

GUIDELINES FOR SCARIFICATION  
IN NORTHERN MANITOBA

BY

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## *FOREWORD*

Practical scarification guidelines were considered a useful forest management tool for northern Manitoba where extensive cutover areas are treated annually. Under contract to the Canadian Forestry Service the author studied the problem and provided the guidelines that are presented in this report.

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## *AVANT-PROPOS*

L'auteur présente un guide pratique de scarifiage, jugé un outil utile pour l'aménagement des forêts de la partie nord du Manitoba, où l'on exerce chaque année l'exploitation à blanc sur une grande échelle. L'auteur, par contrat avec le Service canadien des forêts, a étudié le problème. D'où le guide présenté ici.

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## *INTRODUCTION*

### SITE FACTORS

The problem area, north of The Pas, Manitoba, stretches from an essentially flat area with slightly tilted plateaus and low drumlins, north to the Precambrian Shield. In the north is bedrock topography with shallow organic soils often over shattered bedrock. Outcrops are numerous. There are many lakes with interlocking drainage channels and fast streams.

The climate is cold continental with a short cool growing season (average 157 days above 5.5° C) and moderate precipitation (457 mm total; 279 mm, May to September). Mean annual temperature is 0.6° C. Permafrost (peat plateaus and palsas) is commonly found in the extensive peatland in the area.

Vegetation cover throughout is mainly boreal forest with black spruce dominant. Drier sites support fire-origin jack pine stands. White spruce-trembling aspen or balsam poplar stands occupy moderately to imperfectly drained sites on heavier-textured mineral soils. The area is thus a mosaic of white-spruce, black-spruce, and jack-pine types dependent on physiography and fire history, and on certain well-defined limiting edaphic site factors such as shallowness to bedrock, restricted vertical drainage in mineral soils (especially lacustrine clays), and depth of organic soils.

Rowe (1972) includes this rather variable group of forest cover types in his description of the B-15, Manitoba Lowlands Forest Section. Calcareous parent material influences soil development towards humic gleysols and organic soils. Tree sizes are small with heights of 18-24 m (60-80 ft) at 100 yr, 15-20 cm (6-8 in.) dbh, in dense (1200-2000 stems per ha or 3000-5000 per acre) stands. Locally, white spruce stems reach larger sizes on better-drained deeper tills. An excellent account of the range of stand and physiographic site types is contained in Zoltai, Tarnocai, and Oswald's 1970 report on the Cormorant Lake Biophysical Project.

## UTILIZATION

The pulpmill at The Pas, Manitoba draws on the forest resources of a 103 600-km<sup>2</sup> (40 000-mile<sup>2</sup>) area of such sites; 46 620 km<sup>2</sup> (18 000 miles<sup>2</sup>) are forested, of which 25 900 km<sup>2</sup> (10 000 miles<sup>2</sup>) are forested, of which 25 900 km<sup>2</sup> (10 000 miles<sup>2</sup>) are currently merchantable. There are numerous local mills sawing dimension lumber and special assortments such as posts, poles, and railroad ties. Annual allowable cut for the area has been estimated at 2 million m<sup>3</sup> (600 000 cords), and one pulp mill complex, not including an integrated 0.5 million m<sup>3</sup> (100 million bd ft) per-annum lumber mill, will utilize 1 million m<sup>3</sup> (350 000 cords) per annum at capacity. Rotation ages for allowable cut estimation are set at 100 yr for white spruce, 80 yr for black spruce, and 75 yr for jack pine. Dense stands and slow growth rates on cold soils result in small stem sizes (0.1 m<sup>3</sup>, 4.3 ft<sup>3</sup>) per tree or about 50 trees per Mfbm). Short (5-m, 16-ft) wood is truck-hauled up to 193 km (120 miles) to this mill and there are longer (240-km, 150-mile) rail hauls. The sawmill handles material to a 14-cm (5½-in.) top, and sends the remainder and resulting chips to be pulped.

## CUTTING SYSTEMS

Progressive and alternate block clear-cutting (up to 200 ha or 500 acres) and alternate strip clear-cutting are practised. Block boundaries are usually cover-type boundaries, especially in pine stands. Leave blocks and strips may be laid out in spruce types. Powersaw felling and cable skidding on rubber are commonly used, but the use of mechanical felling and bunching equipment is increasing. In deep winter snow, mechanical tree shears get closer to the ground, leaving low stumps. Terrain and tree sizes are suited to fully mechanized shortwood harvesting systems, and the implications for silviculture are being assessed.

## SITE PREPARATION

Site preparation has comprised the use of spiked anchor chains and shark-finned barrel drags. Objectives have been to:

1. break down slash and reduce fire hazard
2. expose a receptive mineral soil seedbed

3. redistribute cone-bearing slash over the cut block
4. break cones from the slash and scatter them on the seedbed.

Shark-finned barrels, designed to operate on wetter sites with deeper organic soil layers, have been successful only on better-drained sites with light slash and shallow organic soil layers. Under these conditions, spiked anchor chains would be more efficient. Drags are commonly pulled by rubber-tired skidders but steel-tracked tractors are often necessary on steeper slopes and wetter soils. Here drags are less efficient. Dense and high stumps are a barrier to effective penetration of organic soil horizons and redistribution of slash. They also wear out tires, and reduce operator comfort and productivity.

