COOPERATION
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WORKER PRODUCTIVITY IN COMMERCIAL THINNINGS PART III

INTRODUCTION

Since 1982, approximately 13,000 hectares of commercial thinnings and shelterwoods (Appendix I) were completed under cost shared federal-provincial agreements (Figure 1). Between 1989 and 1991, two reports were published which summarize the results of studies carried out to determine worker productivity in softwood commercial thinnings harvested using shortwood methods (NSDLF,1989; NSDNR,1991). During 1992, the sample was expanded to include hardwood species and methods of harvest other than shortwood.

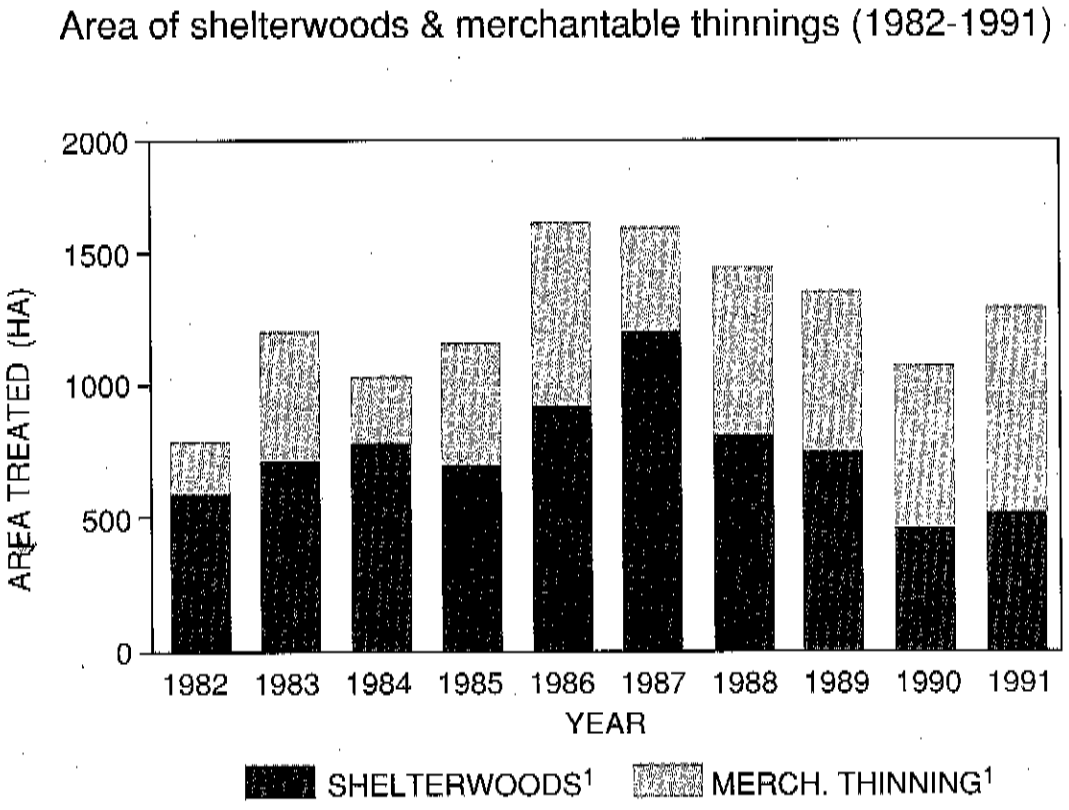
This report discusses and compares the separate and combined results of the pre-1992 and 1992 productivity studies. In 1993, additional studies will be carried out to define productivity in both hardwood and softwood commercial thinnings using tree length and random length methods of harvest.

METHODS

A total of 34 locations were included in the pre-1992 and 1992 studies. These included 15 from the earlier study and 19 from the 1992 study (Figure 2). The 15 locations from the pre-1992 study included 36 blocks of uniform site and stand conditions. All of the blocks were softwood and harvested using the shortwood method. The 1992 study consisted of 14 softwood and 5 hardwood blocks. Thirteen were shortwood harvested, with the remainder random or tree length. Each of the jobs was large enough to allow for a 2 to 3 day study of the operation. For both studies, selected stands were greater than 60% stocked and at least 14 cm in merchantable diameter. Appendix II shows pretreatment values.

Appendix I describes pre-assessment methodology as well as productivity study and data analyses methods.

Canada
Nova Scotia



[1] Shelterwood and merchantable thinnings are combined in this report.

Figure 1. Area treated with shelterwoods and merchantable thinnings between 1982 and 1991 in Nova Scotia.

