# SCARIFICATION TRIALS IN NEWFOUNDLAND



by
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FOREST RESEARCH LABORATORY
ST. JOHN'S, NEWFOUNDLAND
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FORESTRY BRANCH
DEPARTMENT OF FISHERIES AND FORESTRY
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# INTRODUCTION

Site preparation to secure regeneration of desired species by natural or artificial means is becoming increasingly important to forest management. This is particularly true in Newfoundland where there is a long history of reduction in commercial forest acreage through fire and the devastation of fir (Abies balsamea (L.) Mill.) stands by the balsam woolly aphid (Adelges picea Ratz.). In addition, there is frequently a regeneration problem after clearfelling in upland spruce (Picea mariana (Mill.) BSP) stands. Economic solutions to both these regeneration problems are being sought through scarification procedures followed by natural or artificial seeding.

The first local site improvement trials were undertaken with tractor-mounted attachments including the bulldozer blade, the toothed blade and the rock rake. Later, the Rome discer, towed by a medium-sized tractor, was tested. These equipment types gave only limited success, and clearly indicated the need for specialized forest scarification machines.

A Swedish SFI scarifier was acquired in 1966 for use on heathlands, old burns and burned cutovers. An anchor chain device was obtained in 1967 primarily for the scarification of unburned cutover. These two machines, when used selectively, are capable of producing suitable seedbeds under most conditions. This report describes the machines and outlines their performance under a variety of site conditions.

## EQUIPMENT DESCRIPTIONS

### The SFI twin scarifier

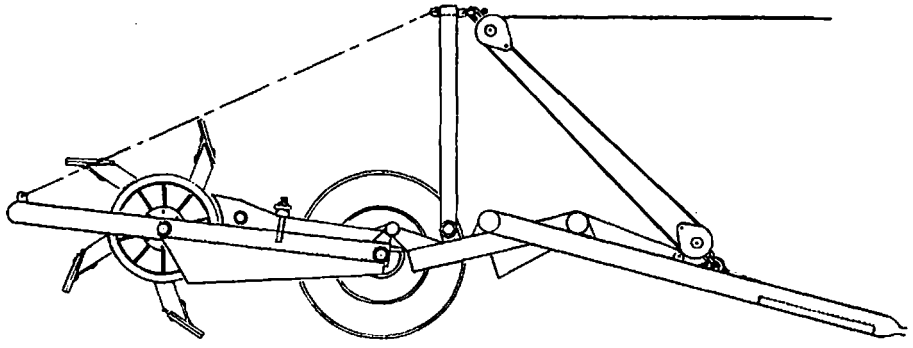
The SFI is manufactured by A.B. Skogsbruksmaskiner of Stockholm, Sweden. The technical details of the machine, as listed here, were obtained mainly from the manufacturer's brochure (1962).

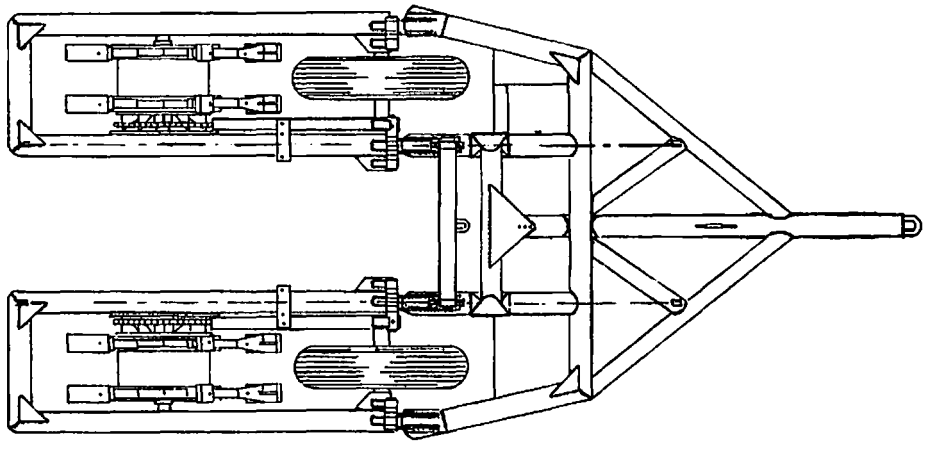
The twin scarifier is composed of two complete units joined by means of a tension frame (Figure 1). Soil cultivation is performed automatically by means of two scarifying wheels, each of which is fitted with three, four, or five ripping arms, depending upon the spacing required. These scarifying wheels are driven by chain transmission from the front drive wheels of the scarifier, and revolve in the same direction as the drive wheels at approximately one-third the speed. The scarification action is a combination of scuffing and loosening.

