scarifying equipment in seedbed preparation in recent and old jack pine (*Pinus banksiana* Lamb.) cutovers in northern Ontario (Brown 1966, Morawski 1966). The principle advantage of the barrel scarifier is its ability to travel over and around obstacles such as stumps, stones and heavy slash.

In recent cutovers, anchor chains have been successfully used (by the Ontario Department of Lands and Forests) for obtaining natural jack pine regeneration by simultaneously preparing mineral soil seedbeds and distributing cone bearing slash over these seedbeds (Morawski 1966). The anchor chains used in this demonstration were made up of 25 32-pound links with two 1 inch by 2 foot rods (SPS steel) welded in the form of an (X) to the centre of each link.

Extensive jack pine logging in northern Manitoba and Saskatchewan is expected with the establishment of new pulp and saw mills at Prince Albert and The Pas. An appraisal of barrel and anchor chain scarification in typical jack pine cutovers will be of value in planning for the regeneration of these areas. In southeastern Manitoba, barrel scarifiers are being used for site preparation of old cutovers and an investigation of the potential of the barrel and anchor chain scarifiers in regenerating recent jack pine cutovers should be of value in the forest management of this region.

Between 1967 and 1969, 10 demonstration areas were established (Figures 2-13). This report describes the treatments carried out and the results of subsequent assessment surveys.

¹ Formerly MS-5 and MS-6.

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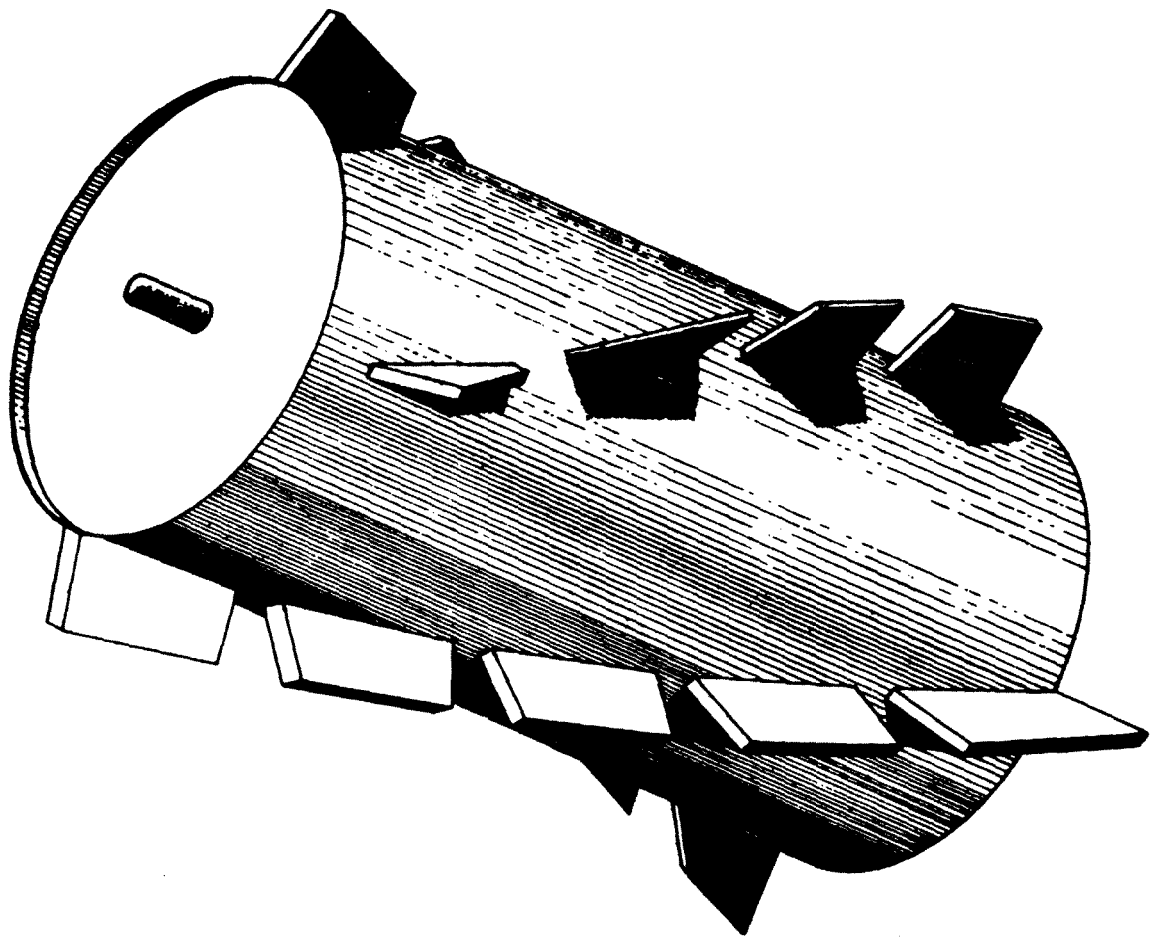


Fig.1 Shark-finned Barrel Scarifier

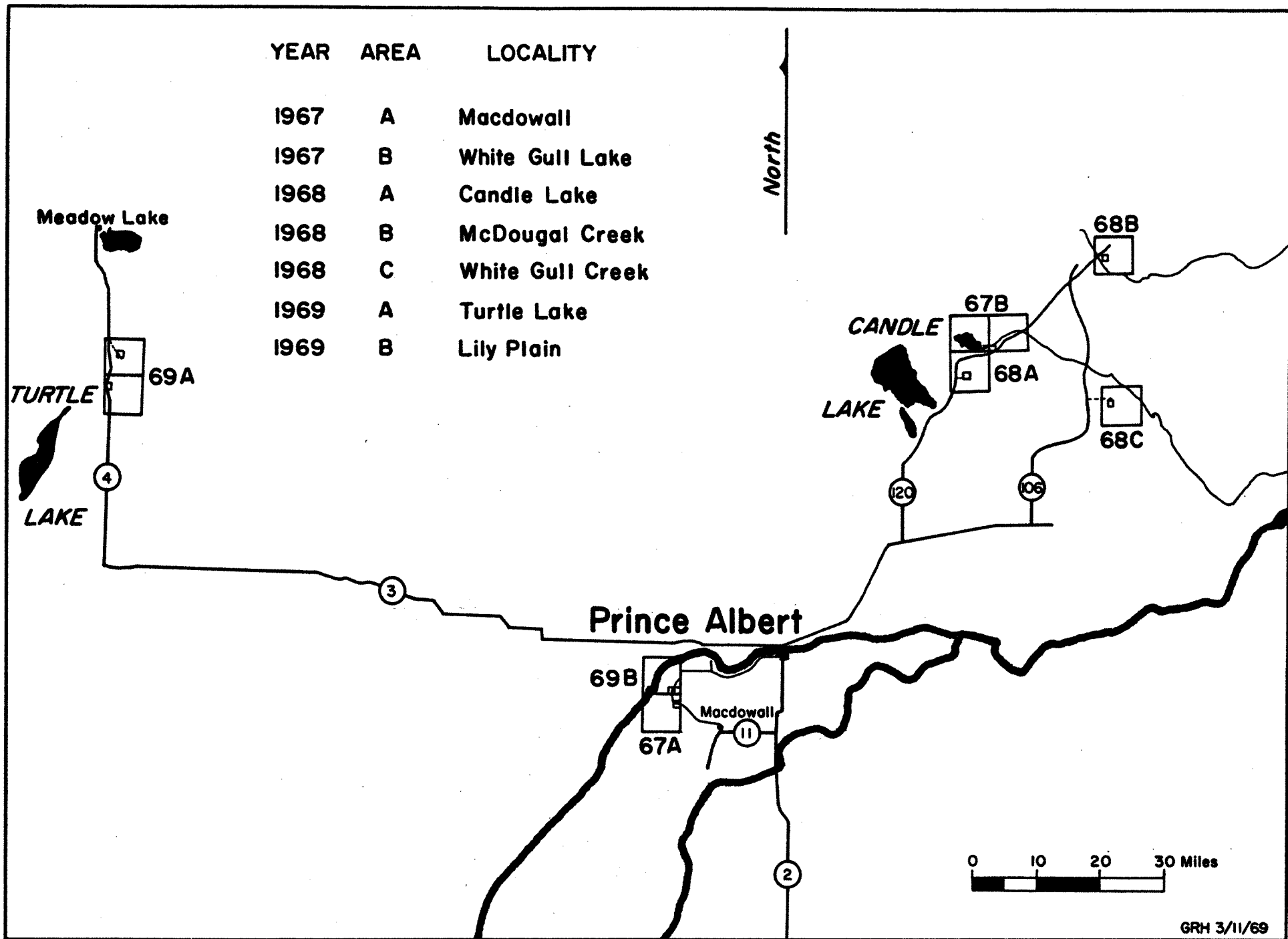


Fig.2 1967-9 Barrel And Anchor Chain Scarification Areas, Saskatchewan

DEMONSTRATION AREAS

1. ESTABLISHED IN 1967Area A - Macdowall

Two old cutovers (Figure 3) on a dry to moderately fresh (moisture regimes 1 and 2) dune sand were barrel scarified in August of 1967. In Block 1, two passes with two barrels per row were used while three passes over the area were used in Block 2. Excellent mineral soil seedbeds were produced by this treatment (Hennessey 1968). Block 1 was approximately 15 acres in size and Block 2 five acres.

Planting

Between July 2 and 4, 1968, approximately 21,000 2-2 jack pine transplants were planted on nine acres of Block 1 and three acres of Block 2 as shown on Figure 3. Planting was carried out by prisoners using planting spades and shovels to prepare slits in the bottom of the furrows.

About 10 per cent of the planting stock had been refrigerated between lifting in early May and planting in July, however, both types of stock appeared in poor condition at the time of planting. Soil moisture at planting and during the subsequent growing season were both excellent.

Table 1 shows the results of examinations carried out on permanently established sample plots. Early survival has been poor and much of the mortality may be attributed to the poor planting stock. The remaining transplants appear vigorous and no browsing has been recorded. With the high planting rate and the occasional volunteer jack pine, reforestation of both Blocks appears successful at this time.