#### REGENERATION SURVEYS

Regeneration surveys are carried out 3-5 yr after site preparation. Steneker (1975) reports adequate and much-more-than-adequate pine regeneration 3-4 yr after treatment (C.F.S. survey). Spruce regeneration decreases from stand margin to clear-cut block. Spruce regeneration is satisfactory on wetter sites where barrel scarification has effectively plowed mineral soil seedbeds. Regeneration reports by field workers Rugg and Chaput (Rugg 1976, pers. comm.) often indicate inadequate restocking to spruce and pine 2-3 yr after treatment. Advance growth and layered seedlings are not included in these estimates.

### *METHODS AND RESULTS*

#### SAMPLING

The reports of Ball (1975) and Steneker (1975) and regeneration survey data sheets were studied for background information. A reconnaissance of the problem area was conducted in June 1975 with Dr. G.A. Steneker (Canadian Forestry Service), and sampling began in August 1975.

Sample areas were selected by substrata of cover type, years since treatment, and method of scarification. Supplementary areas of interest were visited, as time permitted, to fill in the background

to decision-making. Distribution of samples is shown in Fig. 1. At each sample area a 60-m (3-chain) transect was run from a point 30 m (1.5 chains) in the residual stand to 30 m (1.5 chains) into the clear-cut areas. Thus each sample provided approximately 30 contiguous milliacre examination quadrats at which the following information was gathered:

1. Cover type (for transect)
2. Stand density/stump density
3. Mineral soil exposure/site disturbance
4. Advance growth and regeneration stocking
5. Depth to mineral soil

Data are presented in Table 1. Summary statements for each sample follow.

Sample 1. Namew Lake Road, 10 km (Mile 6)

An example of routine site preparation. Conifer regeneration stocking is high (65%) at 6650 seedlings per ha (2650 per acre), approximately 4 yr old. Black spruce advance growth has survived logging and the thorough job of scarification.

Sample 2. Namew Lake Road, 13km (Mile 8)

Without scarification to date, black spruce advance growth has survived logging, and jack pine stocking in the clear-cut is 30% (2950 stems per ha, 1200 per acre).

Sample 3. Namew Lake Road, 1/2 way, North

Recent treatment of wetter white spruce site has been unsuccessful to date. This is a candidate for alternative site preparation.

Sample 4. Namew Lake Road, 1/2 way, East

Barrelled because of wetter site and heavier soil, this site supports only jack pine seedlings thriving in barrel furrows. Vegetation competition is severe.

Sample 5. Namew Lake Road, 16 km (Mile 10)

A representative area with black spruce advance growth and jack pine regeneration.

