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FOREST RESEARCH REPORT

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A HARDWOOD SHELTERWOOD EXTRACTION TRIAL: CONVENTIONAL VERSUS TRAIL HARVEST SYSTEM

INTRODUCTION

The shelterwood method is a regeneration technique, whereby one or more partial cuts are used to promote the establishment of natural regeneration. After this regeneration is well established, (able to survive full exposure) the remaining overstory is removed. The final cut must not result in excessive damage to the future crop trees.

In this study, two harvesting systems (trail and conventional) were utilized in the final-removal cut of a two-stage, hardwood uniform shelterwood. The trial was undertaken to determine which of these systems would result in the least amount of damage to the regeneration.

SITE DESCRIPTION

The trial site, located along Harlow Road in Kings County, south central Nova Scotia, is moderately exposed, with undulating terrain and a northwesterly aspect. The soil is somewhat imperfectly drained and classified as Gibraltar (a pale yellowish brown sandy loam derived mainly from granite). Fifty percent of the basal area was removed in 1979-80, during the first stage of the shelterwood (a combined preparatory and seed cut (Hannah, 1988)). Prior to the second stage or final-removal cut, carried out in 1987, the overstory consisted of 30% sugar maple (*Acer saccharum* Marsh.), 30% red maple (*Acer rubrum* L.), 30% yellow birch (*Betula alleghaniensis* Britton) and 10% white birch (*Betula papyrifera* Marsh.). Regeneration was well established at this time and consisted primarily of sugar maple (40%) and red maple (31%) with lesser amounts of conifers (12%), yellow birch (7%) and other hardwoods (10%).

Canada

Nova Scotia

METHODS

The site was divided into 2 blocks, each approximately 1 hectare in size. The trail system was used in Block 1 ensuring controlled movement of forwarding equipment along predetermined trails, while uncontrolled forwarding was used in Block 2 (conventional system). In Block 1, parallel trails were established at 20 metre intervals for the extraction of wood. Cutters were required to pile the wood so the forwarder could reach all piles without leaving the trail. In Block 2, no trails were established and the cutters were allowed to pile the wood wherever it was most convenient. A local contractor provided 2 experienced cutters for felling.

Prior to the removal cut, the quantity of natural regeneration in both blocks was assessed. Data were collected from circular 16 m^2 regeneration plots located at 20 m intervals along predetermined cruise lines running diagonally across the blocks. The total number of stems in height classes 1 (0.03-0.30 m) and 2 (0.31-0.90 m) were counted in the northeast quadrant (4 m^2) of these plots. The stems in height classes 3 (0.91-1.80 m) and 4 (1.81 m +) were counted in the entire 16 m^2 plot (Table 1).

Table 1. Measurement area by height class

Height Class	Height Range (m)	Measurement Area (m^2)
1	0.03-0.30	4
2	0.31-0.90	4
3	0.91-1.80	16
4	1.81+	16

The removal cut began in Block 1 on July 27, 1987 and in Block 2 on August 4, 1987. The trails in Block 1 were previously cut. The harvested wood was extracted by forwarder starting on July 29, 1987. Productivity studies were carried out by Lands and Forests staff during the cutting and forwarding stages in both blocks to determine the time required to accomplish each activity.

A post-harvest assessment was conducted on July 19, 1988, one year following cutting, using the same plots as the pre-assessment. The number of dead and damaged stems were counted during this assessment and subtracted from the pre-harvest assessment total to determine the density of undamaged regeneration. Stocking was also calculated from this data.

RESULTS AND DISCUSSION

Pre-Assessment

Figure 1, Appendix I and Appendix II provide a breakdown of the regeneration by origin and height class prior to the final-removal cut. The regeneration shorter than 0.91 m (height classes 1 and 2) averaged 29,990 stems/ha for both blocks and originated predominately from seed. The trees taller than 0.90 m (height classes 3 and 4) averaged 9,010 stems/ha and originated equally from both seed and sprouts. For all height classes combined, the percentage of regeneration originating from seed was 76%, from sprouts 22% and from suckers 2%.