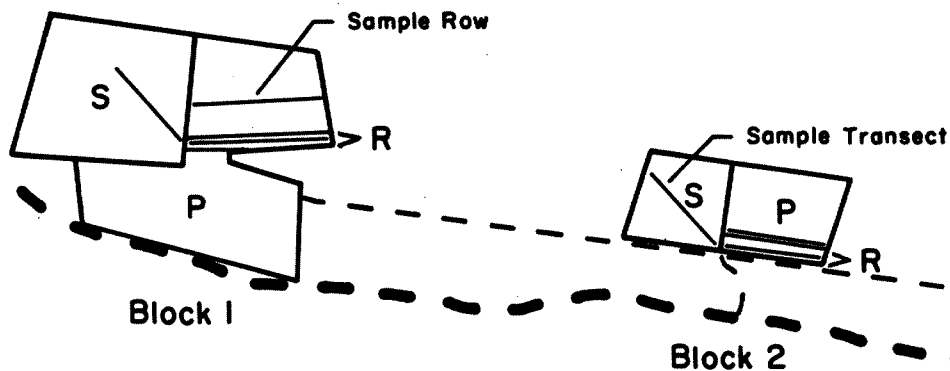
Seeding

A six-acre portion of Block 1 and a two-acre portion of Block 2 was seeded to jack pine on April 24, 1969. Good distribution was assured by dividing the areas into one chain strips, the strips being at right angles to the barrel furrows. Seed provided by the Saskatchewan Department of Natural Resources was treated prior to seeding with Arasan, Endrin, and aluminum flakes. Viability of the treated seed was found to be 62 per cent. Eight pounds or about 110,000 viable seeds per acre were sown on Block 1. Three pounds or about 120,000 viable seeds per acre were sown on Block 2. Weather conditions during the first growing season appeared excellent for the establishment of the sown jack pine.

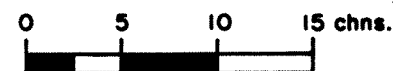
Table 2 shows the results of the permanent sample plots established in the autumn of 1968. Both blocks were still fully stocked with jack pine seedlings after two growing seasons. However, mortality during the past year was about one third of the originally marked seedlings. Most of the dead seedlings have been replaced by new germinants or seedlings missed in the original survey. While stocking is satisfactory the seedlings are of poor appearance and the average seedling is less than an inch and a half high.

Sec.25, Twp.47, Rge.2

North



- S - Seeded April 24/68
- P - Planted July 2-4/68
- R - Planted Refrigerated Stock July 2-4/68



GRH 13/3/69

**Fig.3 Barrel Scarification Demonstration Area,
Macdowall, Saskatchewan**

TABLE 1
 AVERAGE HEIGHT AND PER CENT SURVIVAL OF MACDOWALL PLANTATIONS,
 1968-1969

Block No.	Type of stock	No. of transplants	Average height in inches (at time of planting)	Per cent survival	
				Autumn 1968	Autumn 1969
1	Refrigerated	100	7.7	65.0	55.0
	Non-refrigerated	100	6.2	64.0	54.0
2	Refrigerated	100	6.9	64.0	50.0
	Non-refrigerated	100	5.6	73.0	67.0
All		400	6.6	66.5	56.5

TABLE 2
 PER CENT STOCKING AND NUMBER OF SEEDLINGS PER ACRE OF THE
 SEEDED AREAS AT MACDOWALL, 1968-1969

Block No.	Autumn 1968		Autumn 1969	
	Per cent stocking	No. of seedlings per acre	Per cent stocking	No. of seedlings per acre
1	88.0	4,600	84.0	5,200
2	94.0	6,000	88.0	5,000
All	91.0	5,300	86.0	5,100

Basis: 50-1 milacre plots per block with five total count plots.

Area B - White Gull Lake

Two recently cutover areas (Figure 4) were scarified in August of 1967 to create seedbeds suitable for natural regeneration from cone-bearing slash. The cutover areas had supported dense, mature stands of jack pine on a fresh to moderately moist (moisture regimes 3 and 4) silt loam textured soil. The treatments and early results are reported in (Hennessey 1968, 1969).

Tables 3 and 4 show the results of the permanent sample plots established in the autumn of 1968.

All blocks were still fully stocked after two growing seasons. As shown in Table 4 mortality of the seedlings on mineral soil seedbeds has been very high in Block 2 and to a lesser extent Block 4. This mortality can be attributed to strong vegetative competition from a bunch grass which has completely invaded the mineral soil seedbeds in Block 2 and much of the same seedbed of Block 4. There was a marked contrast between Block 2 and Block 3. Grass and herbs completely covered Block 2 while only about five per cent of Block 3 was similarly covered in the autumn of 1969. This appears partially attributable to the treatment which left long continuous mounds of moss and slash to impede vegetative invasions of Block 3. In this case the controlling factor in ground vegetation development seems to be the deep mor horizon in the soil profile under pine stands associated with black spruce, as in Block 3, as opposed to the shallow mor under pine stands associated with aspen, a drier site, as in Block 2. Second year germination has almost equaled mortality losses for Blocks 1, 3, and 4, as a whole.

Seedling growth and appearance is good with best seedlings four to six inches in height.

Although there was considerable variation in treatment of Blocks, all have provided good jack pine regeneration and the best treatment (and most economical) on this site was anchor chaining.

2. ESTABLISHED IN 1968

(i) Saskatchewan

Area A - Candle Lake, Area B - McDougal Creek, Area C - White Gull Creek

During August 1968, nine recently cutover areas near Candle Lake (Figures 5, 6, 7) were scarified to create seedbeds suitable for natural regeneration from cone-bearing slash.

The cutover areas had supported open to dense, mature stands of jack pine on moderately fresh to moderately moist (moisture regimes 2 to 4) sand to sandy loam textured soils. The cuts preceded scarification treatment by periods from one month to about a year.

- Block 1,4 - Barrel Scarified
- 2 - Barrel Scarified and Anchor Chained
- 3 - Anchor Chained Only

North

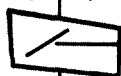
Sec. 2

Sec. 1, Twp. 57, Rge. 21

Sec. 6, Twp. 57, Rge. 20

four week old cut

4

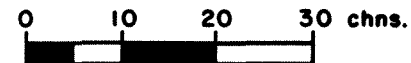


Sample Transect

one week old cut



Candle Lake



GRH 19/12/67

**Fig.4 Barrel Scarification Demonstration Areas,
White Gull Lake, Saskatchewan**

TABLE 3
 PER CENT STOCKING AND SEEDLINGS PER ACRE OF JACK PINE,
 WHITE GULL LAKE, SASKATCHEWAN, 1968-1969

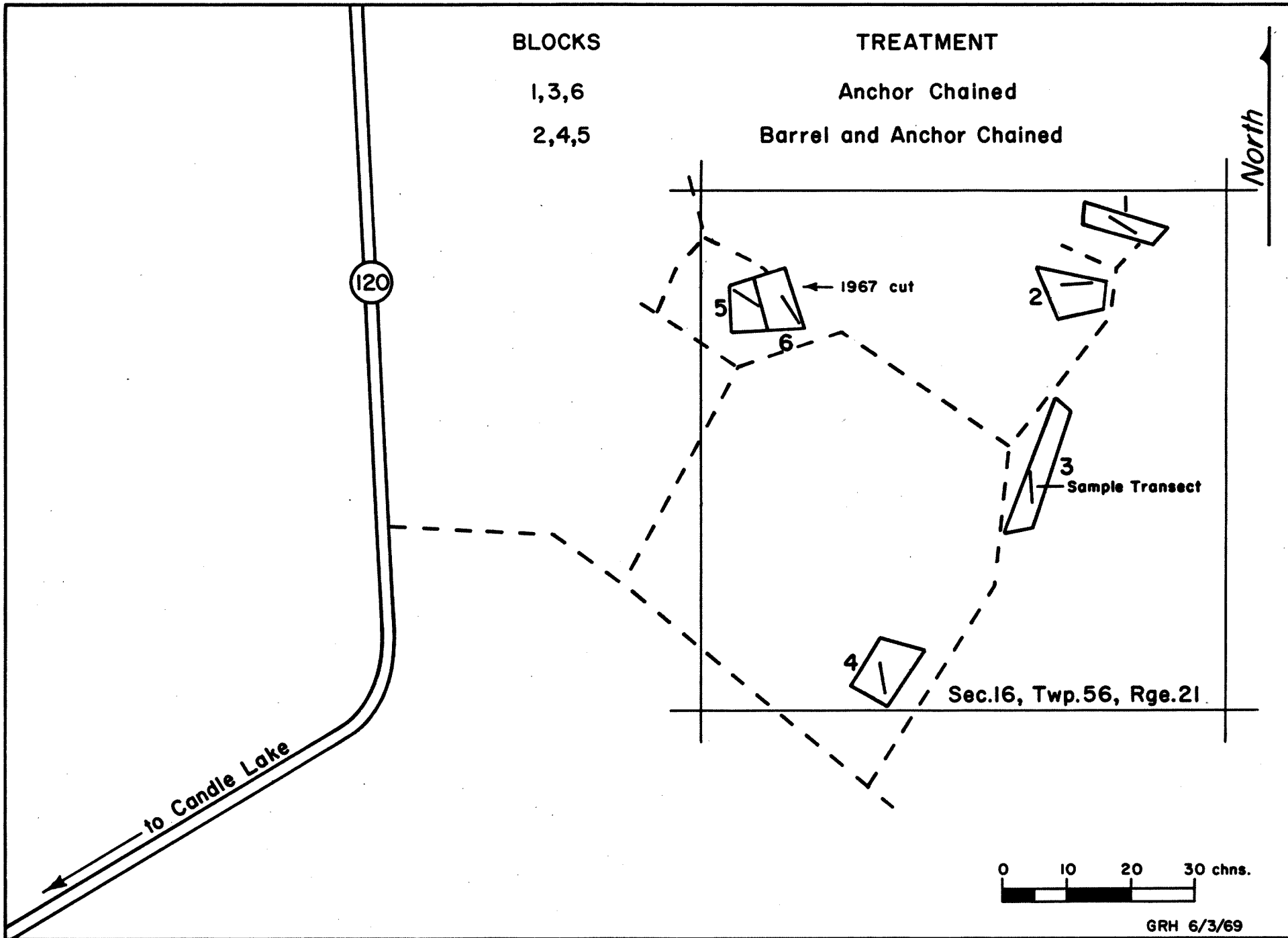
Block	Treatment	Autumn 1968		Autumn 1969	
		Per cent stocking	No. of seedlings per acre	Per cent stocking	No. of seedlings per acre
1	Barrel scarified	96.0	14,200	92.0	10,000
2	Barrel and anchor chain scarified	100.0	75,000	100.0	37,200
3	Anchor chain scarified	94.0	26,800	94.0	27,200
4	Barrel scarified	92.0	11,000	92.0	14,400

Basis: 50-1 milacre plots per block with five total count plots.