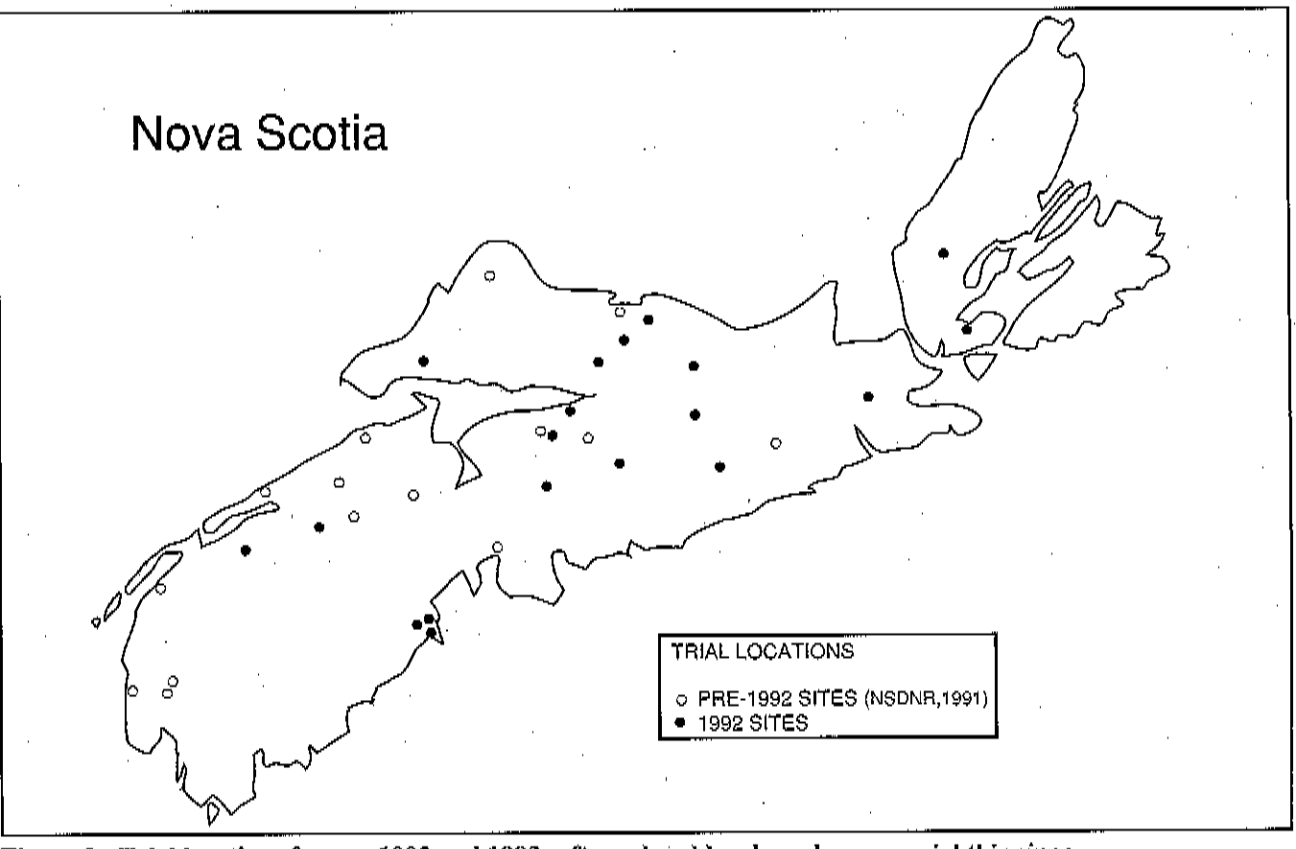


Figure 2. Trial locations for pre-1992 and 1992 softwood and hardwood commercial thinnings.

RESULTS AND DISCUSSION

Productivity Versus Stand Index

It was found that productivity (P) was inversely related to Stand Index (SI) in a nonlinear manner (Figure 3). Therefore the following model was used to relate P with SI:

$$P = b_0 SI^{b_1}$$

Where, P = Productivity, expressed in m^3/Productive Hour (PH),

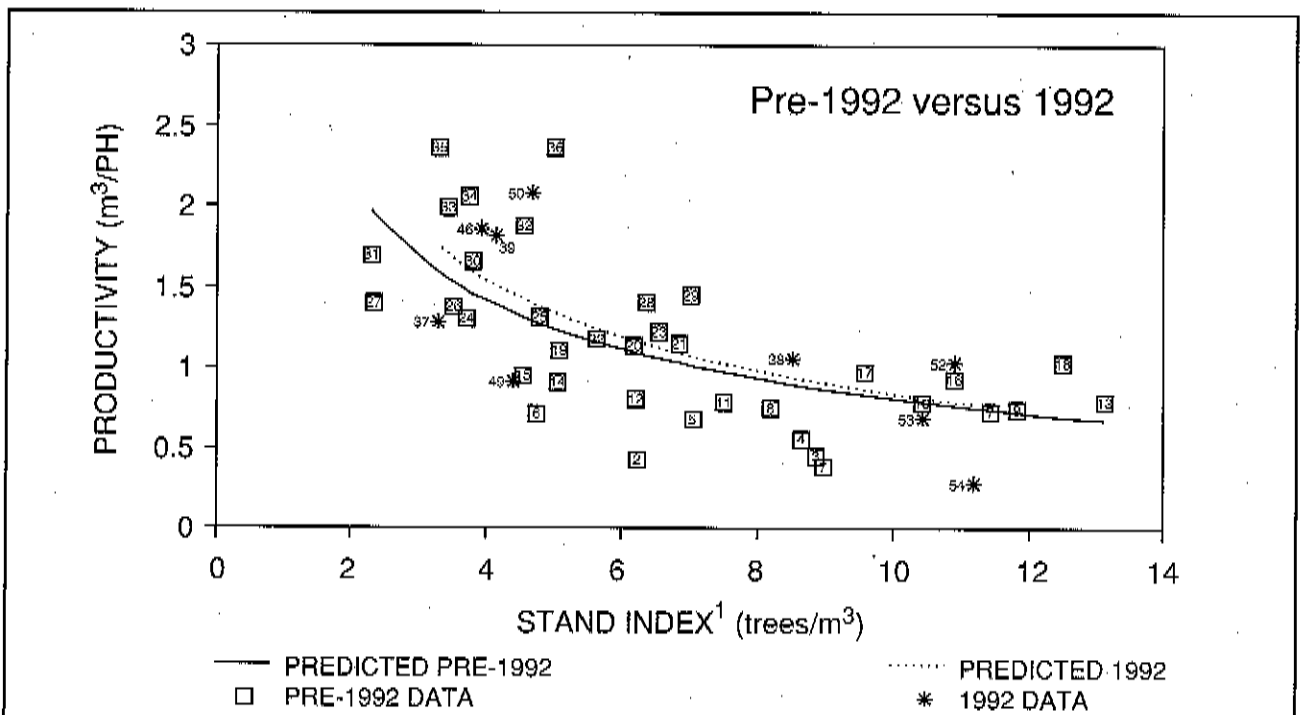
b_0 & b_1 = Regression coefficients,

SI= Stand Index, expressed in trees/m^3, based on merchantable trees >9.0 cm divided by the merchantable volume prior to harvest

m^3 = Cubic metres solid.

Initially, separate equations were derived for the shortwood harvested softwood stands in the pre-1992 and 1992 studies (Figure 3). It was found that these equations were not significantly different (Appendix III) and even though only 9 blocks were measured in 1992, the "best-fit" equation was almost identical to the previously derived equation (NSDNR,1991).

The data were subsequently combined and non-linear regression performed (Appendix III). Table 1 shows the predicted values from the "combined" equation. As indicated above, only data from shortwood harvested softwood blocks were used to construct this equation (Appendix IV & V). The equation shows that worker productivity decreases as the Stand Index increases (trees get smaller). For example, when SI increases from 6 to 10 (average merchantable diameters of 18.5 cm and 15.5 cm), a worker could expect productivity to drop approximately 26%, from 6.9 m^3/day (3.0 cords) to 5.1 m^3/day (2.3 cords).



[1] Stand Index is calculated by dividing the pretreatment merchantable density by the merchantable volume.
[2] Further information on blocks can be found in Table1, Appendix II and Research Report #28 (NSDNR, 1991).

Figure 3. Manual productivity in shortwood-harvested softwood commercial thinnings (1992 study versus pre-1992 study).

Table 1. Predicted daily production in softwood commercial thinnings by Stand Index (SI) and Merchantable Diameter (MD) for shortwood operations based on combined 1992 and pre-1992 data.

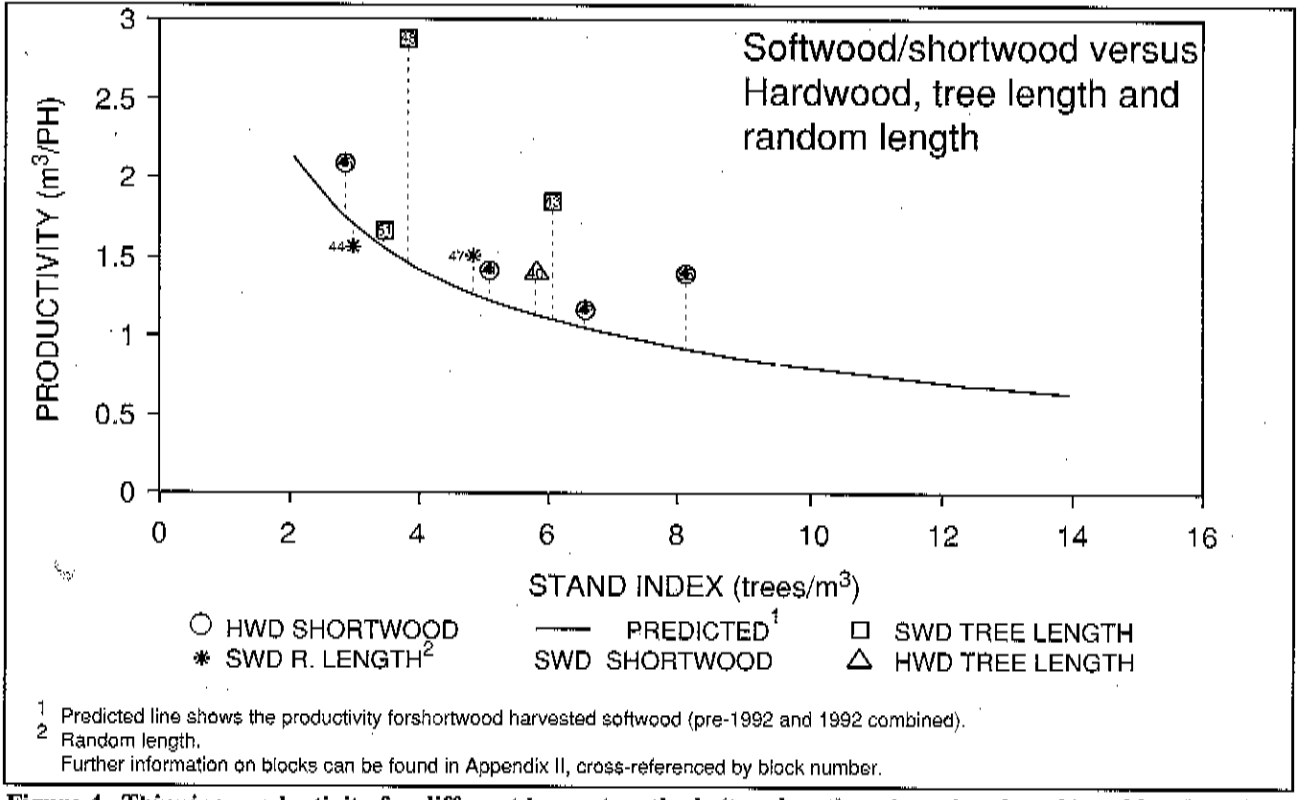
Stand Index[1] (trees/m^3)	Merchantable Diameter[2] (cm)	Production[3]	
		m^3/Day	Cords/Day
2	26.8	13.1	5.8
3	23.3	10.3	4.6
4	21.2	8.7	3.9
5	19.6	7.7	3.4
6	18.5	6.9	3.0
7	17.5	6.3	2.8
8	16.8	5.8	2.6
9	16.1	5.4	2.4
10	15.5	5.1	2.3
11	15.0	4.8	2.1
12	14.6	4.6	2.0
13	14.2	4.4	1.9
14	13.9	4.2	1.9