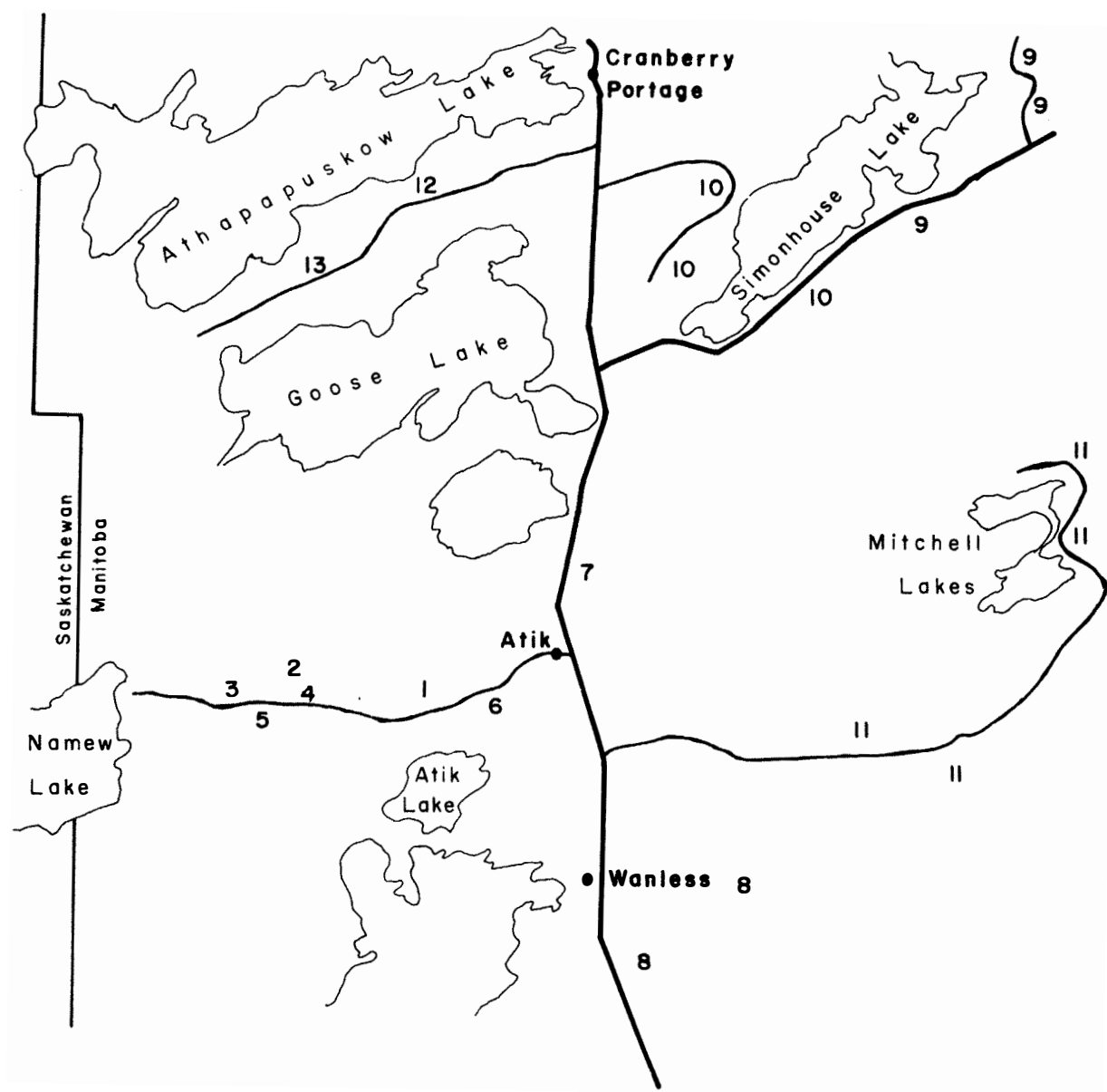


Figure 1. Sample area locations



Sample 6. Namew Lake Road, 10 km (Mile 6)

Pine regeneration is better than spruce. Seedlings commonly occur in cleat marks of tracked tractors--moisture-conserving microsites.

Sample 7. North of Wanless, Larch Road

Barrel scarification with planted stock. Performance of Siberian larch was outstanding. Effective exposure of mineral soil on this "no problem" site. Natural regeneration of conifers was commonly 45% (2600 stems per ha, 1050 per acre).

Sample 8. South of Wanless, Current Logging

Spiked chain scarification was observed here, and trials of one pass in two were sampled. Black spruce advance growth fell from 3100 stems per ha (1251 per acre) in the uncut stand to 1700 stems per ha (700 per acre) at the stand margin, and to 0 following 100% scarification. However, 370 stems per ha (150 per acre) survived the 50% (one pass in two) treatment where mineral soil exposure was 40%. Jack pine regeneration is anticipated on the treated areas. A small area without site treatment was also sampled and here black spruce advance growth stocking was 13%.

Sample 9. Simonhouse Road, South

A good representative of black spruce advance growth survival and pine regeneration ingress.

Sample 10. Simonhouse Road, South

Barrel scarification had been carried on in 1973 in a 3.23-ha (8-acre) bowl-shaped depression. Scarification destroyed advance growth of black spruce and balsam fir and regeneration was unsatisfactory. Pine was absent.

Sample 11. Mitchell Lake Road

On more recent and thorough scarification, (heavier chains and longer spikes, larger skidders) many new spruce and pine seedlings (1-2 yr) were present on this wetter site.

TABLE 1. FIELD SURVEY SUMMARY

TRANSECT LOCATION	STAND TYPE	SAMPLE UNIT	NO. OF QUADRATS	MIN. SOIL % EXPOSED	DENSITY STEMS/STUMPS per ha (acre)	ADVANCE GROWTH				REGENERATION				
						STOCKING		STOCKING		STOCKING		STOCKING		
						AGE	STEMS/ha	(ACRE)	%	%	STEMS/ha	(ACRE)		
I. Namew Lake Road, 10 km Cut 1971 (Chains)	bSjPtA	Uncut	20	-	bS	3954	(1600)	12	988	(400)	15	-	-	-
					jP	371	(150)	-	-	-	-	-	-	
					tA	-	-	-	-	-	-	-		
		Margin	20(15,5)	15	bS	2100	(850)	-	-	-	-	-	-	
					jP	247	(100)	-	-	-	25	1853	(750)	
					tA	-	-	371	(150)	10	-	-	-	
		Cut	20	100	bS	1606	(650)	13	741	(300)	20	20	988	(400)
					jP	618	(250)	7	247	(100)	10	45	5560	(2250)
					tA	-	-	247	(100)	10	10	247	(100)	
2. Namew Lake Road, 13 km Cut 1973 (No Treatment)	bSjPtA	Uncut	10	-	bS	1483	(600)	17	8154	(3300)	90	-	-	-
					jP	247	(100)	-	-	-	-	-	-	
					tA	-	-	-	-	-	-	-		
		Margin	10(8,2)	-	bS	494	(200)	18	988	(400)	30	-	-	-
					jP	741	(300)	-	-	-	-	-	-	
					tA	741	(300)	-	494	(200)	20	20	494	(200)
		Cut	10	-	bS	988	(400)	15	988	(400)	20	-	-	-
					jP	-	-	-	-	30	2965	(1200)		
					tA	741	(300)	-	-	-	-	-	-	
3. Namew Lake Road 1/2 Way N. Cut 1973 (Chains)	wSbStA	Cut	20	90	bS	618	(250)	-	-	-	-	-	-	
					jP	-	-	-	-	10	988	(400)		
					wS	618	(250)	-	-	-	-	-		
					tA	-	-	1236	(500)	40	20	1977	(800)	