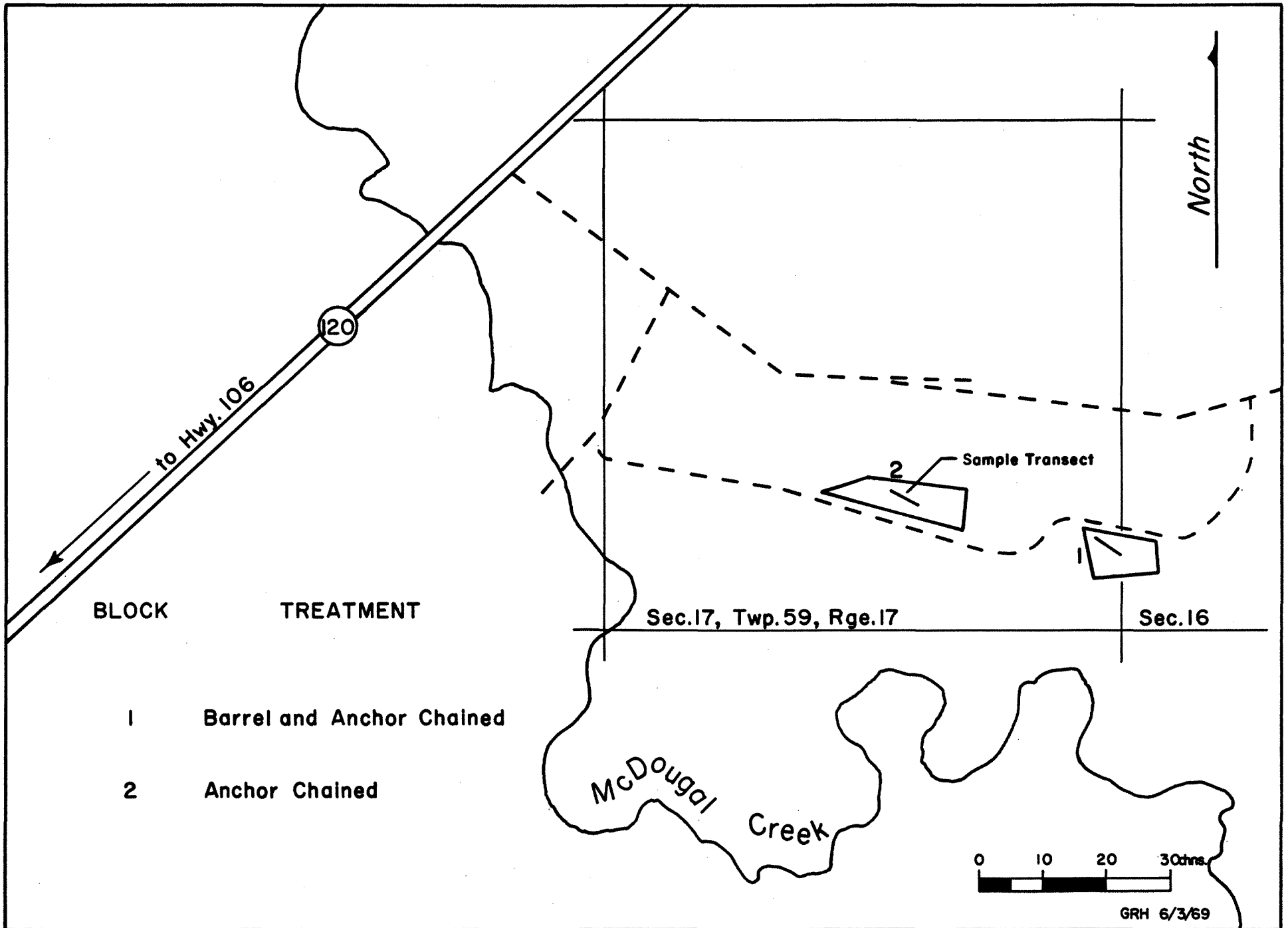
TABLE 4

PER CENT MORTALITY IN AUTUMN OF 1969 OF SEEDLINGS FOUND IN AUTUMN 1968 BY
SEEDBED TYPE, WHITE GULL LAKE, SASKATCHEWAN

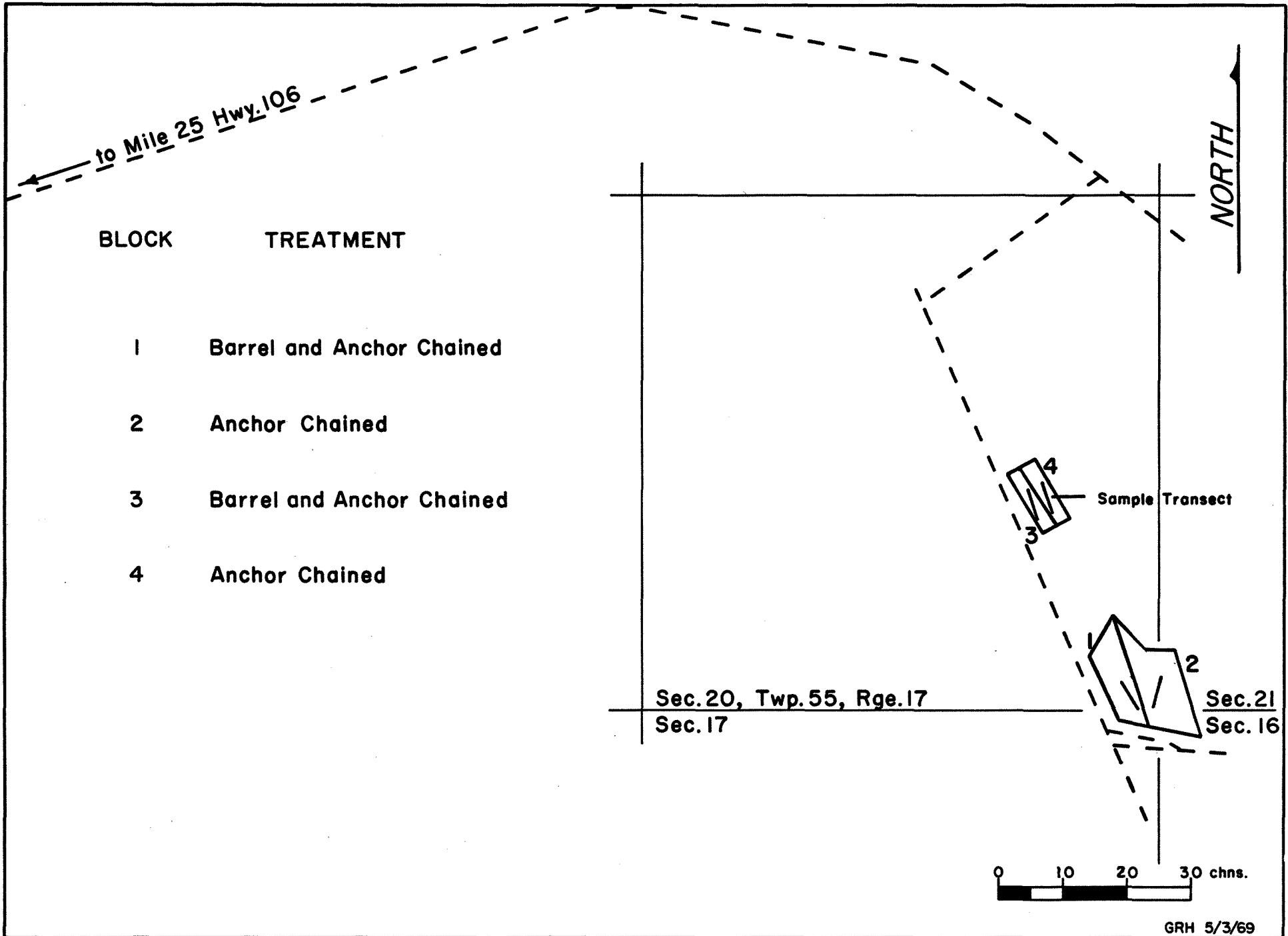
Block	Treatment	Mineral Soil		Humus		Mounds or undisturbed	
		Basis: No. of seedlings	Per cent mortality	Basis: No. of seedlings	Per cent mortality	Basis: No. of seedlings	Per cent mortality
1	Barrel scarified	20	5.0	21	14.3	7	42.8
2	Barrel and anchor scarified	26	46.2	12	8.3	12	25.0
3	Anchor chain scarified	12	8.3	25	12.0	10	30.0
4	Barrel scarified	21	23.8	20	30.0	5	20.0
All		79	24.0	78	16.7	34	29.4



**Fig. 5 Barrel And Anchor Chain Scarification Area,
Candle Lake, Saskatchewan**



**Fig.6 Barrel And Anchor Chain Scarification Area,
McDougal Creek, Saskatchewan**



**Fig.7 Barrel And Anchor Chain Scarification Area,
White Gull Creek, Saskatchewan**

In general, two treatments were used, barrelling and anchor chaining. Barrelling consisted of one pass over the block with three barrels (two full, one empty) and subsequently anchor chaining, at right angles, using two chains on a drawbar (six foot spacing) to improve scarification and cone distribution. Anchor chaining consisted of two passes, at right angles, over the area using two chains on a drawbar. A more complete description of the treatments and cutovers is found in (Hennessey, 1968).

Meteorological records for the region indicate an average growing season in 1969, however, June was dry and cold with killing frosts and August had a three week dry period.