[1] Stand Index (SI) determined by dividing the pretreatment merchantable density by the merchantable volume.
[2] Based on the equation $MD=33.84*SI^{-0.34}$ where $r^2=0.84$ and $S_{yx}=1.29$ cm.
[3] Assumimg 6.0 productive hours per day and productivity (P) based on $P=3.27*SI^{-0.58}$.

Harvesting Methods and Species Comparisons

Studies are planned to provide additional information to define separate productivity curves for softwood and hardwood commercial thinnings using random and tree length systems. In the interim, the relatively few samples available for these types of thinnings were plotted on the combined softwood/shortwood productivity graph to provide an indication of differences in productivity between harvest methods and species (Figure 4).

As expected, in all tree length operations, worker productivity was higher than the predicted level for shortwood harvested softwood. In the softwood tree length operations, productivity averaged 51% higher (2.15 m^3/PH versus 1.42 m^3/PH, Table 2) while in the corresponding hardwood operation, worker productivity was 22% higher (1.44 m^3/PH versus 1.18 m^3/PH). For random length operations, productivity in softwood stands averaged 3% higher than the predicted value for shortwood (1.57 m^3/PH versus 1.53 m^3/PH). Productivity in shortwood harvested hardwood was 21% higher than in softwood stands (1.55 m^3/PH versus 1.28 m^3/PH).



1 Predicted line shows the productivity forshortwood harvested softwood (pre-1992 and 1992 combined).
2 Random length.
Further information on blocks can be found in Appendix II, cross-referenced by block number.

Figure 4. Thinning productivity for different harvest methods (tree length and random length) and hardwood species versus predicted productivity for shortwood-harvested softwood commercial thinnings.

Table 2. Comparison of expected productivity in softwood commercial thinnings using shortwood methods versus actual productivity in softwood and hardwood stands harvested random length, tree length and shortwood.

Harvest Method	Cover Type	Site (#)	Productivity (m^3/PH)		Percent Difference (%)
			Actual	Predicted[1]	
Random[2]	Softwood	47	1.54	1.31	+17.6
Random	Softwood	44	1.59	1.75	- 9.1
	AVERAGE	ALL	1.57	1.53	+ 2.6
Tree Length[3]	Softwood	51	1.68	1.61	+ 4.3
Tree Length	Softwood	43	1.88	1.15	+63.5
Tree Length	Softwood	48	2.89	1.51	+91.4
	AVERAGE	ALL	2.15	1.42	+51.4
Shortwood[4]	Hardwood	42	1.20	1.09	+10.1
Shortwood	Hardwood	55	1.44	0.97	+48.5
Shortwood	Hardwood	41	1.45	1.27	+14.2
Shortwood	Hardwood	45	2.12	1.80	+17.8
	AVERAGE	ALL	1.55	1.28	+21.1
Tree Length	Hardwood	40	1.44	1.18	+22.0
	AVERAGE	ALL	1.44	1.18	+22.0

1 Based on the equation for the combined shortwood softwood method, where Productivity (P)=$3.27*SI^{-0.58}$.
2 3.7- 6.1 metres in length, minimum top diameter 7.5 cm (See Appendix I for definitions).
3 3.7-16.2 metres in length, minimum top diameter 7.5 cm.
4 2.4 metre lengths.

