

FOREST RESEARCH REPORT



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Table of Contents

Introduction.	1
Data.	2
Methods.	2
Table 1. Commercial thinning sites .	3
Figure 1. Location of PSPs.	4
Table 2. Number of observations	5
Results.	6
Discussion	7
Acknowledgments.	7
References	7
Appendix I: Predicted versus Actual	8

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Diameter Growth of Commercially Thinned Softwood Stands

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Introduction

Softwood commercial thinnings can provide numerous benefits. Increased yield can be achieved by salvaging trees that would have otherwise been lost to mortality. Tree quality can be improved through selection of preferred species of superior form, quality and vigour. Increases in future harvesting efficiency can be achieved through increased piece size and tree spacing.

The area of commercial thinning treatments (CT) in Nova Scotia has recently increased. These commercial thinnings have mainly occurred in previously pre-commercially thinned (PCT) or planted sites because these stands are more wind firm and economical to thin than un-spaced naturally regenerated stands. Limited data exists for this treatment especially for previously PCTed stands. As a result, Version 1 of the Softwood Growth and Yield Model (NSDNR 1993a) does not estimate the growth and yield of commercially thinned softwood stands that had been previously pre-commercially thinned. Starting in 1997, several trials were established to determine the growth and yield response to this treatment. Most of these trials have now been measured for five years, enabling the development of growth and yield estimates.

Data

Table 1 shows a summary of the Nova Scotia Dept. of Natural Resources (NSDNR) and J.D. Irving Ltd. (JDI) permanent sample plots (PSP) in commercially thinned softwoods stands used for this study. Ten of these sites previously received PCT, eight were plantations, two were commercially thinned for the second time, and the remaining 19 sites were previously un-spaced naturally regenerating stands. Figure 1 shows the locations of the PSP's within Nova Scotia. Table 2 summarizes the data by species, site and initial basal area (m^2/ha). A broad range of sites (13-29 m) and basal areas (12- 63 m^2/ha) are represented. The bulk of the data are for red and white spruce¹, representing over 90% of the data, and relatively little data exists for balsam fir, pine species and black spruce.

Methods

To predict the response of softwood stands to commercial thinning treatments, the 5 year increment in quadratic mean diameter (cm) at breast height (Dbh, 1.3 m) was examined using regression analysis (Husch *et al.* 1972). This mean Dbh increment was calculated based only on trees that were living through the entire growth period. In this way, the affect of mortality on the mean diameter increment was eliminated. Any PSP that lost greater than 10% of its trees to mortality during a growth period was also excluded. This eliminated 42 of the 459 data points from analysis.

¹ Scientific names are found in Table 1.

Table 1. Commercial thinning PSP sites.