Table 5 summarizes the results of regeneration surveys carried out during August 1969.

All blocks were well to fully stocked with jack pine regeneration and, as cone opening and germination were in progress at the time of the survey, the results appear excellent for most blocks. The relatively poorer results obtained on the better soils, the sandy loams, are due to black spruce and aspen components in the original stands. In jack pine-black spruce stands, black spruce regeneration (up to 3,000 per acre) substituted for jack pine on portions of the regeneration survey understocked with jack pine. In the jack pine-aspen stands, the higher proportion of cut but unharvested wood has interfered with scarification. The combination of poor scarification and a natural reduction in cone-bearing slash resulted in understocking of jack pine in the aspen portions of the stands. This was particularly evident in Block 4, where, in addition to relatively low stocking of jack pine located on the poorer seedbeds, the block appeared fully stocked with aspen suckers. The felling of unutilized aspen would appear detrimental to the establishment of jack pine regeneration using scarifying treatments. The results in Block 5 and 6 indicate that considerable delays in treating cutover stands are possible in this region, although ground vegetation seemed more diverse and well developed than on scarifications of newer cutovers. Drought appeared to be killing many new germinants on the sand sites during the regeneration survey.

(ii) Manitoba

Area A - Marchand

A winter of 1967-68 cutover near Marchand in southeastern Manitoba (Figure 8) was scarified in the spring, to create seedbeds suitable for natural regeneration from cone-bearing slash. The area had supported an open to dense, mature stand of jack pine on a moderately fresh (moisture regime 2) sand textured soil.

The cutover was divided into three blocks; one anchor chained with two passes at right angles to each other, one barrelled then anchor chained at right angles to the barrelling, and one barrelled between windrowed slash then anchor chained to drag slash over the scarified ground.

Table 6 shows the results of the permanent sample plots established in the autumn of 1968.

TABLE 5

PER CENT STOCKING AND SEEDINGS PER ACRE OF JACK PINE - AUTUMN OF
1969, CANDLE LAKE, MCDUGAL CREEK, AND WHITE GULL CREEK, SASKATCHEWAN

Area	Block	Date of cut	Soil	Treatment ¹	Per cent stocking	No. of seedlings per acre
68A	1	July '68	Sandy loam	Anchor chained	80.0	7,400
Candle Lake	2	July '68	Sandy loam	Barrelled	76.0	3,800
	3	June '68	Sandy loam	Anchor chained	90.0	14,600
	4	June '68	Sandy loam	Barrelled	74.0	1,200
	5	Summer '67	Sandy loam	Barrelled	80.0	5,200
	6	Summer '67	Sandy loam	Anchor chained	96.0	13,200
	68B	1	July '68	Sand	Barrelled	98.0
McDougal Creek	2	July '68	Sand	Anchor chained	100.0	12,400
68C						
White Gull Creek	1	July '68	Sand	Barrelled	100.0	11,600
	2	July '68	Sand	Anchor chained	98.0	4,600
	3	June '68	Sand	Barrelled	98.0	19,600
	4	June '68	Sand	Anchor chained	100.0	18,200

¹ Treatments carried out in August 1968.

Basis: 50-1 milacre plots per block with five total count plots.

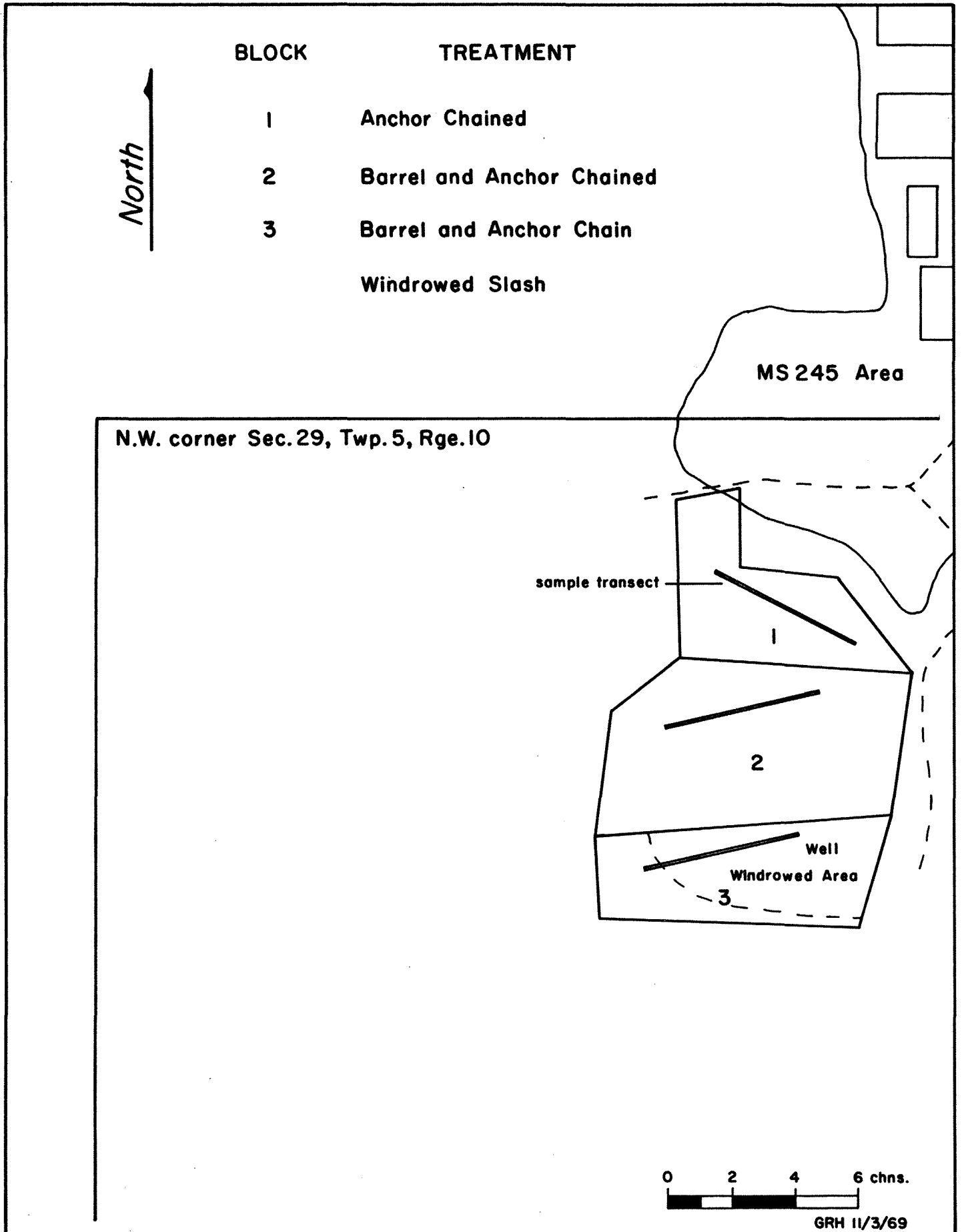


Fig.8 Barrel And Anchor Chain Scarification Area, Marchand, Manitoba

TABLE 6

PER CENT STOCKING, SEEDLINGS PER ACRE, AND RECORDED MORTALITY BY SEEDBED OF JACK PINE,
MARCHAND, MANITOBA, 1968-1969

Block	Treatment	1968		1969		Mortality					
		No. of		No. of		Mineral soil		Humus		Mounds and	
		Per cent seedlings	stocking per acre	Per cent seedlings	stocking per acre	Basis:	Per	Basis:	Per	Basis:	Per
1	Anchor chained	76.0	1,400	78.0	2,200	16	18.8	19	21.1	3	33.3
2	Barrelled	86.0	6,200	82.0	3,600	12	25.0	24	25.0	7	71.4
3	Barrel and anchor chained windrowed slash	82.0	1,800	60.0	600	17	17.7	11	45.5	13	76.9
All						45	20.0	54	27.8	23	69.6

Basis: 50-1 milacre plots per block with five total count plots.

All blocks were still well to fully stocked after two growing seasons, however, stocking has dropped sharply in Block 3. On this block most of the mortality occurred on the unscarified or poorly scarified portions of the block where only one pass with the anchor chains was used. Although this area had the poorest regeneration of all the areas examined, the best early growth occurred here, with best seedlings six to eight inches tall 15 months after treatment. Some second year germination was found on the anchor chain block but the large numbers of unopened cones appeared well shaded by the medium to heavy cover of herbs, shrubs, and grasses when examined in the autumn of 1969.

The excellent early growth and lack of strong competition for the jack pine found on the better seedbeds should enable Blocks 1 and 2 and the well scarified portions of Block 3 to develop adequate young jack pine stands.

Area B - Atik

During July 1968, five recently cutover areas near The Pas in northern Manitoba (Figure 9) were scarified to create seedbeds suitable for natural regeneration from cone-bearing slash. The areas had supported dense mature stands of jack pine on a fresh to moist (moisture regimes 3 to 5) slightly stoney, calcareous loamy till. The area was cut in June and July.

Block 1 was barrel scarified (four barrels on a drawbar at six foot spacing) with two passes over the block. Blocks 2 and 6 were anchor chained (three chains on a drawbar at four-and-one-half-foot spacing) with two passes at right angles to each other. Blocks 3 and 5 were barrel scarified (four barrels on a drawbar at nine foot spacing) with two passes and subsequently anchor chained using three chains. Block 4 was left undisturbed as a control.

Meteorological records for the region indicate a good growing season in 1969, with above average precipitation, however, June was cold and killing frosts were recorded.

Table 7 shows the results of regeneration surveys carried out during August 1969.

All scarified blocks were well to fully stocked with jack pine regeneration and as cone opening and germination were in progress at the time of the survey, the results appear good. The control block was poorly stocked. About a quarter of the germinants on the block were found on logging scarifications. The rest were found on undisturbed ground where a high mortality rate can be expected. As indicated by Table 7 most germinants on the drier sites were found on mineral soil or shallow humus seedbeds. On the moister sites, as in Blocks 5 and 6, a high percentage of the germinants were found on deep humus or mor type seedbeds as much of the mineral soil seedbeds appeared to have been under water in the early summer. These blocks resemble the anchor chained block of the White Gull Lake area and it would appear that vegetative competition will not be an important factor in the survival and growth of jack pine on this seedbed for several years after scarification.