Extraction Productivity: 1992 Study

Extraction trails varied from 3 to 5 metres in width and were spaced 15 to 20 metres apart. The width of the trails depended upon the equipment being used for extraction and stand conditions. Where trails were not cut, existing trails or openings in the stand were used for haulways.

The most common type of equipment used for extraction was a forwarder (8 sites, Appendix VI). The majority were in the range of 90-110 horsepower with a 9 m^3 capacity. Farm tractors were used on 8 blocks. Most were equipped with either a power wagon and loader, or just a winch. Cable skidders (90 horsepower range) were used on 3 blocks.

Extraction productivity varied with the type of equipment and the distance travelled. With forwarders, productivity averaged 7.9 m^3/PH, on sites with an average haul distance of 277 metres. With skidders, productivity averaged 3.8 m^3/PH for sites averaging 101 metres in haul distance, and for tractors 2.2 m^3/PH over 130 metres.

Basal Area & Volume Removal

Total basal area removal from the leave strips averaged 38% for the pre-1992 study, and 42% for the 1992 study. Approximately 42% of the total volume was removed from the leave strips during harvesting for the 1992 study. No comparable information is available from the earlier study.

SUMMARY

The results of worker productivity studies in commercial thinnings, including 55 measurement blocks, (36 from a previous study and 19 from a new study) were as follows. Productivity is expressed in m^3/PH, where PH represents productive hours.

1. The best fit regression equation for shortwood harvested softwood productivity based on the 1992 study (9 blocks) was very similar (not significantly different at P=.05) to the pre-1992 study equation (36 blocks).

2. Worker productivity (P), based on the combined data for shortwood harvested softwood, was determined to be inversely related to Stand Index (SI: trees/m^3) in a curvilinear manner according to the following equation:
$P=3.27*SI^{-0.58}$ ($r^2=0.42$; $S_{yx}=0.40$ m^3/PH)

3. Based on this equation, for a decrease in SI from 12 to 5 (increase in merchantable diameter from 14.6 cm to 19.6 cm) productivity would increase 67% from 4.6 m^3/day to 7.7 m^3/day.

4. Preliminary observations, based on a few samples, show worker productivity in (i) softwood tree length operations (3 blocks) averaging 51% higher than softwood shortwood operations (2.15 m^3/PH versus 1.42 m^3/PH) (ii) softwood random operations (2 blocks) averaging only 3% higher (1.57 m^3/PH versus 1.53 m^3/PH) and (iii) shortwood harvested hardwood (4 blocks) averaging 21% higher than the predicted value for softwood shortwood (1.55 m^3/PH versus 1.28 m^3/PH). Additional studies scheduled for 1993 should provide the data needed to more accurately define these differences.

5. Extraction productivity (1992 study) for forwarders averaged 7.9 m^3/PH, for skidders 3.8 m^3/PH, and for tractors 2.2 m^3/PH. The average extraction distance (in metres) for forwarders was 277, skidders 101 and tractors 130.

LITERATURE CITED

Husch, B., Miller, C. I., and T. W. Beers. 1982. *Forest Mensuration.* New York: John Wiley & Sons. 410 pp.

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NSDNR, 1991. *Worker productivity in merchantable thinning operations-Part II.* Forest Research Section, Nova Scotia Dept. of Natural Resources, For. Res. Rept. No. 32. 8 pp.

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APPENDIX I
Definitions

Commercial Thinnings

In this report Shelterwoods and Merchantable Thinnings are referred to as Commercial thinnings.

Merchantable Thinnings

A spacing operation carried out in stands with a merchantable diameter at least 14.0 cm to i) increase yields by harvesting trees that would otherwise be lost to mortality, and ii) promote the growth and quality of desirable crop trees.

Shelterwood Cutting

One or more spacing operation carried out in stands at least 14.0 cm in average merchantable diameter to provide conditions conducive to the establishment of natural regeneration and/or enhance the growth of regeneration already established.

Random Length harvesting

Trees cut in lengths of 3.7 to 6.1 metres with a minimum top diameter of 7.5 cm.

Tree Length Harvesting

Trees cut in lengths of 3.7 to 16.2 metres with a minimum top diameter of 7.5 cm.

Shortwood Harvesting

The majority of harvested trees are processed into 2.4 metre lengths with some processed into random length logs.

Data Analyses

Non-linear regressions were used to compare harvesting productivity with pre-treatment stand conditions. Stand Index (SI) was used as a predictor of productivity in these equations and was computed by dividing the merchantable density prior to treatment by the merchantable volume.

Pre-Assessment

Between 4 and 10 prism plots (BAF 2) were established in each of the blocks. Recorded for each plot were the diameters of all trees greater than 1 cm and the height of one codominant tree. This information was used to determine the stand index (trees/m^3). A 5 metre fixed-radius plot was also established to measure the total number of stems (alive and dead) greater than 1 cm at breast height (1.3 metre).

Productivity Studies

Productivity studies were performed for both harvesting and extraction operations (no extraction information was collected for the pre-1992 study). Workers productive and nonproductive time was recorded daily.