Location	County ¹	#	Spec ²	Prev. Trt. (yr) ³	Year CT ⁴	Yrs Me ⁵	CT Age ⁶	Plots ⁷	Mea ⁸	Stat ⁹	Cooperator ¹⁰
Scragg Lake	Ann	7825	rS		1967	26	28	1	3	H	CU
Como Lake	Hal	7845	rS		1977	21	43	1	4	H	Neenah
Boars Back Road	Cum	7909	rP	Plant (1955)	1979	25	24	1	5	A,R	CU
Debert	Col	7915	rP	Plant (1957)	1975	29	18	1	5	A,R	CU
Butler Lake	Lun	7926	rS		1979	16	68	1	2	H,S	Neenah
Georgefield	Han	7931	wS		1979	6	46	1	2	H	SP
Springfield	Ann	7932	wP		1976	28	31	1	3	A	CU
Paradise	Ann	7935	wP		1977	7	21	1	1	H	SP
SunnyBrae	Pic	8034	rS	CT (1980)	1999	24/5	46/65	11	36	A	C-Stora
7 Mile Road	Hal	8046	rS		1980	20	43	5	13	H	C-Neenah
Georgfield	Han	8058	wS		1980	10	46	13	22	H	SP
SunnyBrae	Pic	8070	rS		1980	10	46	6	12	H,S	C- Stora
10 Mile Lk Road	Hal	8107	rS		1980	6	66	2	1	H,S	Neenah
Union Dam	Hal	8110	rS		1980	6	65	3	3	H,S	C-Neenah
Keppoch	Ant	8113	wS		1980	21	43	6	21	A,S	C-Stora
Gairlock	Pic	8125	wS		1980	11	46	6	2	H,S	C-Stora
Debert	Col	8210	rP	Plant (1958)	65/75	27	16	1	4	A,H	CU
Governor Lake	Hal	8232	rS	PCT (1982)	1997	5	44	8	7	A	Neenah
10 Mile Lake	Hal	8253	rS		1982	20	41	15	61	H	Neenah
Fielding Road	Inv	8324	bF	PCT (1983)	1998	5	28	5	5	A	C-Stora
Manganese Mines	Col	8345	wS	Plant (1969)	2000	5	31	2	2	A	Neenah
St Margarets Bay	Hal	8347	rS	PCT (1968)	1998	5	44	3	2	A	Bowater
MacQuarrie Lake	Pic	8357	rS		1983	5	55	6	6	H,S	C-Stora
MacQuarrie Lake	Pic	8365	rS		1983	20	53	8	32	A	C-Stora
St Margarets Bay	Han	8378	rS	PCT (1967)	1998	5	44	3	3	A	Bowater
Truro Dump	Col	8411	rS		1983	16	59	3	4	H	Truro
Barn Lake	Dig	8723	rS	CT (1987)	2000	18/5	44/57	4	12	A	Bowater/JDI
Barn Lake	Dig	8729	rS	PCT (1987)	2000	5	54	2	2	A	Bowater/JDI
McCallum Sett.	Col	8801	rS	PCT (1971)	1998	5	45	4	4	H	CU
Garden of Eden	Guy	9201	wP		1991	11	42	1	2	A	C-Stora
East River Lake	Guy	9308	rS		1991	12	49	1	2	A	C-Stora
Garry's Rd	Vic	9309	rP	Plant (1965)	1993	10	28	2	4	A,G	C-Stora
Caduesky Lake	Que	9812	rS	PCT	1998	5	51	2	1	A	Bowater
Governor Lake	Guy	9815	rS	PCT	1999	5	40	1	1	A	Neenah
Garvie Lake	Ant	9924	bF	PCT	1999	5	30	1	1	A	C-Stora
6 Mile Brook	Pic	9926	rP	Plant (1977)	1999	5	22	1	1	A,G	Neenah
Mill Dam Lake	Pic	9927	bF	PCT	1999	5	26	1	1	B	C-Stora
Black Brook	NB	8701	wS/rS	Plant (1963)	1987/95/97	10	24	35	77	A	JDI
Black Brook	NB	8703	wS	Plant (1968)	1987/97	10	19	24	48	A	JDI
Total								193	417		

1. Ann - Annapolis, Col-Colchester, Cum-Cumberland, Dig-Digby, Guy-Guysborough, Hal-Halifax, Han-Hants, Inv-Inverness, Lun-Lunenburg, Pic-Pictou, Que-Queens, Vic-Victoria, NB-New Brunswick .
2. bF - Balsam Fir - *Abies balsamea* (L.) Mill., bS - Black Spruce - *Picea mariana* (Mill) B.S.P., rP - Red Pine - *Pinus resinosa* Ait., rS - Red Spruce - *Picea rubens* Sarg., wP - White Pine - *Pinus strobus* L., wS - White Spruce - *Picea glauca* (Moench) Voss.
3. previous treatment and year of this treatment: Plant -plantation, CT - commercial thinning, PCT - pre-commercial thinning.
4. Year commercially thinned.
5. Years measured since the commercial thinning treatment.
6. Age of stand at time of commercial thinning.
7. Number of plots at this site.
8. Number of diameter increment measurements at this site.
9. Status/Comment Codes: A - Active, H - Harvested, S - Shelterwood, B - Blowdown, G- Good Site, R - Row Thinning
10. Cooperating Landowners/Managers: Bowater - Bowater Mersey Paper Co. Ltd, C-Neenah - Crown managed by Neenah Paper Inc, C-Stora - Crown managed by Stora Enso Port Hawkesbury Ltd, CU - Crown unlicensed, JDI - J.D. Irving Ltd., Neenah - Neenah Paper Inc, SP- Small Private, Truro - Town of Truro.