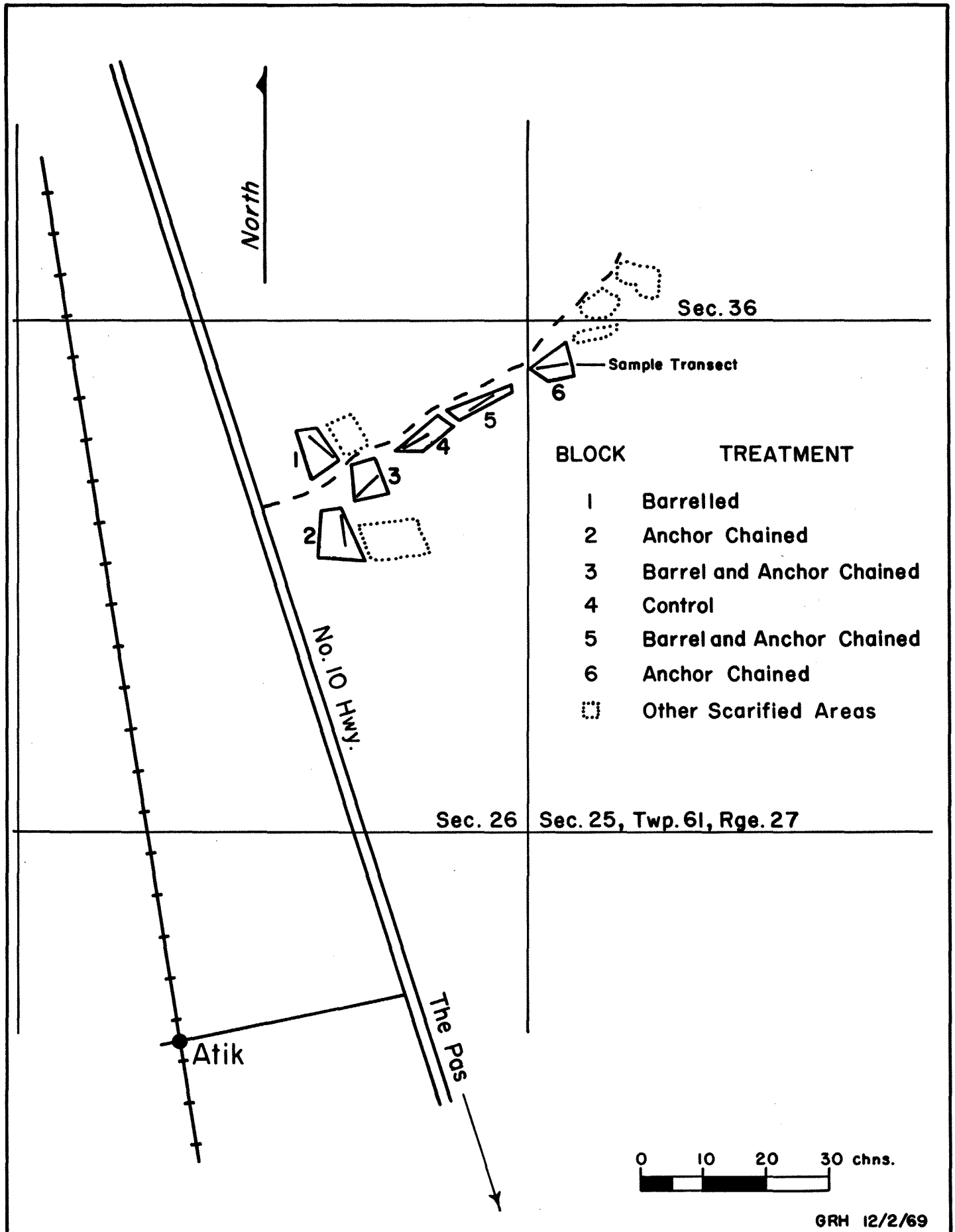


Fig.9 Barrel And Anchor Chain Scarification Area, Atik, Manitoba

TABLE 7
 PER CENT STOCKING, SEEDLINGS PER ACRE, AND SEEDLING LOCATION OF
 JACK PINE - AUTUMN OF 1969, ATIK, MANITOBA

Block	Treatment	Predominant moisture regimes	Per cent stocking	No. of seedlings per acre	Per cent seedlings found on		
					Mineral soil	Humus	Mounds or undisturbed
1	Barrelled	3, 4	66.0	2,200	33.3	48.5	18.2
2	Anchor chained	3, 4	86.0	3,400	67.4	18.6	14.0
3	Barrel and anchor chained	3, 4	96.0	8,000	47.9	37.5	14.6
4	Control	4, 5	36.0	800	5.6	22.2	72.2
5	Barrel and anchor chained	4, 5	90.0	7,000	26.7	46.7	26.6
6	Anchor chained	4, 5	78.0	8,600	17.9	56.4	25.7

Basis: 50-1 milacre plots per block with five total count plots.

In August 1969, vegetative competition was light on drier sites, principally woody herbs, and very light on the scarified moister sites.

Early results indicate that untreated cutovers will be understocked with jack pine regeneration.

3. ESTABLISHED IN 1969

(i) Saskatchewan

Area A - Turtle Lake

Several recent cutovers near Turtle Lake (Figures 10 and 11) were chosen to investigate the use of tractors and scarifiers, in providing fire control in heavily slash covered cutovers, and in increasing natural regeneration of jack pine. The cutovers had supported closed, immature stands of jack pine on a fresh to moist (moisture regimes 3 to 5) sandy loam textured soil. The stands were cut for fence posts. Blocks 3, 5, 6, 8, 9, and 10, were cut in the spring of 1969 and Blocks 1, 2, 4, and 7, were cut in 1968.

Barrel Scarification

Blocks 1 and 3 were barrel scarified, with two passes at right angles to each other, using four barrels in two rows of two on a drawbar at a six foot spacing. The barrels were empty, weighing about 700 pounds a piece, and the D-4 tractor had no trouble working in the heavy but small topped slash with this load. The barrels and drawbars were inter-connected by chains and swivels allowing independent rotation of the barrels. As the slash was well windrowed, the first pass over the block was concentrated on the bare ground between the slash piles. Scarification of Block 1 began on July 20, 1969, and the five acre cut required approximately¹ seven hours to complete (0.7 acres per hour).

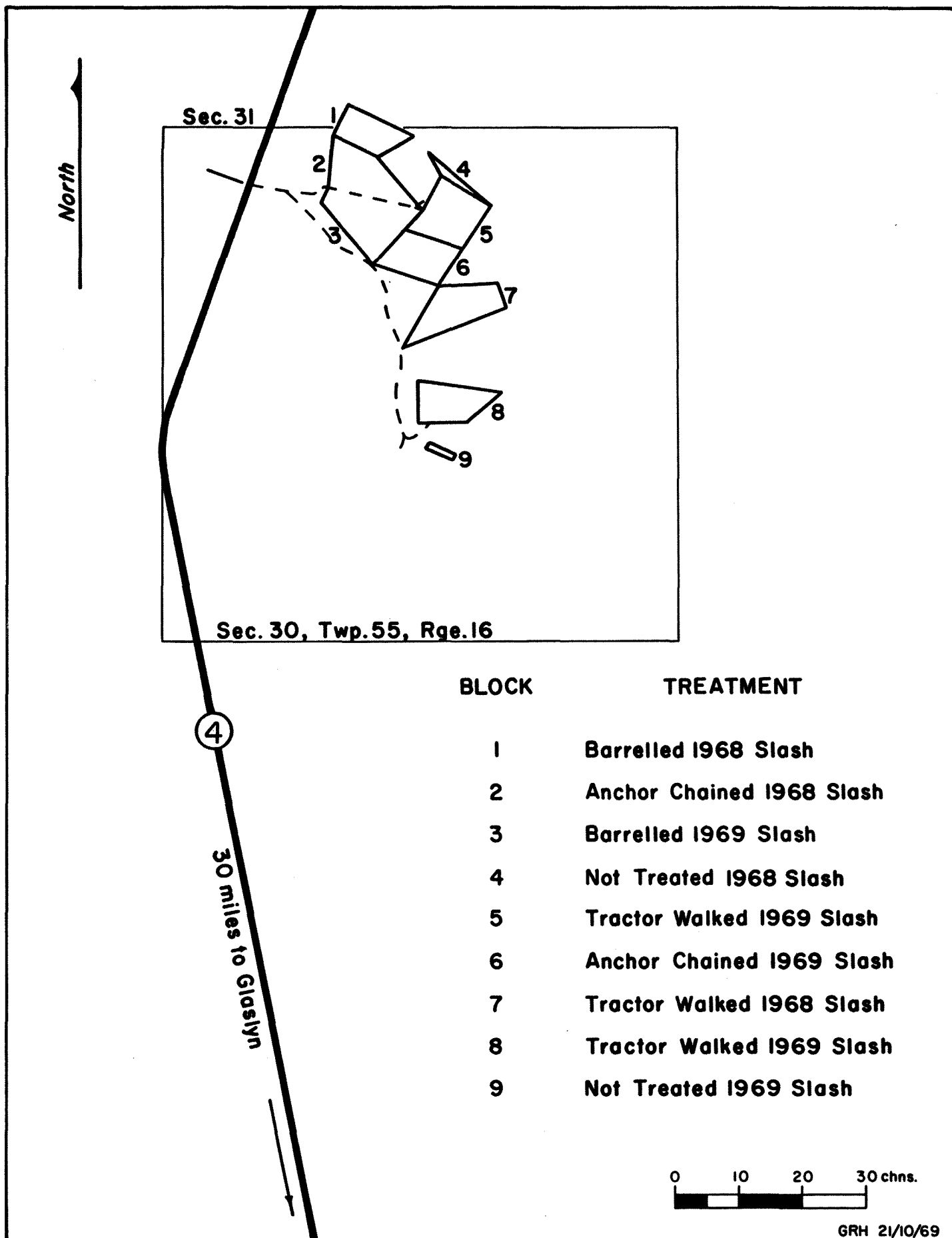
Block 3, a nine-acre cut, was started on July 16, 1969, and required 13 hours to complete (0.7 acres per hour).