Depending on the size of the operation, harvested trees or portions thereof, were scaled either in the stand or at roadside. Wood scaled in the stand was scaled piece by piece, whereas at roadside, bulk scaling methods were used. Volumes were calculated using either Smalians formula (Hush et. al.,1982) or the New Brunswick Log Rule. For trees harvested tree length, a local volume table was produced for the site using Newtons formula (Hush et. al.,1982).

Productivity for harvesting and extraction operations was determined by dividing the volumes harvested or brought to roadside, by the productive time required to harvest or extract the wood. Productivity was expressed in solid cubic metres/productive hour (m^3/PH).

APPENDIX II
Pretreatment description of pre-1992 and 1992 block conditions.

Block #	Location	County	Dominant Species	Average Height (m)	Merchantable			Density		Stand Index[2] (trees/m³)
					Volume (m³/ha)	Diameter (cm)	Basal Area (m²/ha)	Merchantable (stems/ha)	Total (stems/ha)	
1	Mill Lake	Halifax	Swd.	12	201	16.0	36	1795	3121	8.9
2	Morden	Kings	Swd.	14	202	18.5	34	1258	4791	6.2
3	Barrachois	Colchester	Swd.	13	237	15.7	40	2092	2674	8.8
4	Georgefield	Hants	Swd.	12	295	16.1	52	2551	5122	8.6
5	Georgefield	Hants	Swd.	13	241	17.4	40	1699	2067	7.1
6	South Hampton	Annapolis	Swd.	15	218	20.1	33	1030	1569	4.7
7	Barrachois	Colchester	Swd.	12	170	14.6	33	1940	2271	11.4
8	Georgefield	Hants	Swd.	13	245	16.2	41	1999	3377	8.2
9	Georgefield	Hants	Swd.	11	207	14.9	42	2439	4141	11.8
10	Barrachois	Colchester	Swd.	12	151	15.1	28	1577	2704	10.4
11	Barrachois	Colchester	Swd.	13	223	16.8	37	1676	2427	7.5
12	Morden	Kings	Swd.	13	134	18.8	23	828	4443	6.2
13	Amherst Head	Cumberland	Swd.	11	155	14.0	31	2025	3235	13.1
14	South Hampton	Annapolis	Swd.	15	192	19.3	29	971	1470	5.1
15	Pleasant Valley	Colchester	Swd.	17	381	19.6	51	1697	2095	4.5
16	Woodstock	Yarmouth	Swd.	12	142	15.2	28	1537	3875	10.9
17	Amherst Head	Cumberland	Swd.	12	168	16.0	32	1609	2149	9.6
18	Woodstock	Yarmouth	Swd.	11	229	14.5	47	2859	7729	12.5
19	Pleasant Valley	Colchester	Swd.	17	306	18.6	42	1549	1748	5.1

[1] Blocks 1-19 are from the pre-1992 study. Additional information can be obtained from Research Report #28, (NSDNR,1991).

[2] Pretreatment merchantable density divided by the merchantable volume.

APPENDIX II Cont.

Block[1] #	Location	County	Dominant Species	Average Height (m)	Merchantable			Density		Stand Index[2] (trees/m³)
					Volume (m³/ha)	Diameter (cm)	Basal Area (m²/ha)	Merchantable (stems/ha)	Total (stems/ha)	
20	Leminster	Lunenburg	Swd.	15	254	18.0	40	1559	1974	6.2
21	Gilberts Cove	Digby	Swd.	15	241	17.0	37	1638	1811	6.8
22	Leminster	Lunenburg	Swd.	15	221	19.1	35	1231	2429	5.6
23	Goshen	Guysborough	Swd.	13	192	18.0	32	1253	2441	6.5
24	Pickle Bay Lake	Yarmouth	Swd.	16	234	20.3	35	1107	1107	4.7
25	Pleasant Valley	Colchester	Swd.	17	487	21.4	64	1778	1778	3.7
26	Pickle Bay Lake	Yarmouth	Swd.	17	270	22.4	37	946	946	3.5
27	Leminster	Lunenburg	Swd.	17	336	26.6	43	780	780	2.3
28	Fanning Lake	Yarmouth	Swd.	15	327	17.3	49	2068	3091	6.3
29	Goshen	Guysborough	Swd.	13	193	17.8	33	1347	2397	7.0
30	Pleasant Valley	Colchester	Swd.	18	330	20.8	42	1240	1439	3.8
31	Sherbrooke Lake	Lunenburg	Swd.	20	401	25.9	48	909	1211	2.3
32	East Torbrook	Annapolis	Swd.	ND	248	21.1	39	1114	1942	4.5
33	Sherbrooke Lake	Lunenburg	Swd.	18	268	21.8	35	914	2340	3.4
34	East Torbrook	Annapolis	Swd.	ND	219	22.5	32	806	1899	3.7
35	Gilberts Cove	Digby	Swd.	17	347	22.9	47	1129	2399	3.3
36	East Torbrook	Annapolis	Swd.	ND	251	21.2	44	1241	2005	5.0

[1] Blocks 20-36 are from the pre-1992 study. Additional information can be obtained from Research Report #28, (NSDNR,1991).