Cutting treatment and scarification unsuited to cover and site type

TABLE 1. Continued FIELD SURVEY SUMMARY

TRANSECT LOCATION	STAND TYPE	SAMPLE UNIT	NO. OF QUADRATS	MIN. SOIL <sup>*</sup> % EXPOSED	DENSITY		ADVANCE GROWTH				REGENERATION				
					STEMS/STUMPS		STOCKING		STOCKING		STOCKING				
					perha	(Acre)	AGE	STEMS/ha	(ACRE)	%	%	STEMS/ha	(ACRE)		
4. Namew Lake Road 1/2 Way E Cut 1971 (Barrels)	wSjPtA	Margin	20(11,9)	-	wS	-	-	-	-	-	-	-	-	-	
					jP	-	-	-	-	-	5	124	(50)		
					tA	494	(200)	-	1606	(650)	40	25	618	(250)	
		Cut	40	80	wS	74	(30)	13	74	(30)	3	-	-	-	
					jP	-	-	-	-	20	988	(400)			
					tA	-	-	1112	(450)	40	50	1236	(500)		
	Jack pine seedlings grew well in flooded furrows; severe vegetation competition.														
	5. Namew Lake Road, 16 km Cut 1972 (chains)	bSjPtA	Cut	20	85	bS	247	(100)	30	371	(150)	15	-	-	-
						jP	-	-	-	-	-	65	4818	(1950)	
						tA	124	(50)	-	-	-	-	-	-	-
6. Namew Lake Road, 10 km Cut 1970 (Chains + cat)	bSjPtA	Spruce Cut	20	70	bS	618	(250)	17	618	(250)	20	15	1853	(750)	
					jP	-	-	-	-	-	25	1853	(750)		
					tA	-	-	-	-	-	25	1853	(750)		
	jPbStA	Pine Cut	20	95	bS	-	-	-	-	-	-	-	-	-	
					jP	-	-	-	-	-	65	4818	(1950)		
					tA	-	-	-	-	-	10	494	(200)		
7. Wanless Larch Road (Barrels)	bSjPtA	Margin	10(5,5)	100	bS	494	(200)	-	-	-	-	-	-	-	
					jP	-	-	-	-	-	40	2965	(1200)		
					tA	-	-	-	-	-	90	4448	(1800)		
		Cut	20	100	bS	618	(250)	-	-	-	15	371	(150)		
					jP	-	-	-	-	-	30	2224	(900)		
					tA	-	-	247	(100)	10	50	1236	(500)		

TABLE 1. Continued FIELD SURVEY SUMMARY

TRANSECT LOCATION	STAND TYPE	SAMPLE UNIT	NO. OF QUADRATS	MIN. SOIL % EXPOSED	* DENSITY		ADVANCE GROWTH				REGENERATION		
					STEMS/STUMPS per ha (acre)		STOCKING		%	STOCKING			
							AGE	STEMS/ha		(Acre)		%	STEMS/ha
8. 5 km S. of Wanless Cut 1975 (chains)	bSjPtA	Uncut	20	—	bS	420 (1700)	11	3089	(1250)	40	—	—	—
					jP	1483 (600)	—	—	—	—	—	—	
					tA	—	—	—	—	—	—	—	
		Margin	20(7,13)	65	bS	2842(1150)	8	1730	(700)	25	—	—	—
					jP	741 (300)	—	—	—	—	—	—	
					tA	124 (50)	—	—	—	—	—	—	
		(100% Scarification)	Cut	20	100	bS	1977 (800)	—	—	—	—	—	—
						jP	865 (350)	—	—	—	—	—	—
						tA	—	—	618	(250)	20	—	—
		(50% Scarification)	Cut	20	40	bS	1359 (550)	17	371	(150)	15	—	—
						jP	124 (50)	—	—	—	—	—	—
						tA	247 (100)	—	865	(350)	35	—	—
		(No Scarification)	Cut	20	—	bS	—	17	—	—	13	—	—
9. Simonhouse Road Cut 1973 (chains)	bSjPtA	Uncut	10	—	bS	1977 (800)	—	—	—	—	—	—	
					jP	494 (200)	—	—	—	—	—	—	
					tA	—	—	—	—	—	—	—	
		Margin	20(8,12)	35	bS	865 (350)	10	741	(300)	25	—	—	
					jP	988 (400)	—	—	—	—	—	—	
					tA	—	—	—	—	—	—	—	
		Cut	20	95	bS	494 (200)	14	3212	(1300)	55	5	124	(50)
					jP	988 (400)	—	—	—	10	741	(300)	
					tA	—	—	—	—	10	494	(200)	

\* at 93 cm<sup>2</sup> (1 ft<sup>2</sup>) mineral soil exposed.

TABLE 1. Continued FIELD SURVEY SUMMARY

TRANSECT LOCATION	STAND TYPE	SAMPLE UNIT	NO. OF QUADRATS	MIN. SOIL % EXPOSED	DENSITY STEMS/STUMPS per ha (acre)	ADVANCE GROWTH STOCKING			REGENERATION STOCKING		
						AGE	STEMS/ha (Acre)	%	%	STEMS/ha (Acre)	
10. Simonhouse Road Cut 1973 (Barrels)	bSwSbF	Cut	40	10	bS 420 (170)	12	494	(200)	10	-	-
					wS 494 (200)	-	-	-	-	-	
					bF 321 (130)	12	988	(400)	30	-	-
11. Mitchell Lake Road (Chains)	bSjPtA	Very recent scarification (i.e. heavier chains + longer spikes) on wetter sites. Duff to 15 cm (6 in). Many seedlings.									
12. Athapapuskow Lake Road (Chains)	bSjPtA	recent treatment on wetter sites. Many seedlings.									
13. Athapapuskow Lake Road M. 8-10	wStA	75 years wS to 24.4 m(80 ft), 30 cm (12") stump, 20 cm (8") d.b.h. clay loam soil, (15-23 cm) (15-23 cm) O.M. Severe vegetation competition. Regeneration problems. Suggest summer operation with site preparation by Finnish plow.									