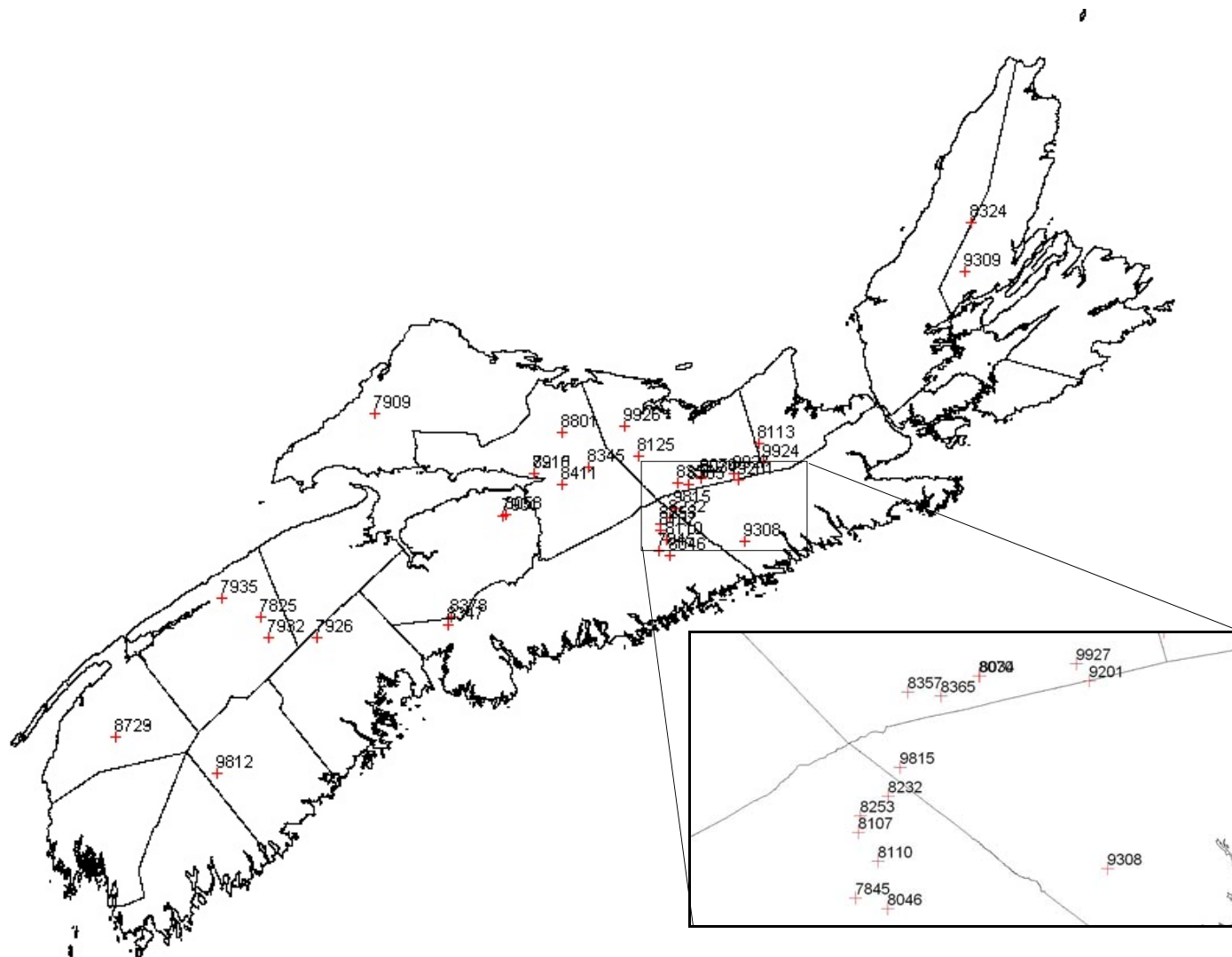


Figure 1. Location of commercially thinned PSPs in Nova Scotia

Table 2. Number of diameter increment observations by species, initial basal area class and site index class																
Initial Basal Area (m²/ha)	Site Index Class (dominant height in metres, at breast height age 50)															All
	14	18	22	26	30	14	18	22	26	30	14	18	22	26	30	
	Red Spruce (57%)					White Spruce (36%)					Balsam Fir (2%)					
15	8	4					6	16				1	1			
25	53	30	4			3	11	59			4	1				
35	45	29	2			2	9	32								
45	25	20				3	2	3								
55	6	9				1										
65		2				1										
Tot	137	94	6	0	0	10	28	110	0	0	4	2	1	0	0	
	White Pine (5%)					Red Pine (1%)					All Species					
15			1	1			2			1	8	13	18	1	1	41
25		1	5	2							60	43	68	2	0	173
35		1	1								47	39	35	0	0	121
45		3		1				1			28	25	4	1	0	58
55				3				1			7	9	1	3	0	20
65								1			1	2	1	0	0	4
Tot	0	5	7	7	0	0	2	3	0	1	151	131	127	7	1	417

Results

Observations showed that when less basal area was left after thinning the diameter growth rate was higher. On better sites, with a higher site index, diameter growth response was more pronounced. White spruce, red spruce and balsam fir showed intermediate levels of growth, while red and white pine showed comparatively greater growth and black spruce and jack pine showed less growth for equivalent sites and initial basal areas. Although species trends were apparent it was decided to derive a combined curve for pines and spruce excluding black spruce and jack pine. A combined curve is compatible with the existing GNY model and represents improved predictions relative to existing functions. Existing black spruce data was collected from very poor naturally regenerated stands or plantations with a high proportion of multiple stems. These problems preclude the ability of using this data in the existing analysis as they artificially reduced Dbh growth. As black spruce is planted frequently throughout Nova Scotia, these stands will be logical targets for future commercial thinning and would justify future data collection efforts so that species specific growth estimates can be made.

The regression model used, incorporates site index and initial basal area as follows:

$$\text{delta TD} = (b_0 \cdot \text{sim} + b_1) \cdot \exp(b_2 \cdot \text{tba}_m)$$

Where:

delta TD	=	The 5 year increase in the quadratic mean stand diameter (outside bark at breast height) in centimetres (Husch <i>et al.</i> , 1972)
sim	=	The Site Index of the stand, expressed as dominant height in metres at an index age of 50 years at breast height (NSDNR, 1993b)