Anchor Chain Scarification

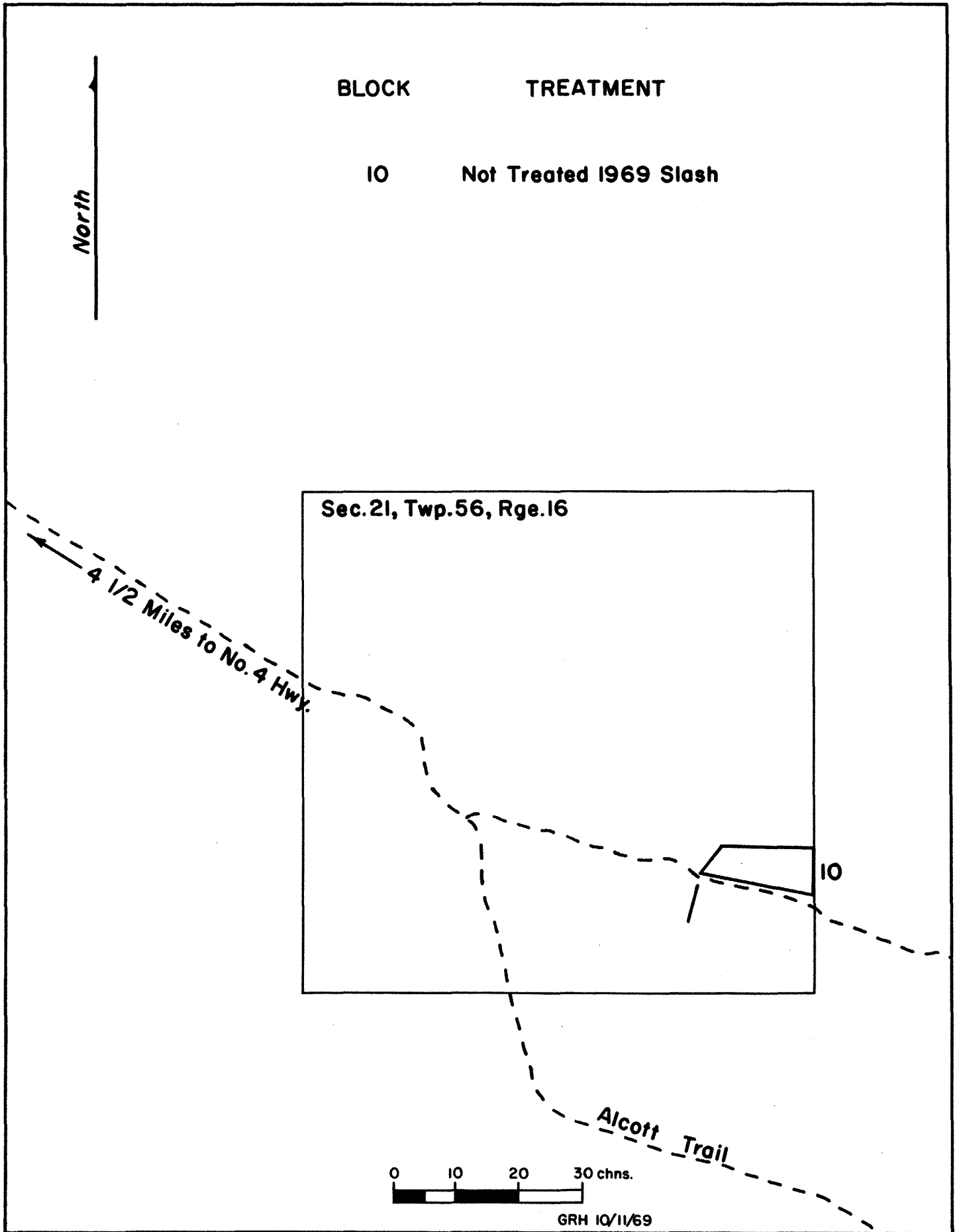
Blocks 2 and 6 were scarified in the same manner as Blocks 1 and 3 using two anchor chains in place of the barrels. Scarification of Block 2 began on July 19, 1969, and the seven-acre cut required six hours to complete (1.2 acres per hour).

Block 6, a seven-acre cut, was started on July 18, 1969, and required seven hours to complete (1.0 acres per hour).

¹ Elapse times are working time including minor holdups.



**Fig. 10 Barrel And Anchor Chain Scarification Area,
Turtle Lake, Saskatchewan**



**Fig. 11 Barrel And Anchor Chain Scarification Area,
Turtle Lake, Saskatchewan**

Tractor Walked

Foresters in this region have observed that natural regeneration on previously logged pine stands on moist site types has been adequate and were primarily interested in investigating the potential value of utilizing large tractors to tramp down the heavy slash to reduce initial fire hazard and promote rapid rotting of the finer slash materials by contact with moist ground. Secondly, they wished to increase natural regeneration by moving cone-bearing slash closer to the ground where higher temperatures can induce cone opening and seed dispersal.

A D-7 tractor was used to walk down the slash windrows on three blocks in this area. The effective coverage of the tractor tracks was about 75 per cent of the slash covered area, with some double passes over the heavier piles. The average depth of the slash appeared about three feet varying from one to four feet. This treatment reduced the average slash depth about 50 per cent. Block 5, an eight-acre cut, was started on July 23, 1969, and required five hours to complete (1.6 acres per hour).

Block 7, a seven-acre cut, was started on July 25, 1969, and required five hours to complete (1.4 acres per hour).

Block 8, a six-acre cut, was started on July 23, 1969, and required five hours to complete (1.2 acres per hour).

Not Treated

Three blocks were established on cutovers adjacent to the treated blocks and a few miles to the north. Regeneration surveys will be carried out on these in conjunction with surveys of the treated blocks to determine the extent and distribution of jack pine regeneration of untreated cutovers. Block numbers are 4, 9, and 10.

Cone Survey

Surveys were carried out to estimate the potential seed supply of the slash prior to treatment (Table 8).

The survey indicated that there was over 100,000 cones per acre on these cutovers with about a quarter of the cones on the 1968 cutovers having opened prior to treatment.

Fire Control

1. Cost

In considering treatment costs, scarification on this site would be 50 to 100 per cent faster with a D-7 rather than the D-4 that was used. The apparent better scarification rate of the chains as opposed to the barrels is due to the tractor speed being limited by the D-4's power capacity in the case of the barrels and by operator's riding comfort in the case of the anchor chains.

It might be helpful at this point to construct a table of theoretical treatment rates using a few assumptions and limitations. If the assumptions and limitations are:

TABLE 8

NUMBER OF CONES PER ACRE IN SLASH AT TURTLE LAKE AREA BEFORE TREATMENTS

Year of cut	Block No.	Basis: 2 sq. ft. plot every 1/20 of a chain		No. of cones in thousands per acre		
		Number of plots	Closed	Half-open	Open	Total
1968	1	80	91	1	20	112
1968	2	80	62	2	22	87
1968	4	80	51	8	32	92
1968	7	80	74	3	43	120
ALL 1968		320	69	4	29	102
1969	3	80	63	2	10	76
1969	5	80	101	2	14	118
1969	6	80	76	5	15	97
1969	8	80	94	1	14	110
1969	10	80	102	2	46	150
ALL 1969		400	87	3	20	110
ALL 1968-69		720	79	3	24	107

- the use of a D-7 class tractor;
- that two thirds of the cutover is covered with slash when tractor walking;
- the area is easily worked, pure clear cut jack pine, gentle terrain, few large stumps or stones;
- tractor working speed is 2.5 miles per hour to allow an acceptable ride for the operator;
- a 25 per cent loss of time for turning and overlapping as has been experienced in agricultural field work studies of small or difficult fields;
- an additional five per cent loss from slippage when the tractor is loaded to near capacity on the drawbar;

the result is Table 9.

Although treatment rates are generally higher in Table 9 than found in practice, the relationship between rates should be fairly accurate. This table suggests that a fully utilized tractor can scarify as much as it can walk where more than one pass is necessary due to a wider working width. If one pass of tractor walking is considered an adequate treatment it would appear to be more economical than the scarifiers which have additional fixed and maintenance costs.

2. Effectiveness

Initial fire control appeared excellent for the barrel scarifications and to a lesser extent, the anchor chain scarifications. For the barrelled blocks most of the finer materials and small branches were stripped from the slash, much of it being buried in, or mixed, with mineral soil. The anchor chains produced similar results but did not seem to throw up as much mineral soil to cover the slash. These blocks did not appear capable of supporting a continuous fire after scarification. In contrast, the tractor walked blocks looked capable of supporting a dangerous fire with perhaps some reduction in intensity due to compaction of the fuel.

All treatments should accelerate natural decay of the slash by placing it in closer contact with moist ground and in this way provide an eventual reduction in fire hazard. Here again, the stripping and distributing action of the scarifiers would seem superior to the compacting action of the tractor in stimulating the decay process.

Of the two slash ages treated, the older slash seemed to drop more of its needles during treatment. This could reduce the fire hazard somewhat more in the tractor walked block with 1968 slash than in those with 1969 slash.

3. Site Preparation for Natural Regeneration

The scarified blocks were typical of previous well scarified cutovers with about 40 per cent of the block being mineral soil or humus seedbeds and many cones stripped from branches and left lying on the ground. The empty barrels exposed more mineral soil than was expected on this soil texture (sandy loam) and this was attributed to the waterlogged condition of the ground.

TABLE 9
 THEORETICAL PER ACRE TREATMENT RATES FOR A D-7 CLASS TRACTOR
 AND SCARIFIERS

Treatment	Acres per hour using		
	1 pass	1½ passes	2 passes
Tractor walking (12 ft. working width)	4.1	2.7*	2.0
Anchor chaining (2 chains) (12 ft. working width)	2.7	1.8*	1.4
(3 chains) (18 ft. working width)	4.1	2.7	2.0
(4 chains) (24 ft. working width)	5.1	3.4	2.5
Barrelling (2 barrels) (6 ft. working width)	1.4	0.9	0.7
(4 barrels) (6 ft. working width)	2.7	1.8*	1.4
(6 barrels) (18 ft. working width)	3.8	2.5	1.9

* Approximate treatments carried out at Turtle Lake.