A wet bowl-shaped depression--scarification was ineffective

Sample 12. Athapapuskow Lake Road, (13-16 km) Mile 8-10

Recent scarification on a wetter site had resulted in many new seedlings, especially pine.

Sample 13. Athapapuskow Lake Road

A white spruce-aspen type on heavier soils had severe vegetation competition, no seedlings, and a fair cone crop this year. Summer logging operations with site preparation by plowing could be considered.

Sample 14. Hudson Bay Junction, Saskatchewan, (Greenbush)

The problems of site preparation on wetter clay soils, especially white spruce-aspen/balsam poplar sites were further investigated at Hudson Bay, Saskatchewan. The Finnish Martini double mouldboard plow had been used there in 1974, and 2 + 2 conventional white spruce transplants had been planted.

A reconnaissance of the cutover area revealed that the transplants had a high survival rate but little or no height growth. Most of the spruce which were located in this survey had been planted *in* the furrows or on the side of the plowed ridge, but *not* on the ridge top. Vegetation competition was severe and grasses formed an overstory about 1.8 m (6 ft) above the planted stock.

A combination of blading ahead and plowing behind a tracked machine on these sites might achieve (1) better control of ground vegetation and (2) a favorable microsite on the ridges for natural regeneration, seeding, or planting. It is recommended here.

#### LIMITING FACTORS AND CONSTRAINTS

A partial list of limiting factors and their implications for site preparation by scarification follows.

##### 1. Access

Access to summer operational areas is very good. Log haul roads are well built to handle highway loads in summer. Access is good on frozen roads in winter but poorer, with poor machine manoeuvrability in subsequent summer site preparation.

Summer logging operation implies easy or better manoeuvrability for scarification equipment.

## 2. Stand Cover Type

Black spruce types ( $\geq 60\%$ ) occupy wetter soils with deeper organic soil layers. Once logging removes the insulating cover, deep mosses dry out and die. Soil temperatures increase and advance growth, including layering, often releases. Semiserotinous cones ensure a seed supply from stand margins and from logging slash.

Jack pine types ( $\geq 60\%$ ) occupy drier sites. There is little advance growth except in natural openings. Since slash-borne cones are the main seed source, adequate redistribution of cones on the cutover is essential (about 5 cones per  $m^2$ , 10 per milliacre).

White spruce types ( $\geq 30\%$ ) occupy the drumlinoid topography, valley slopes, and creek banks. Heavier-textured mineral soils, deep duff, heavy vegetation competition, and the need for marginal or overhead seed sources are limiting.

## 3. Stem Density

Dense stands of spruce and pine, individually and in mixture, result in many cut stumps after logging. High stumps, especially after winter logging in deeper snow, hinder scarification since spiked chain drags cannot effectively penetrate to mineral soil. Barrels are ineffective.

## 4. Depth to Mineral Soil

Organic matter depth is an indication of soil moisture and temperature. Deep organic layers make site preparation difficult, and lower temperatures hinder cone opening, seed germination, and seedling root growth.

## 5. Vegetation Competition

Site improvement for conifer seedlings means site improvement for weed species too. Competition is severe on moist to very moist sites with 15-30 cm (6-12 in.) of organic matter, and is especially severe under spruce-aspen/balsam poplar cover types. Drier sites under pine and wetter sites under black spruce have a less diverse and sparser ground vegetation cover.

## 6. Advance Growth

Advance growth seedlings of pine and spruce and layers of spruce are seen to survive both logging and scarification and to release. Scarification should not be permitted to destroy this regeneration stocking completely.

## 7. Time Scale

Two time scales are limiting here. The first is the rate at which logging proceeds. Because of the demands of the pulp mill at The Pas, strip and block clear-cutting proceeds very rapidly. Little site classification and stratification are required for logging, and the more carefully planned site preparation may fall behind.

The second is the time-lapse between site preparation and regeneration surveying. The longer the period, the better the chance of achieving satisfactory stocking. The regeneration period limits rotation length but a 2-yr extension in regeneration period now appears justifiable and a limit of 10 yr is suggested.

## 8. Very Moist Sites

Because of deep organic matter, poorly drained mineral soils, and heavy vegetation, methods other than drag scarification should be employed. Plowing seems to be effective.

## 9. Weight of Slash

On most sites, dense stands and small stem sizes yield low slash weights and fine fuels. Scarification helps break up slash, dislodges cones from branches, and accelerates slash decay. On higher volume sites, however, high slash weights hinder scarification and reduce effectiveness. Slash estimates might be based on surveying. A relationship of slash weight to machine size and effectiveness is not available and should appear in a list of research needs. Skidder manufacturers have indicated a willingness to cooperate here.

The regeneration data were used to generate the relationship (Fig. 2) between stocking percentages and number of seedlings per acre. If 40% stocking is the lowest acceptable level, a density of 4200 stems per ha (1700 per acre) is indicated.