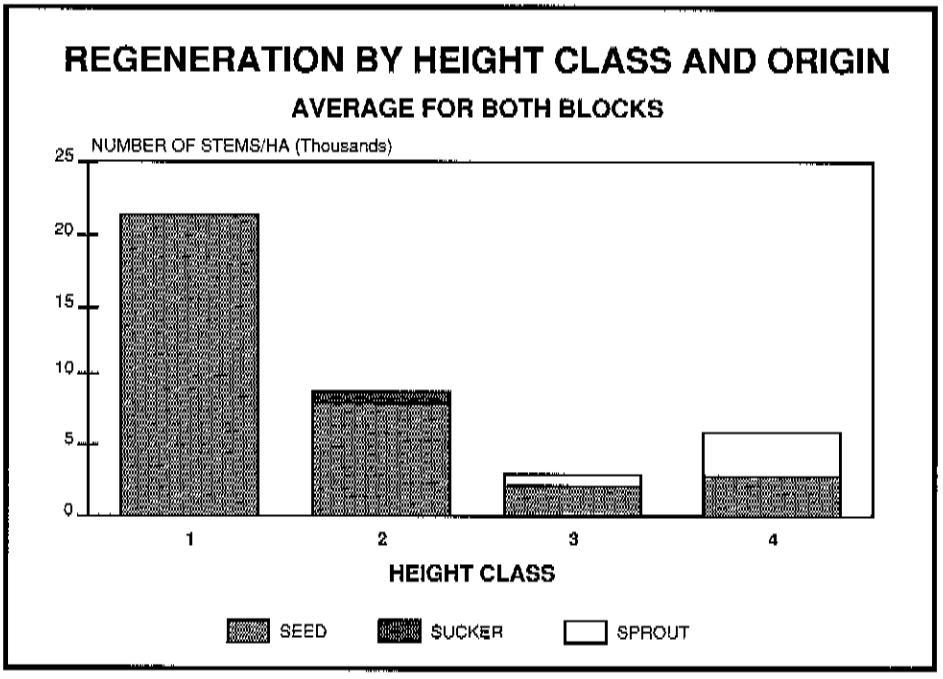

Figure 1. Regeneration by height class and origin prior to the final-removal cut.

Post-Assessment

The trail harvest system resulted in 18% mortality compared to 29% for the conventional system (Appendix II). Damage to the regeneration was minimal for both harvest systems (4% and 3%). For damage and mortality combined, the trail system resulted in fewer trees affected (22% versus 32%) (Figure 2, Appendix II).

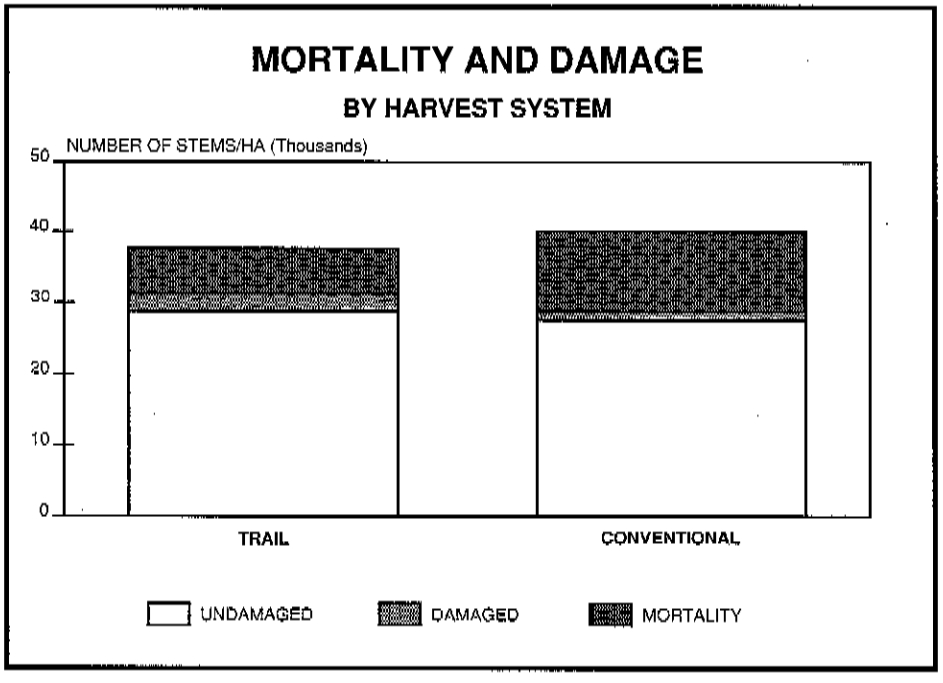

Figure 2. Mortality and damage by harvest method.

Mortality was concentrated in the smaller trees in the conventionally harvested block. For instance, 34% of the trees less than 0.31 m in height were killed as compared to only 8% for trees greater than 1.80 m tall (Appendix II). On the other hand, in the trail harvested block, mortality was more evenly distributed between height classes (16% for height class 1 versus 12% for height class 4). Overall, mortality was concentrated in the smaller regeneration (Figure 3, Appendix II). Damage was nil to minimal for all height classes except for those trees exceeding 1.80 m tall (18% for Block 1 and 14% for Block 2). The most common types of damage included severed stems, damaged stems, broken tops and leaning trees (Appendix III). Despite this mortality and damage, both blocks were approximately 80% stocked and the density of undamaged regeneration was in excess of 27,000 stems/ha (Figure 2). Of this amount, approximately 6,000 stems/ha exceeded .90 m in height. This taller regeneration would be considered established according to guidelines found in Lees (1978) and Tubbs (1977).