For the tractor walked blocks cone opening should be greatly improved as most are within one or two feet of the ground where higher temperatures can be expected. Most germination may be confined to the edges and shallow portions of the slash, excessive shade in the heavy slash and the lack of cones on the open ground being the limitations.

Area B - Lily Plain

Two recently cutover areas (Figure 12) were chosen for scarification to create seedbeds suitable for natural regeneration from cone-bearing slash. The cutovers had supported dense immature stands of jack pine on a dry to moderately fresh (moisture regimes 1 and 2) dune sand. The stands were cut for fence posts during June, July, and August of 1969. The cone crop in the slash was typical of scarification areas with lighter cone crops--from 50 to 100 thousand cones per acre.

Barrel Scarification

Block 2 was barrel scarified with one pass using six barrels on a drawbar in three groups of two barrels at four-and-one-half-foot spacings. All barrels were filled with water and weighed approximately 1,300 pounds a piece. The barrels, drawbar, and TD20B tractor were interconnected with chains and swivels. Scarification commenced September 17, 1969, and the 25 acre cut required approximately nine hours to complete (2.8 acres per hour). The close spacing between barrel sets encouraged slash jamming of the barrels and tended to scarify by scraping of the conglomeration rather than solely by the digging action of the rotating barrels.

Anchor Chain Scarification

Block 1 was anchor chain scarified using three chains at four-and-one-half-foot spacings on a drawbar. Two passes, at right angles to each other, were used to expose mineral soil. Scarification commenced on September 17, 1969, and the 15 acre cut required approximately nine-and-one-half hours to complete (1.6 acres per hour). The extra pass working the narrower dimension of the cutover reduced the scarification rate drastically in comparison to the barrelled block.

Seedbeds Created by Scarification

Excellent mineral soil exposure was obtained with one pass of the barrel scarifiers. A six foot spacing between barrel sets would probably be equally satisfactory and more economical. Unfortunately the drawbar used is not fitted for this spacing. Insufficient seedbed exposure was obtained with one pass of the anchor chains. The second pass produced seedbeds approximately equivalent to that of the barrelled cutover. The second pass in the anchor chain block seemed to improve cone distribution over good seedbeds.

The high scarification rate in the barrelled block illustrates the advantages of having large cutovers, a large tractor, a fast operator, and barrel scarifiers on this site. From the viewpoint of economic scarification it would be better to establish large unit cutting blocks in this fairly uniform stand and site rather than the patch work cutting plan presently used.

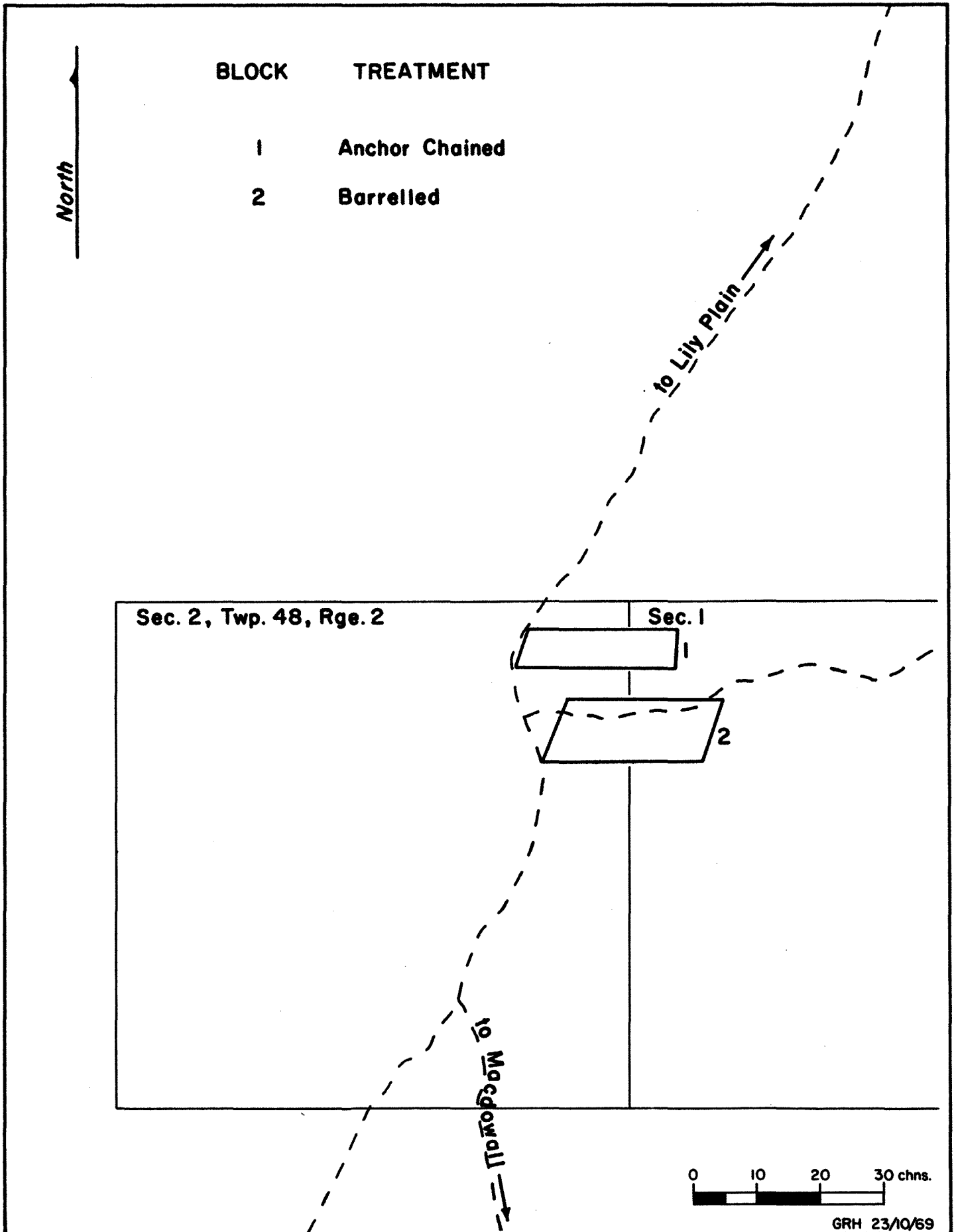


Fig.12 Barrel And Anchor Chain Scarification Area, Lily Plain, Saskatchewan

(ii) Manitoba

Area A - Marchand

A winter of 1968-69 cutover near Marchand in southeastern Manitoba (Figure 13) was chosen for scarification to create seedbeds suitable for natural regeneration from cone-bearing slash. The area had supported an open to dense mature stand of jack pine on a moderately fresh (moisture regime 2) sand textured soil. Most of the slash had been windrowed.

Barrel and Anchor Chain Scarification

Block 1 was barrel scarified with one pass at approximately four foot spacings in the cleared ground between the slash windrows and subsequently anchor chained (using four-and-one-half foot spacings) at right angles to the barrelling to drag slash over the seedbeds produced by the barrels (Figure 14). Three full barrels (about 1,300 pounds a piece) in a line were used to ensure good mineral soil exposure. Three chains on a drawbar were used for the anchor chaining. A D-4 was the tractor used for these scarification treatments. Scarification commenced on June 25, 1969, and the eight acre cut required twelve hours to complete (0.6 acres per hour).

Block 3 was barrel scarified at six foot spacings over the whole block then anchor chained at right angles to the barrelling. Scarifying equipment was arranged as in Block 1. Scarification commenced on June 27, 1969, and the 13 acre cut required 23 hours to complete (0.6 acres per hour).

Anchor Chain Scarification

Block 2 was anchor chain scarified using three chains and two passes at right angles to each other. The second pass covered all three blocks to improve the scarification rate. Scarification commenced on July 3, 1969, and the nine acre cut required nine hours to complete (1.0 acres per hour).

Cone Survey

A cone survey prior to scarification indicated that there was an average of 70,000 cones per acre, two thirds still closed at the time of scarification (Table 10). Post scarification cone surveys showed a large seed supply over good seedbeds in Block 3 and comparatively low seed supplies over good seedbeds in the other blocks.

Seedbeds Created by Scarification

As previously reported for the Marchand area of the preceding year, scarification appears hindered by a more tenaciously rooted ground vegetation found on this site, in this region. Three barrels in a line were necessary to provide well furrowed ground. The post scarification surveys showed considerable sweeping of litter, principally needles, from this age of slash into the well prepared furrows, by the second pass with the anchor chains. This could be due to this age of the slash being susceptible to needle shedding at scarification or the close spacing of