The mechanism is protected from damage by contact with solid objects by an automatic device called the "raised pull point". This device permits the scarifying wheels to be automatically lifted when the arms meet a certain maximum resistance allowing the transmission to turn without interruption.

The SFI is equipped with a lifting frame and block which is connected to the winch on the tractor thus enabling the scarifying wheels to be lifted over obstructions or hoisted into the raised position for travelling. The unit is approximately 8 ft. wide and 15 ft. long and weighs about two tons. It can be towed and operated satisfactorily by a 60 H.P. wheeled skidder or by a light crawler tractor.

Figure 1





Plan of
SFI Twin Scarifier

The scarification effect consists of a series of equally spaced holes in which the mineral soil has been loosened and intermixed with organic material to provide a good seeding medium. The spacing between holes can vary from 6 to 10 feet depending on the number of scarifying arms in use; lateral spacing can be adjusted between 6 and 7 feet.

The maximum number of scarifying arms will give approximately 1,300 equally spaced holes per acre. The hole size varies somewhat with soil conditions but is normally about 2.5 sq. ft. This means that only about 7% of the total area is scarified but the result is an even pattern.

The Anchor chain scarifier

This drag-type scarifier was constructed locally from plans described by Anderson (1965). It consists of a series of 6 lengths of heavy chain spaced along a tow bar which is drawn behind a conventional crawler tractor by means of a single chain hitch. Details, as shown in Figure 2, are as follows:

(1) Tow bar (A) - constructed of $\frac{1}{2}$ inch gauge steel pipe 12 feet long, 8 inches in diameter and fitted with a centre towing lug ($A_1$) and six evenly spaced anchor chain lugs ($A_2$). The lugs are constructed of 1" steel plate which are extended through the pipe and fitted with a hole at each end.

(2) Anchor chains (B) - length ten feet with a 1" diameter steel rod welded to each link and protruding 4" on each side as a tooth ($B_1$). Chain links are made of 2 1/16" diameter steel; each

link measures 12 inches and weighs 22 lbs. Each chain is fitted with a 1" jaw and eye swivel ($B_2$) and a 1 1/8" galvanized anchor shackle for attachment to the tow bar.