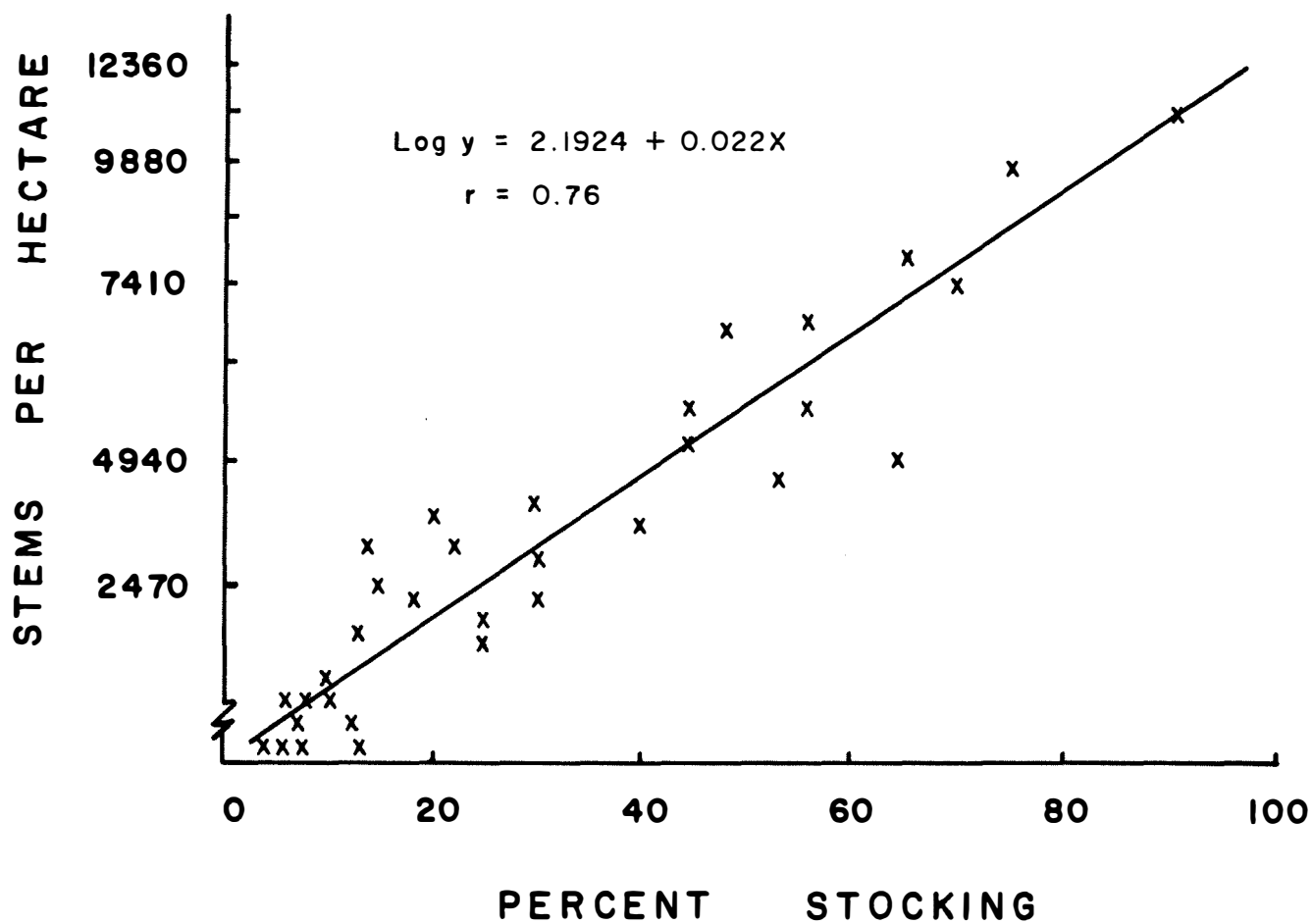


Figure 2. Relationship between number of seedlings per hectare and percent stocking

Stocking standards must be adjusted in the light of two important considerations: density of stems and rate of regeneration ingress following site preparation (Ball 1975; Crossley 1976).

### DISCUSSION

In preparation of the attached "Site preparation key" the constraints of current logging practice, utilization levels, and integrated resource uses were considered along with physical and biological constraints of limiting site factors.

Use of the key implies a *more* intensive appraisal of site conditions and "regeneration chance" so that site preparation may become *less* intensive and thus less expensive, wherever conditions allow.

Advance planning for scarification through site appraisal and supervision of site preparation were not in evidence during this survey. Logging was orderly, production was smooth, and access was excellent, but regeneration was considered only in retrospect.

The objectives of these guidelines are thus:

1. To make the outcome of regeneration projects more predictable

This should be achieved through an appraisal of regeneration chance. To make predictions easier, information should be collected on the ground, and probably just before and during logging, which will help to interpret subsequent regeneration successes and failures and so improve techniques.

Field appraisal will include:

Before Logging

- Cover type - % representation of species by basal area
- Age
- Density
- Height/Site index
- Season of logging
- Equipment used, or to be used

Site type

Landform

Soil series (+ growth and production capability rating  
if available)

Soil texture

Moisture regime (wet, moist, dry)

Depth to mineral soil

Principal ground vegetation cover-type components (observe  
in openings) height, % cover, and main species

Advance growth stocking (height and age)

#### After Logging

Density of stumps

Stump height

Distribution of slash

Weight of slash (using fire-hazard rating techniques)

Mineral soil exposure (use a stocking-type survey)

Remaining advance growth

Number of cones per milliacre (combine with exposed  
mineral soil appraisal)

This information should be obtained sequentially just as in a regeneration survey so that when the information is substantially complete, surveying stops.