[2] Pretreatment merchantable density divided by the merchantable volume.

APPENDIX II Cont.

Block[1] #	Location	County	Dominant Species	Average Height (m)	Merchantable			Density		Stand Index[2] (trees/m³)
					Volume (m³/ha)	Diameter (cm)	Basal Area (m²/ha)	Merchantable (stems/ha)	Total (stems/ha)	
37	Tatamagouche Mt.	Colchester	Swd.	15	267	24.9	42	872	2368	3.3
38	Heckmans Island	Lunenburg	Swd.	14	272	16.3	49	2310	5411	8.5
39	Torbrook East	Kings	Swd.	14	160	23.8	29	658	2462	4.1
40	Alder River	Guysborough	Hwd.	15	159	19.0	26	916	2483	5.8
41	McCormick Corner	Inverness	Hwd.	16	172	19.5	26	867	4202	5.0
42	Sporting Mt.	Richmond	Hwd.	13	147	19.4	29	960	2483	6.5
43	MacBeth Road	Pictou	Swd.	13	234	20.0	44	1401	2642	6.0
44	Old Barns	Colchester	Swd.	17	205	25.0	30	599	2769	2.9
45	South Range	Digby	Hwd.	21	319	22.8	36	891	971	2.8
46	Barr Settlement	Halifax	Swd.	18	280	20.7	37	1085	1406	3.9
47	South Victoria	Cumberland	Swd.	17	374	19.8	55	1785	1865	4.8
48	Denmark	Colchester	Swd.	16	294	22.7	45	1112	2292	3.8
49	Stewiacke East	Colchester	Swd.	19	488	19.0	60	2139	2595	4.4
50	Parrsborro	Cumberland	Swd.	15	184	20.9	29	852	1640	4.6
51	Beaverbrook	Colchester	Swd.	18	343	15.2	46	1160	2164	3.4
52	Heckmans Island	Lunenburg	Swd.	13	214	15.2	42	2323	9231	10.9
53	Conqueral Mills	Lunenburg	Swd.	14	300	15.2	57	3122	4190	10.4
54	Upp. Musquodobit	Halifax	Swd.	13	241	14.9	47	2689	6922	11.2
55	Watervale	Colchester	Hwd.	14	104	17.3	18	839	2586	8.1

[1] Blocks 37 to 55 are from the 1992 study.
[2] Pretreatment merchantable density divided by the merchantable volume.

APPENDIX III

Regression statistics and F-test difference results for pre-1992 and 1992 regressions.

Study	Sample Size (#)	*r^2	**S_{yx}	Parameters		F Statistic
				b_o	b_i	
Pre-1992	36	0.41	0.40	3.181	-0.576	0.223[t]
1992	9	0.46	0.46	3.750	-0.631	
Combined	45	0.42	0.40	3.273	-0.584	

* Correlation coefficient.

** Standard error of the estimate.

[1] Coefficients of the regression equation: $y=b_oSI^{b_i}$

[t] The null hypothesis (Ho) cannot be rejected at the 0.05 level. Ho: the regression functions represent the same population (Zar,1974:234).

APPENDIX IV

Thinning productivities by block and harvest method for the 1992 study[1].

Block #	Harvest Methods	Cover Type	Stand Index[2] (trees/m³)	Harvesting			
				No. of Cutters (#)	Volume (m³)	Productive Hours (PH)	Productivity m³/PH
54	Shortwood[3]	Swd	11.2	4	23.2	72.5	0.32
53	Shortwood	Swd	10.4	2	25.6	35.0	0.73
49	Shortwood	Swd	4.4	1	19.0	20.5	0.93
52	Shortwood	Swd	10.9	3	28.8	26.8	1.07
38	Shortwood	Swd	8.5	2	39.6	36.3	1.09
37	Shortwood	Swd	3.3	3	72.2	55.5	1.30
39	Shortwood[4]	Swd	4.1	2	56.3	30.8	1.83
46	Shortwood	Swd	3.9	3	57.9	30.9	1.87
50	Shortwood	Swd	4.6	2	65.1	31.0	2.10
ALL		AVERAGE	6.8	2	43.1	37.7	1.25
47	Random[5]	Swd	4.8	2	93.2	60.5	1.54
44	Random	Swd	2.9	1	21.3	13.4	1.59
ALL		AVERAGE	3.9	2	57.3	37.0	1.57
51	Tree Length[6]	Swd	3.4	2	43.5	25.9	1.68
43	Tree Length	Swd	6.0	1	52.5	27.9	1.88
48	Tree Length	Swd	3.8	1	61.9	21.4	2.89
ALL		AVERAGE	4.4	1	52.6	25.1	2.15
42	Shortwood	Hwd	6.5	4	83.4	69.5	1.20
55	Shortwood	Hwd	8.1	2	32.6	22.7	1.44
41	Shortwood	Hwd	5.0	2	61.9	42.7	1.45
45	Shortwood	Hwd	2.8	1	14.2	6.7	2.12
ALL		AVERAGE	5.6	2	48.0	35.4	1.55
40	Tree Length	Hwd	5.8	1	7.9	5.5	1.44
ALL		AVERAGE	5.8	1	7.9	5.5	1.44

[1] No harvesting production information was collected for the pre-1992 study (Blocks 1 to 36).
[2] Determined by dividing the pretreatment merchantable density by the merchantable volume.
[3] Trees cut into 2.4 metre lengths (See Appendix I).
[4] Some trees processed into random length logs.
[5] Random Length : 3.7 - 6.1 metres; minimum top diameter 7.5 cm.
[6] Tree Length : 3.7 - 16.2 metres; minimum top diameter 7.5 cm.