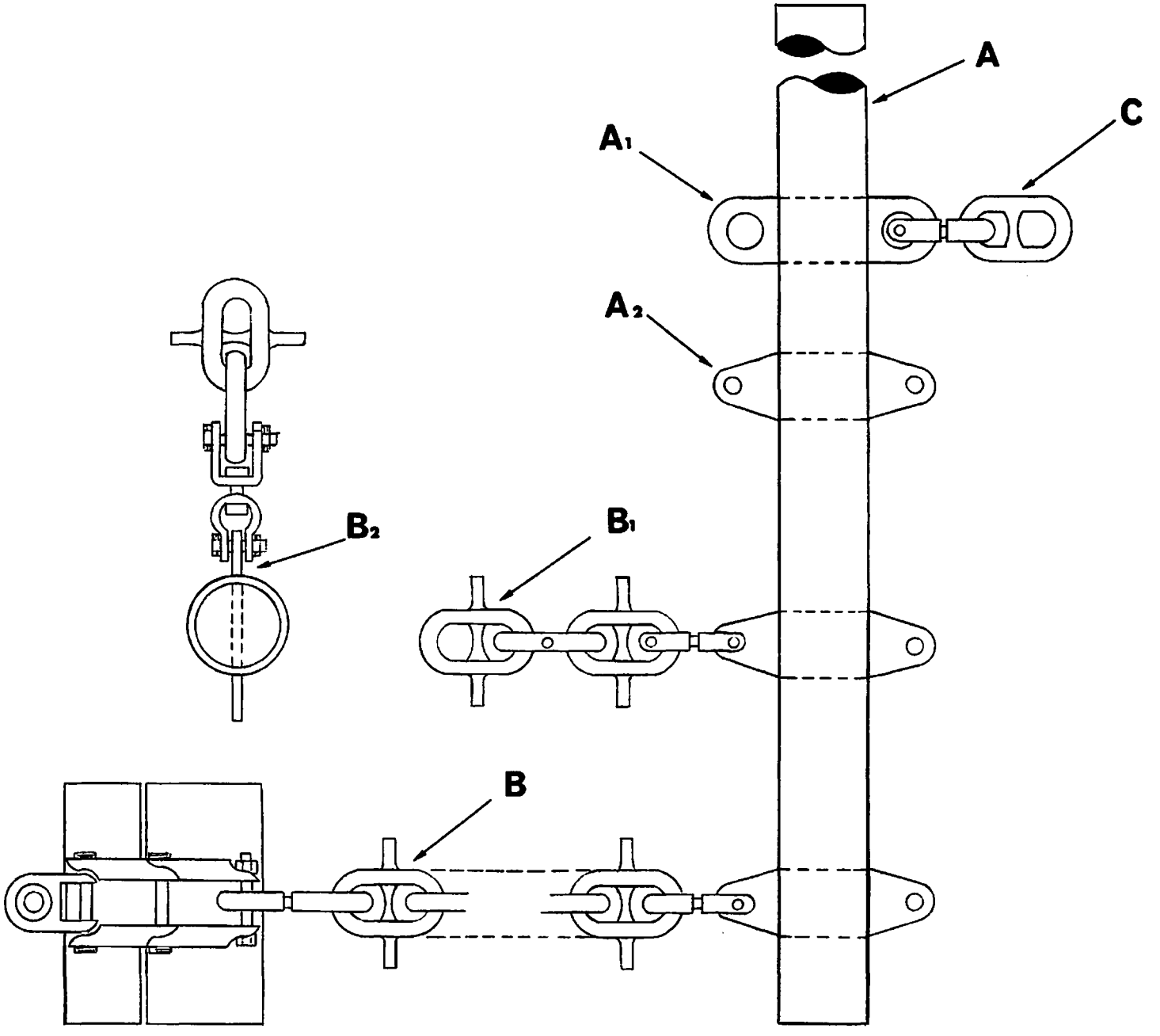
(3) Tow bar chain (C) - This is a single-chain hookup to the tractor from the center of the tow bar. The chain is 6½ feet long and is fitted with a 1 1/8" galvanized anchor shackle at either end and a 1" tow ring at the tractor end. The link diameter is 1 3/4".

The equipment is operated to best advantage by a crawler tractor in the medium horsepower range. Scarification is accomplished by the weight of the chains plus the snagging action of the teeth as the equipment is dragged across the terrain. The chains, turning on their swivels, mix and pulverize the humus and mineral soil and consequently produce a good seeding medium. In early trials it was found that greater efficiency was achieved by adding a terminal weight of at least 100 lbs. to prevent the chain ends from flailing. This was accomplished by adding a number of tractor pads to the end of each chain.

## EQUIPMENT PERFORMANCES

The SFI was used initially in 1966 and was tested under a variety of site and disturbance conditions using both wheeled and tracked towing equipment. The machine performed well on clean surface conditions and gave satisfactory results on cut-over burns. It did not perform adequately on normal cutovers unless towed by a medium-sized tractor equipped with a bulldozer blade for removing obstacles thereby creating a clean surface for the scarifier.

Figure 2




Plan of
Anchor Chain Scarifier

The anchor chain device, acquired in 1967, performed satisfactorily when towed by a medium-sized tractor on all conditions encountered except heavy concentrations of logging slash. Here the bulldozer blade was again necessary for removing debris to enable the scarifying chains to work effectively. The anchor chain is considered the best machine for work on ordinary pulpwood cutovers; while its performance is satisfactory on clean surface conditions it cannot compete economically with the lighter SFI machine.

A summary of equipment used and operational sites is given in Table 1. The sites represent practically all conditions on which satisfactory scarification is possible with present equipment.