tba_m	=	The stand basal area (outside bark) in m ² /ha at the beginning of the 5 year growth period
b0, b1, b2	=	Regression coefficients

The regression model shown above accounted for 70.6% of the total variation ($r^2 = .706$) and resulted in the following coefficients based on 417 data points.

b0	=	+0.195
b1	=	+0.854
b2	=	-0.033

Appendix I shows the fit of the model predictions to the data.

Discussion

The diameter growth model for commercial thinning will be incorporated into version 2.1.0 of Nova Scotia's Growth and Yield model (GNY). This addition to the software, will enable simulation of silviculture scenarios not previously possible with GNY. Simulations of commercial thinning in pre-commercially thinned and previously commercially thinned stands will now be possible. The updated model will expand the planning alternatives that can be examined within the growth and yield model. The latest version of GNY can be downloaded from <<http://www.gov.ns.ca/natr/forestry/gny2004/growthandyield.htm>>.

It is recommended that growth predictions for jack pine and black spruce be excluded from the GNY model due to insufficient data. Future efforts should concentrate on determining the growth of commercially thinned black spruce plantations as the existing black spruce data is currently limited to very poor sites or in areas dominated by multiple stems. Black spruce is a commonly planted species in Nova Scotia and determining the effectiveness of commercial thinning in these plantations should be given a high priority.

Acknowledgements

The data for this report was gathered from numerous commercial thinning trials and operations. These operations were carried out thanks to efforts of many forest companies and provincial crown staff. For a complete list of land owners and managers who cooperated on the establishment of these thinnings see Table 1. Collection, editing and maintenance of the data from Nova Scotia was undertaken by the staff of the Nova Scotia Department of Natural Resources and its predecessor the Department of Lands and Forest. The New Brunswick data was accessed through the cooperation and efforts of J.D. Irving Ltd. Appreciation is extended to reviewers including Edwin Swift of the Canadian Forest Service of Natural Resources Canada.

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Appendix I

Predicted (✱) versus actual (○) five year average diameter growth at breast height (cm) by initial basal area after treatment (m²/ha) and site index class (4 m classes). Site index is in dominant height in metres. Index age at breast height is 50 years.