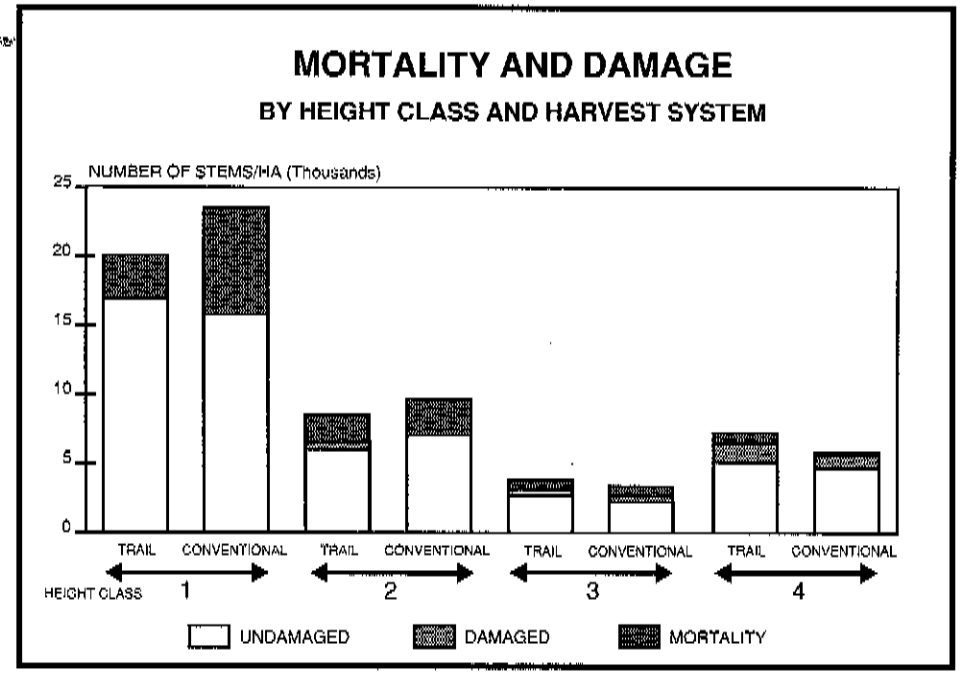

Figure 3. Mortality and damage by height class and method of harvest.

Productivity

The average productivity for cutters was 2.9 stacked cubic metres per hour (m^3(s)/hr) in Block 1 (trail system) compared to 2.8 m^3(s)/hr in Block 2 (conventional cut). Although this difference is minor, it was observed by Lands and Forests staff that the cutters adjusted their productivity according to the conditions that they were working in at the time. That is, they worked harder during trail harvest operations (where more time was required to pile wood along predetermined trails) in order to realize an output approximately equal to that achieved for the conventional harvest. Extraction productivity for the trail system was slighty higher than that of the conventional system (13.5 m^3(s)/hr vs. 12.8 m^3(s)/hr) (Table 2).

Table 2. Productivity by method of extraction.

	Average Haul Distance (m)	Area (ha)	Volume (m^3(s))	Time (hrs)	Forwarder (m^3(s)/hr)	Forwarder (m/m^3(s))*	Cutter (m^3(s)/hr)
Trail	119 (29 trips)	1.0	204.0	15.09	13.5	33.8	2.9
Conventional	195 (19 trips)	0.8	150.3	11.75	12.8	49.2	2.8

* metres travelled per stacked cubic metre extracted

SUMMARY

Two harvesting systems (trail and conventional) were used in the final removal cut of a hardwood shelterwood to determine which system would result in the least amount of damage to regeneration. The major findings of this trial were as follows:

1. The trail system resulted in lower mortality than the conventional system (18% vs. 29%).
2. Damage to regeneration (excluding mortality) caused by either method was minimal (4% and 3%). Most of the damage was attributed to the forwarder.
3. Stocking to natural regeneration after the removal cut was adequate and basically unaffected by method of harvest and extraction (81% for the trail system vs. 84% for the conventional harvest method).
4. The average cutter productivity was 2.9 m^3(s)/hr for the trail system compared to 2.8 m^3(s)/hr for the conventional harvest method.
5. The average rate of extraction was slightly higher for the trail system (13.5 vs. 12.8 m^3(s)/hr).
6. Most of the taller regeneration (greater than 0.90 m) consisted of sprouts whereas the shortest regeneration (less than 0.31 m) originated primarily from seed.
7. Mortality was highest in the shorter regeneration (less than 0.31 m) while damage was highest in the taller regeneration (greater than 0.90 m).