Table I

Summary of Equipment and Work Areas

| Scarifying unit | Motive Power | Operational Site |
|---|---|---|
| (A) Swedish SFI | (1) Wheeled Skidder | (i) Burned cutover.<br>(ii) Heathland.<br>(iii) Cutover with slash removed.<br>(iv) Cutover controlled burn. |
| | (2) Bombardier Muskeg | (i) Heathland. |
| | (3) Light tractor | (i) Cutover controlled burn. |
| | (4) Medium tractor | (i) Cutover. |
| (B) Anchor Chain | (1) Medium tractor | (i) Cutover controlled burn.<br>(ii) Cutover. |

Descriptions of operational sites are shown in Table 2. These sites are from several areas and are considered as average conditions. It will be shown later that the dominant environmental factor limiting effective scarification is surface debris; within reasonable limits the ground cover is unimportant and no differences were noted as a result of soil variations. Natural surface obstacles, in the form of boulders and wet depressions, are deterrents and must be avoided.

Effectiveness of scarification on areas covered by pulpwood logging slash is dependent upon the type of cutting, the composition of the original stand and the time since cutting. Neither of the two machines performed adequately on areas covered by windrows of slash, associated with conventional "cut and pile" logging, until the slash had decayed. On areas of loose fresh slash from tree-length skidder logging the anchor chain device performed satisfactorily but the SFI did not.

Unharvested merchantable-sized hardwoods, whether cut or left standing, increase scarification difficulties by decreasing the area of manoeuverability. Scarification with any type machine becomes uneconomical if this hardwood component approaches about 25 percent of the total stand volume.

An equipment performance summary is shown in Table 3. The performance is given for effective work hours rather than gross time; equipment efficiency was approximately 80 percent. The SFI machine, because of its light weight, can be operated by a variety of towing equipment but the anchor chain device is limited to medium and high powered crawler tractors.

Table 2

Operational Site Descriptions

| Serial | Disturbance Condition | Soil Type | Surface Condition | Ground Cover |
|---|---|---|---|---|
| 1 | 5-year old burned cutover | Sandy loam to clay loam with a charred organic layer 4" thick. | Semi-decomposed charred stumps and debris. Scattered surface boulders. | Hardwood weed species 6' tall with scattered epilobium angustifolium and rubus spp. |
| 2 | 25-year old burned cutover | Sandy loam to loamy sand with a raw humus layer 2" thick. | No surface debris, no boulders. | Ericaceous plants with scattered Picea mariana 20' tall. |
| 3 | 25-year old heathland burn | Sandy loam to clay loam with a raw humus layer 2-10" thick. | No surface debris, no boulders. | Ericaceous plants with scattered scrub Picea mariana, Sphagnum spp. in wet depressions. |
| 4 | 4-year old cutover controlled burn | Sandy loam with a charred organic layer 3" thick. | Scattered charred stumps. | Hardwood weed species 6' tall. Scattered epilobium angustifolium and rubus spp. |
| 5 | 1-year old cutover with slash removed | Clay till with numerous small angular stones. | Scattered stumps. | Associated mosses with some heath plants and scattered alnus rugosa. |
| 6 | New cutover controlled burn | Sandy loam to loamy sand with a charred organic layer 4" thick. | Stumps 2-8" in diameter with scattered areas of semi-decomposed slash. Scattered surface boulders. | Associated mosses with Sphagnum spp. in wet depressions. Scattered hardwood weed species 4' tall. |
| 7 | New cutover | Clay loam with well decomposed organic layer 2-4" thick. | Stumps up to 14" diameter with normal cutover slash. | Associated mosses with scattered abies balsamea regeneration 2-4" tall. |
| 8 | New burned cutover | Sandy loam with charred organic layer 2" thick. | No surface debris. | Associated mosses with scattered epilobium angustifolium and rubus spp. |
| 9 | Undisturbed heathland | Stony clay till with a raw humus layer 2-8" thick. | No surface debris. | Dense ericaceous vegetation 6-10" in height. |

Performance of the SFI is affected more by site conditions than by towing equipment. This is demonstrated in Table 3, which shows that per hour production varies from 1.5 acres on open heathland to approximately 0.6 acres on stump strewn cutover. The one exception to this is shown in Table 3 serial 7 where a medium-sized crawler tractor, equipped with a bulldozing blade, supplied the power. In this instance the bulldozer blade cleared the site and partially completed the scarification. However, this is not an economical method of operation for the SFI.