In effect this appraisal makes the forester aware of constraints and limiting factors in regeneration efforts. It is recommended that factors seen to be potentially limiting be rated on a numerical scale of, say, 1 to 7 where 1 is no limitation, and 7 is severe limitations. Thus weights of slash in tonnes per hectare (tons per acre) depths to mineral soil, vegetation competition, soil moisture, density of stumps, height of stumps and so on might be rated on the 1-7 scale. A high score would warn of problems ahead. A high mean value and narrow range might lead to equipment modification and so avoid needless expense. Such a system is advocated here but not defined, since the severity of certain constraints might rate higher in one area than another, with one cover type or another. And cross comparisons are sometimes difficult. But it is important to get a regeneration chance rating on a numerical and thus less subjective

scale. This is the responsibility of the individual area forester.

2. To align site preparation and reforestation efforts through an appraisal of regeneration chance in order to cut down costs

A regeneration chance assessment, however computed from the field appraisal, leads to prescription for site preparation. Some observations which led to the prescription key are listed below.

1. Cover type distribution in natural stands is a good indicator of site quality and productivity in this region.
2. Canada Land Inventory and Soil maps are useful background to site preparation planning.
3. Advance spruce growth survives logging and drag scarification and will release even after 20-30 yr of suppression.
4. Jack pine advance growth, where present, commonly releases.
5. Dense stumps, high stumps, heavy slash, and deep duff reduce the effectiveness of drag scarification.
6. Low stumps can be achieved by using mechanical shears and snips. Heavy slash can be windrowed. Deep duff requires special equipment.
7. Black spruce layers eventually show strong apical dominance.
8. Barrel scarification has worked well only on better-drained sites with few, low stumps, in moderate slash. Other sites are a problem.
9. A ridge microrelief is an advantage on wet sites and an alternative to barrel scarification is required.
10. Jack pine regeneration is vigorous on wet sites provided that there is good lateral water movement creating favorable soil aeration levels.
11. Balsam fir regeneration may be acceptable in the next rotation and where present should be tallied separately.
12. Heavy-textured soils may be compacted by logging and scarification machinery. More complete cultivation, such as is recommended for white spruce sites, may be required.

#### RESEARCH NEEDS

Design of scarification equipment combinations is a priority. Trials correlating slash weights per hectare and machine size are

appropriate.

The recommendation for blade scarification to treat high, dense stumps and then expose mineral soil is, at best, a stop-gap measure until stump heights are reduced. Trials of tree shears, and relationships of stump height ranges and effectiveness of spiked chain drags are warranted. On white spruce sites where a blade and plow combination is recommended, trials should proceed immediately since vegetation competition is severe on these imperfectly drained mineral soils.

The Finnish plow is recommended as an alternative to barrel scarification but requires evaluation in the area as site preparation proceeds. Blade scarification is the alternative in the interim. White spruce sites it seems, may have to be planted.

Alternative species, such as pine on wetter spruce sites, should be tried. Siberian larch shows promise on moist sites with dense ground vegetation.

The assumption that advance growth of pine and spruce will release should be questioned and a study made of rates of release, health, and vigor of advance growth.

Spruce layers may be more or less dependent on the parent stem even after 15-20 yr, and the time taken to reach independence of that support should be established.

#### *SITE PREPARATION KEY*

##### USING THE KEY

Prescriptions in the key are designed to reduce scarification intensity where black spruce advance growth is present and where pine regeneration would tend to be overdense. Stand cover type is the principal site indicator. Winter and summer logging operations are subclassified because of site disturbance by logging machinery and degree of mineral soil exposure.

Chain drags are always helpful in redistributing slash. The impact of dense, high stumps is provided for at this time, but could be deleted as soon as this problem is overcome. Blade scarification to

mineral soil may be required where a combination of duff, dense stumps, and slash makes drag scarification ineffective. But blade scarification is expensive and slow where obstacles, such as stumps, force backing-up. A zigzag strip scarification pattern is effective when uprooted stumps are added to slash and duff with each bladeful. A combination of widely spaced zigzag strips followed by conventional drag scarification has promise and is recommended where even complete drag coverage produces unsatisfactory mineral soil exposure. This technique appears in the scarification key for problem sites on both spruce and pine types following winter logging.

Toothed blade scarification is prescribed for moist white spruce sites, and blading and plowing for wetter sites.

Consider the key as a series of questions. After cover type is established, there are two choices at each level in the key until a site preparation decision is reached. The decision to accept or reject the recommended site preparation method may be determined by considerations outside the scope of these guidelines.