APPENDIX V

Thinning productivity in shortwood[1] harvested softwood commercial thinnings for the pre-1992 study (NSDNR, 1991).

Block	Productivity[2] (m^3/PH)	Stand Index[3] (trees/m^3)
1	0.43	8.9
2	0.44	6.2
3	0.48	8.8
4	0.57	8.6
5	0.71	7.1
6	0.72	4.7
7	0.77	11.4
8	0.77	8.2
9	0.79	11.8
10	0.80	10.4
11	0.80	7.5
12	0.82	6.2
13	0.83	13.1
14	0.93	5.1
15	0.95	4.5
16	0.98	10.9
17	1.00	9.6
18	1.08	12.5
19	1.13	5.1
20	1.16	6.2
21	1.18	6.8
22	1.20	5.6
23	1.24	6.5
24	1.32	4.7
25	1.33	3.7
26	1.38	3.5
27	1.40	2.3
28	1.43	6.3
29	1.48	7.0
30	1.67	3.8
31	1.71	2.3
32	1.88	4.5
33	1.99	3.4
34	2.06	3.7
35	2.37	3.3
36	2.38	5.0
ALL	1.17	6.6

[1] Trees processed into 2.4 metre lengths.
[2] Expressed in solid cubic metres per productive hour.
[3] Stand Index determined by dividing the pretreatment merchantable density by the merchantable volume.

APPENDIX VI

Extraction productivity[1] by block and equipment type for the 1992 study.

Block #	Extraction Equipment	Harvest Methods	Cover Type	Extraction					
				No. of Trips (#)	Av. Extraction Distance (m)	Vol. (m^3)	Productive Hours	Productivity	
								m^3/Trip	m^3/PH
53	C5D Tree Farmer Forwarder	Shortwood[2]	Swd	3	460	23.0	3.9	7.7	5.9
38	C5D Tree Farmer Forwarder	Shortwood	Swd	15	266	90.9	13.5	6.1	6.7
52	C5D Tree Farmer Forwarder	Shortwood	Swd	15	290	90.9	13.5	6.1	6.7
37	FMG 1010 Forwarder	Shortwood	Swd	20	118	180.9	21.5	9.0	8.4
54	Timberjack® 230 Forwarder	Shortwood	Swd	7	230	61.6	7.2	8.8	8.6
47	C5D Tree Farmer Forwarder	Random[3]	Swd	17	450	135.1	22.6	7.9	6.0
41	Timberjack® 230 Forwarder	Shortwood	Hwd	41	80	344.0	42.0	8.4	8.2
42	Timberjack® 230 Forwarder	Shortwood	Hwd	ND[4]	325	536.3	42.0	ND	12.8
ALL	AVERAGE			17	277	182.8	20.8	7.7	7.9
39	Tractor, Wagon & Loader	Shortwood[5]	Swd	13	170	53.6	16.9	4.1	3.2
46	Tractor, Wagon & Loader	Shortwood	Swd	13	175	37.4	15.5	2.9	2.4
47	Tractor & Winch	Random	Swd	ND	10	93.2	60.5	ND	1.5
44	Tractor & Winch	Random	Swd	21	100	27.4	9.1	1.3	3.0
51	Tractor & Winch	Tree Length[6]	Swd	45	245	43.5	21.1	1.0	2.1
43	Tractor & Winch	Tree Length	Swd	50	200	40.1	29.7	0.8	1.4
45	Trac., Wag., Load., & Winch	Shortwood	Hwd	16	80	57.4	22.3	3.6	2.6
40	Tractor & Winch	Tree Length	Hwd	44	57	23.8	15.1	0.5	1.6
ALL	AVERAGE			29	130	47.1	23.8	2.0	2.2
49	C4D Tree Farmer Skidder	Shortwood	Swd	15	75	19.9	5.5	1.3	3.6
50	Timberjack® 230A Skidder	Shortwood	Swd	71	152	65.2	16.2	0.9	4.0
48	C4D Tree Farmer Skidder	Tree Length	Swd	44	75	55.2	14.3	1.3	3.9
ALL	AVERAGE			43	101	46.8	12.0	1.2	3.8

[1] No extraction information was collected in the pre-1992 study (Blocks 1 to 36).
[2] Trees cut in 2.4 metre lengths.
[3] Random Length: 3.7 - 6.1 metres; minimum top diameter 7.5 cm.
[4] No data.
[5] Some trees processed into random length logs.
[6] Tree Length : 3.7 - 16.2 metres; minimum top diameter 7.5 cm.
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