Performance of the anchor chain is regulated more by the power and speed of the towing equipment than by the condition of the site. This is demonstrated in Table 3 which shows a production of approximately 0.75 acres per hour, regardless of site, using a 75 horsepower crawler tractor as compared to more than 1 acre per hour with a more powerful towing machine.

## QUALITY OF SCARIFICATION

The SFI produced a standard pattern of scarified patches covering approximately 7 percent of the total area. On these patches the organic and mineral soil were well intermixed and pulverized thus producing a good seeding medium. The only exceptions were encountered on stony hard-packed soils where the ripping arms could not fully penetrate and on deep organic layers where the mineral soil was beyond the reach of the arms.

The quality of work produced by the anchor chain device showed more variation with site conditions that did the SFI. Satisfactory results, were achieved on all sites except those with a thick raw humus

Table 3

Summary of Equipment Performance

| Site No. | Scarification Equipment | Towing Equipment | Operational Site | Acres | Acres/Hr. |
|---|---|---|---|---|---|
| 1 | SFI | Wheeled Skidder | 5-year old burned cutover | 80 | 0.7 |
| 2 | SFI | Wheeled Skidder | 25-year old burned cutover | 40 | 1.3 |
| 3 | SFI | Wheeled Skidder | Heathland | 20 | 1.4 |
| 4 | SFI | Wheeled Skidder | 4-year old cutover controlled burn | 42 | 0.8 |
| 5 | SFI | Wheeled Skidder | 1-year old cutover slash removed | 6 | 0.6 |
| 6 | SFI | Crawler Tractor 52 DB H.P. | New cutover controlled burn | 36 | 0.8 |
| 7 | SFI | Crawler Tractor 75 DB H.P. | New cutover | 12 | 0.8 |
| 8 | SFI | Crawler Tractor 75 DB H.P. | New burned cutover | 40* | 0.8 |
| 9 | SFI | Bombardier Muskeg | Heathland | 90* | 1.5 |
| 1 | Anchor Chain | Crawler Tractor 75 DB H.P. | 5-year old burned cutover | 55 | 0.7 |
| 4 | Anchor Chain | Crawler Tractor 75 DB H.P. | 4-year old controlled burn | 37 | 0.8 |
| 7 | Anchor Chain | Crawler Tractor 75 DB H.P. | New cutover | 5 | 0.8 |
| 6 | Anchor Chain | Crawler Tractor 97 DB H.P. | New controlled burn | 36 | 1.1 |

*Work undertaken partially or completely by co-operators

layer or a dense vegetative mat; either condition prohibits the chains and spikes from reaching mineral soil. Where the anchor chain was used without the assistance of a bulldozing blade an area of mineral soil, at least 6 inches square, was produced on 80 percent of the milacre quadrats established throughout the area. Where the anchor chain was used in conjunction with the bulldozing blade a patch of mineral soil was exposed on practically all milacre quadrats.

## CONCLUSIONS

Both the SFI and the anchor chain scarifiers have given satisfactory performances but each machine has its limitations.

The SFI works best under clean surface conditions such as are encountered on open heathlands and old non-restocking burns where production has averaged 1.5 acres per hour. It performs adequately on burned cutover where the average production is close to 1 acre per hour. It does not give satisfactory results on recent cutovers unless towed by a crawler tractor with a bulldozer blade attachment.

The anchor chain device will not work in heavy slash and is not recommended for areas having either a thick raw humus layer or a dense vegetative mat. Elsewhere it works satisfactorily and the rate of performance is governed by the type of towing equipment rather than the site condition. When towed by a medium-sized crawler tractor in the 90-100 draw bar horsepower range the rate of production is an excess of 1 acre per hour.

Under the condition specified for its employment each machine will produce a satisfactory seedbed. Beyond the range of conditions specified heavier equipment is needed. The spiked drum device designed for work in heavy slash and dense underbrush is expected to fill this requirement.

## REFERENCES

Anderson, E.F. & G.A. McCormack. 1965. Anchor chain scarifiers in Ontario. Ontario Department Lands and Forests, Silvicultural Notes No. 2.

Anonymous. 1962. Mechanical cultivation with the SFI scarifying unit. A.B. Skogsbruksmaskiner, Stockholm, Sweden.