*SITE PREPARATION KEY*

Cover type is:

1.	> 60% black spruce	4
2.	> 60% jack pine	17
3.	> 40% white spruce	36
4.	Logging is in winter	6
5.	Logging is in summer	13
6.	Advance growth represents more than 30% stocking	8
7.	Advance growth represents less than 30% stocking	9
8.	Scarify 1 pass in 3-- skidder and chains	
9.	Stumps are less than 2470 per ha (1000 per acre)	11
10.	Stumps are more than 2470 per ha (1000 per acre)	12
11.	Scarify 2 passes in 3-- skidder and chains	
12.	Blade scarify 1 pass in 3 then scarify 2 passes in 3--skidder and chains	
13.	Advance growth represents more than 30% stocking	15
14.	Advance growth represents less than 30% stocking	16
15.	Do not scarify further	
16.	Scarify 1 pass in 3 -- skidder and chains	
17.	Logging is in winter	19
18.	Logging is in summer	26
19.	Spruce advance growth is present	21
20.	Spruce advance growth is absent	22
21.	Scarify 2 passes in 3 --skidder and chains	
22.	Stumps are less than 2470 per ha (1000 per acre)	24
23.	Stumps are more than 2470 per ha (1000 per acre)	25
24.	Scarify all over	
25.	Blade scarify 1 pass in 3, then scarify 2 in 3-- skidder and chains	
26.	Spruce advance growth is present	28
27.	Spruce advance growth is absent	32
28.	Duff less than 5 cm (2 in.)	30
29.	Duff more than 5 cm (2 in.)	31
30.	No scarification	

31.	One pass in three	
32.	Duff less than 5 cm (2 in.)	34
33.	Duff more than 5 cm (2 in.)	35
34.	2 passes in 3	
35.	100% scarification	
36.	Logging is in winter	38
37.	Logging is in summer	42
38.	Duff is less than 15 cm (6 in.)	40
39.	Duff is more than 15 cm (6 in.)	41
40.	Scarify with toothed blade in alternate strips --steel tracks seed or plant if no marginal seed source	
41.	Scarify with blade and plow in alternate strips-- steel tracks seed or plant if no marginal seed source	
42.	Scarify with toothed blade 1 strip in 3 -- steel tracks seed or plant on receptive disturbed sites.	



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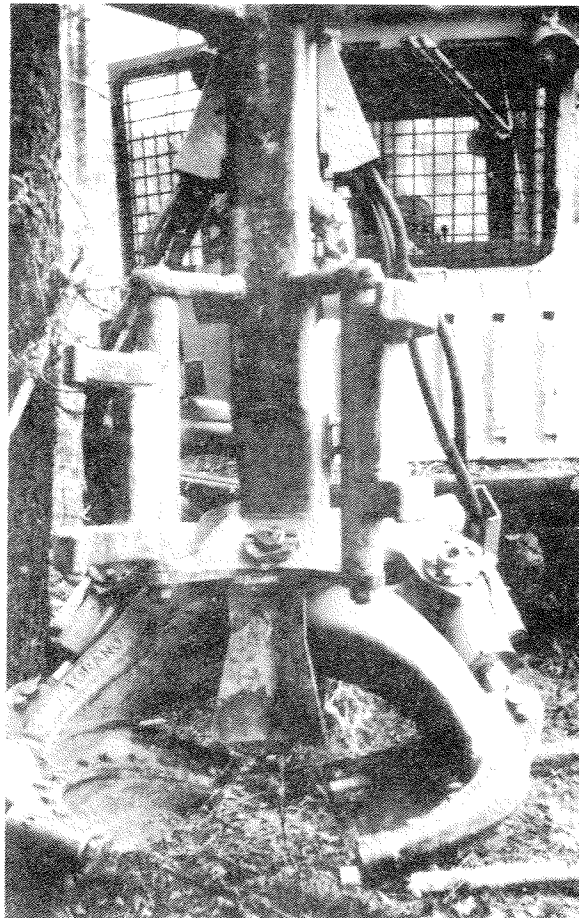
*PHOTOGRAPHS*



3. A high-stump problem following winter logging.



4. Mechanical feller-bunchers work close to ground level.



5. Shears leave low stumps.



6. A receptive seedbed with adequate cone distribution.



7. Barrel scarification works well on easy sites.



8. Wetter sites are associated with vegetation competition.



9. Spruce is seriously affected by vegetation competition.

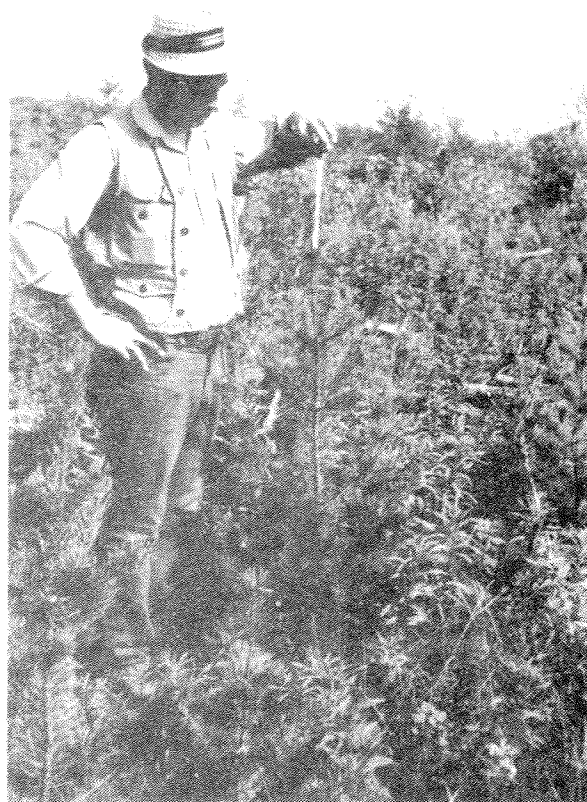


10. Pine shows promise on wetter sites.





11



12



13

11-13. Siberian larch,  
jack pine, and white  
spruce on barrel scarifi-  
cation on an easy site  
(with moderate vegetation  
competition).