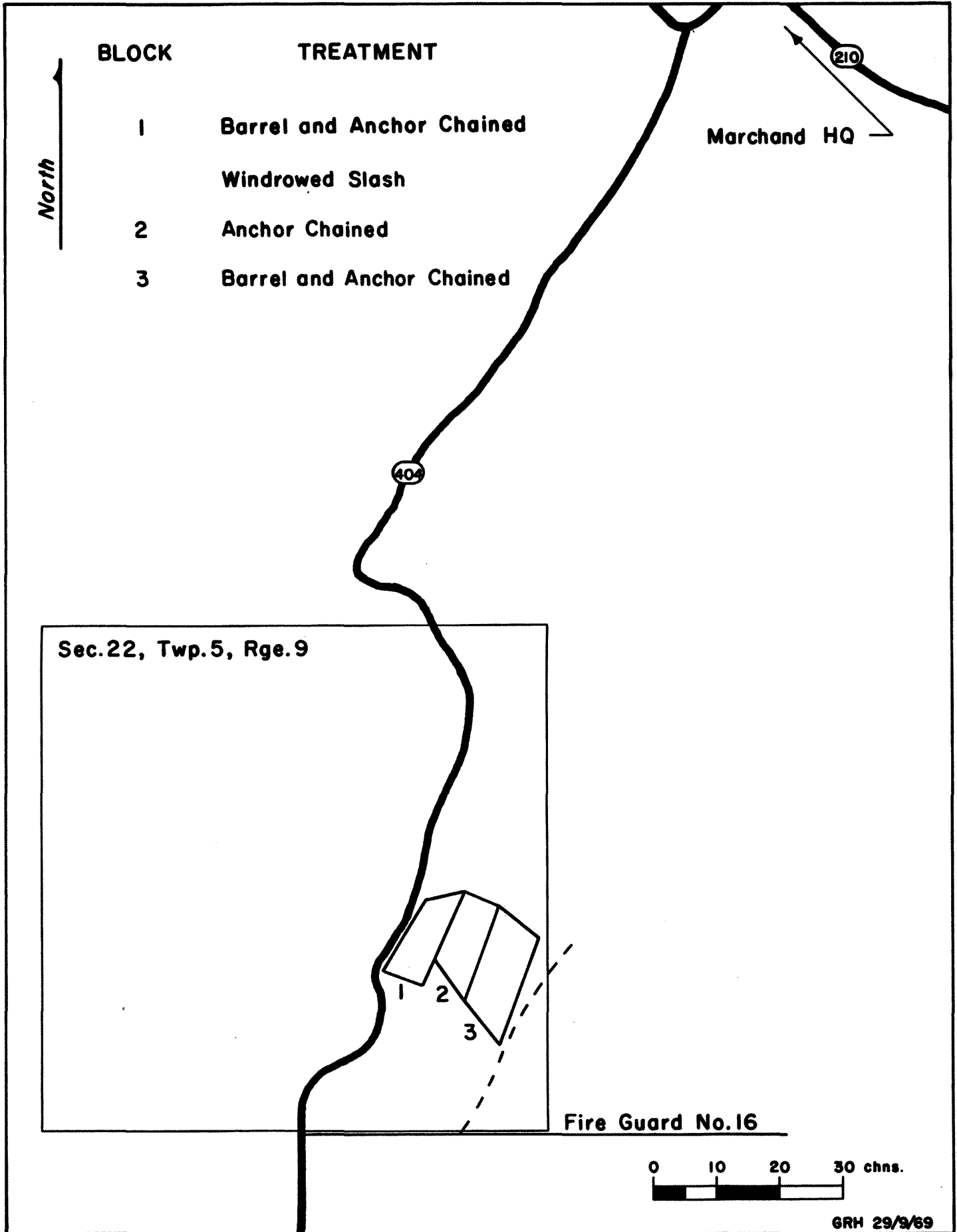


Fig. 13 Barrel And Anchor Chain Scarification Area, Marchand, Manitoba

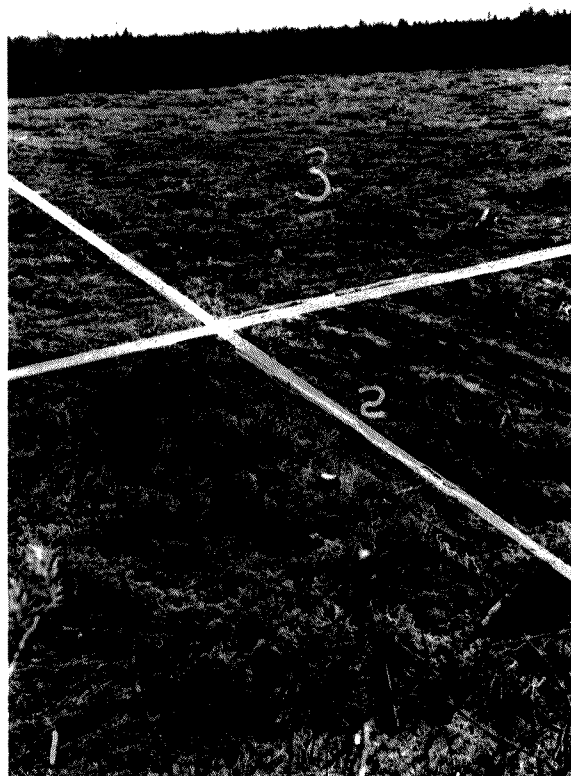


Fig. 14. Left - 1) Undisturbed; 2) Barrelled; 3) Barrelled and anchor chained (Block 3).
Top right - Block 1 - Barrel furrows before and after anchor chaining.
Bottom right - Anchor chaining Block 3.

TABLE 10
EFFECT OF SCARIFICATION ON THE DISTRIBUTION AND NUMBER OF
JACK PINE CONES AT MARCHAND, MANITOBA, 1969

Measurement	Block 1 Barrel and anchor chained windrow slash	Block 2 Anchor chained	Block 3 Barrel and anchor chained	All
Cones/acre before scarification				
Per cent closed	51	76	74	68
Per cent half-open	10	13	5	10
Per cent open	39	11	21	22
Total number	58,000	84,000	66,000	70,000
Per cent seedbeds after scarification				
Mineral soil	17	12	22	17
Humus	7	12	18	12
All mineral and humus seedbeds	24	24	40	29
Closed cones/acre after scarification on mineral soil and humus seedbeds				
Per cent mineral soil	66	61	63	63
Per cent humus	34	39	37	37
Total number	14,000	8,000	32,000	18,000

Basis: 80-2 sq. ft. plots--one every 1/20 of a chain per block.

the anchor chains may have encouraged a sweeping action by the jammed in slash. This layer of litter may effect germination and early growth on these seedbeds.

A brief inspection of the area in the autumn indicated considerable cone opening and germination during the remainder of the growing season following scarification. The area was also well covered with ground vegetation, mainly ferns, fire weed, and shrubs.

DISCUSSION

The objective of this demonstration project is to assess the effectiveness of barrel and anchor chain scarifiers in providing adequate regeneration on jack pine cutovers in this region. This assessment may be divided into three categories, the regeneration results, the costs, and the limitations of the barrel and anchor chain scarifiers.

Table 11 indicates that the regeneration results are generally good to excellent. The barrels provided excellent scarification of old jack pine cutovers on sand sites preparatory to planting and artificial seeding. Where natural regeneration was expected from cone-bearing slash, good germination and early establishment of jack pine with some additional germination in the second year and stocking of other softwoods combined with the absence of strong ground competition from grasses and herbs in most scarified cutovers, indicate that these scarifiers are excellent silvicultural tools for natural regeneration of jack pine cutovers in this region. The regeneration results appear particularly good in the main boreal forest north of Prince Albert and The Pas, rather than in the transitional regions close to agricultural areas.

Scarification costs, exclusive of capital expenses, range from \$5.00 to \$10.00 per treated acre where large (over 15 acres), easily scarified, jack pine cutovers are treated with large tractors loaded to capacity. This cost tends to double for blocks from five to 15 acres or where serious obstacles such as high stumps, large boulders, felled large aspen, and extremely hilly terrain occur. The cost can triple, when using an inadequate tractor, or, on cutovers of less than five acres with scarifying obstacles. These observations are based on estimated scarification rates varying from less than half an acre an hour to rates of almost three acres an hour. The off site and capital costs would involve the transportation of tractors and scarifying equipment, the repair and depreciation of the scarifiers, and the interest loss on the capital investment in the scarifiers. This would normally be a small percentage of the on-site costs where the scarifiers are used on an extensive basis. Management costs would be incorporated in the normal duties of a forest manager. In comparison, the present principle alternate silvicultural treatments of recent cutovers, site preparation and planting, and prescribed burning and artificial seeding or planting, appear more expensive. Off-site and capital costs tend to be similar with all treatments requiring special equipment and transportation to the site. For planting treatments, on site costs of \$50.00 to \$60.00 including the value of the transplants, commonly occur. Site preparation costs of \$3.00 per acre, for prescribed burning, have

TABLE 11

STATUS OF REGENERATION ON SCARIFIED JACK PINE CUTOVERS - AUTUMN, 1969

Demonstration area No.	Local	Treatment						Prospect* rating	Comments or principal limitation
		Planted		Seeded		Natural regeneration			
		Per cent survival	Trees per acre	Per cent stocking	Trees per acre	Per cent stocking	Trees per acre		
67A	Macdowall	56	1,050					G	Poor planting stock
67A	Macdowall			86	5,100			F	Poor early growth
67B	White Gull Lake					96	22,200	E	Strong ground competition in Block 2
68A	Candle Lake					83	7,600	G	Aspen regenera- tion in Block 4
68B	McDougal Creek					99	12,300	E	None
68C	White Gull Creek					99	13,500	E	None
68A 68A	Marchand					73	2,100	G	Strong ground competition Poor scarifica- tion in Block 3
68B 69B	Atik					75	5,000	G	Poor regenera- tion in control Block

* Prospect - an arbitrary estimation of the eventual development of fully stocked jack pine stands.
E - excellent; G - good; F - fair; P - poor.

been reported for jack pine cutovers of 50 acres where per acre costs of fire guard construction and fire crew can be minimized. Unfortunately, subsequent scarification treatments may be necessary to moderate the harsh environment produced by the burn and this, in addition to costly seeding or planting operations, would appear to make this treatment more expensive, especially for smaller cutovers. In summary, barrel and anchor chain scarification of recent cutovers would seem to be an attractive silvicultural investment for adequate-sized cutovers.

Four limitations of the scarifiers have been noted. These are: the anchor chains were incapable of satisfactorily scarifying, in one pass, on any site; the barrels were generally incapable of satisfactorily scarifying, in one pass, sites with soils heavier than sands using only two barrels per furrow; both scarifiers had difficulty in scarifying where large aspen were felled and left on the cutover; and finally, the low efficiency, and hence, high power requirements of drag scarifiers when compared to agricultural plows. The first three limitations may, possibly, be minimized by modifying the scarifiers for the first two, the cutting practice for the third. The fourth limitation is considered inherent for drag scarifiers.

FUTURE WORK

A reduced program is anticipated for the field season of 1970 as a fairly good cross-section of typical jack pine cutovers and cutting years have been treated. It is expected that an additional area will be established in the Sandilands Forest Reserve in southern Manitoba in the summer of 1970. Regeneration surveys and remeasurements will be carried out in the established areas and in scarifications carried out in the summer of 1969 at Atik by the Manitoba Forest Service and near Candle Lake by the Saskatchewan Pulp Co.

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