LITERATURE CITED

Hannah, P. R. 1988. The shelterwood method in northeastern forest types: a literature review. North. J. Appl. For., 5(1):70-77.

Lees, J. C. 1978. Hardwood silviculture and management: An interpretive literature review for the Canadian Maritime provinces. Information Report M-X-93. Maritime Forest Research Centre, Canadian Forestry Service, Dept. of Fisheries and the Environment. 69 pp.

Tubbs, C. H. 1977. Natural regeneration of northern hardwoods in the northern Great Lakes region. USDA Forest Service Research Paper NC-150. North Central Forest Experiment Station, Forest Service, US Dept. of Agriculture. 20 pp.

APPENDIX I

Percentage of regeneration, before treatment, by height class and origin*.

Method of Harvest	Height Class 1 0.03 - 0.30m			Height Class 2 0.31 - 0.90m			Height Class 3 0.91 - 1.80m			Height Class 4 1.81m +		
	SE	SU	SP	SE	SU	SP	SE	SU	SP	SE	SU	SP
Trail	100	0	0	92	7	1	65	4	31	48	0	52
Conventional	100	0	0	100	0	0	65	0	35	37	3	60

*SE - Origin by Seed SU - Origin by Sucker SP - Origin by Sprout

APPENDIX II

Number of stems/ha before and after the final-removal cut by harvest system, height and damage class.

Height Class		Trail		Conventional	
		Stems / ha	% *	Stems / ha	% *
1 (0.03-0.30m)	Before Removal Cut				
	- Total	19800		22976	
	After Removal Cut				
	- Mortality	3200	16.2	7857	34.2
	- Damaged	0	0	0	0
	- Undamaged	16600	83.8	15119	65.8
2 (0.31-0.90m)	Before Removal Cut				
	-Total	7800		9405	
	After Removal Cut				
	-Mortality	1900	24.4	2857	30.4
	-Damaged	200	2.6	0	0
	-Undamaged	5700	73.1	6548	69.6
3 (0.91-1.80m	Before Removal Cut				
	-Total	3275		2946	
	After Removal Cut				
	-Mortality	650	19.8	714	24.2
	-Damaged	175	5.3	328	11.1
	-Undamaged	2450	74.8	1904	64.6
4 (1.81m+)	Before Removal Cut				
	-Total	6650		5149	
	After Removal Cut				
	-Mortality	825	12.4	387	7.5
	-Damaged	1225	18.4	717	13.9
	-Undamaged	4600	69.2	4045	78.6
All	Before Removal Cut				
	-Total	37525		40476	
	After Removal Cut				
	-Mortality	6575	17.5	11815	29.2
	-Damaged	1600	4.3	1045	2.6
	-Undamaged	29350	78.2	27616	68.2

* All percentages are based on the number of regenerating stems prior to the final-removal cut.

APPENDIX III

Percentages and number of surviving trees damaged by harvest system, height and damage type.

Damage Type	Height Class 1 0.03 - 0.30m		Height Class 2 0.31 - 0.90 m		Height Class 3 0.91-1.80 m		Height Class 4 1.81 m +	
Trail System								
	Stems/ha	% *	Stems/ha	%*	Stems/ha	%*	Stems/ha	%*
Broken Top	0	-	0	-	50	1.9		
Broken Base	0	-	0	-	0	-	150	2.6
Damaged Top	0	-	0	-	0	-	100	1.7
Damaged Stem	0	-	100	1.7	50	1.9	150	2.6
Uprooted	0	-	0	-	0	-	200	3.4
Severed Stem	0	-	0	-	0	-	0	-
Moderate Lean	0	-	0	-	0	-	350	6.0
Severe Lean	0	-	100	1.7	75	2.9	25	0.4
Saw Damage							250	4.3
Total	0	-	200	3.4	175	6.7	0	-
Conventional System							1225	21.0
Broken Top	0	-	0	-	0	-	149	3.1
Broken Base	0	-	0	-	30	1.3	60	1.3
Damaged Top	0	-	0	-	30	1.3	60	1.3
Damaged Stem	0	-	0	-	30	1.3	208	4.4
Uprooted	0	-	0	-	0	-	60	1.2
Severed Stem	0	-	0	-	208	9.3	90	1.9
Moderate Lean	0	-	0	-	30	1.3	60	1.2
Severe Lean	0	-	0	-	0	-	30	0.6
Saw Damage	0	-	0	-	0	-	0	-
Total	0	-	0	-	328	14.5	717	14.9

* Percentages are based on the number of surviving stems/ha after the final removal cut.

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