



# FOREST RESEARCH REPORT

No. 50: March, 1994

## THE EFFECT OF SHEARING ON THE QUALITY OF BALSAM FIR CHRISTMAS TREES (PICTORIAL PRESENTATION)

### INTRODUCTION

This report is comprised of a series of photographs illustrating the effect of spacing and shearing on the growth and quality of balsam fir Christmas trees. The photographs were taken as part of a 5-year study designed to provide information for the development of a Christmas tree computer simulation model (to be published at a later date). The five sites selected for this study were recent cutovers naturally regenerated to balsam fir (Figure 1). Site conditions varied from well drained fertile soils derived from shale, slate, and sandstone to imperfectly drained soils (Table 1). At each site, dominant fir, averaging approximately 1 metre in height, were spaced 1.8 metres apart. Spacing took place in the fall of 1985 and shearing between July and August of each year from 1986 to 1990 inclusive. Photographs of selected trees were taken annually from permanently located sample points with a tripod-mounted 35mm camera.

For the purposes of this report, photographs of 24 trees were selected to illustrate the degree to which shearing can increase crown density and correct various types of crown defects. Each selected tree is represented by a series of 5

pictures. The first shows the tree one year after spacing and before it was sheared in 1986. The second through fifth shows the same tree, following shearing, in 1987, 1988, 1989 and 1990. In addition, the crown height, width and density, foliage nutrient content and needle length are listed adjacent to each picture.

The pictures are organized into two Appendices. Appendix I shows the relative affects of shearing on the density of trees as related to initial foliage density (light, moderate, and high) and site fertility (low to high). By studying these time series of photos, it can be observed that lighter density trees on the poor sites require more years of shearing to produce well-formed Christmas trees.

The second Appendix includes 12 trees having noticeable crown defects before shearing. These photo series indicate the degree to which various types of defects can or cannot be corrected by shearing.

Appendix III defines the terms used in the first two appendices.

# Nova Scotia

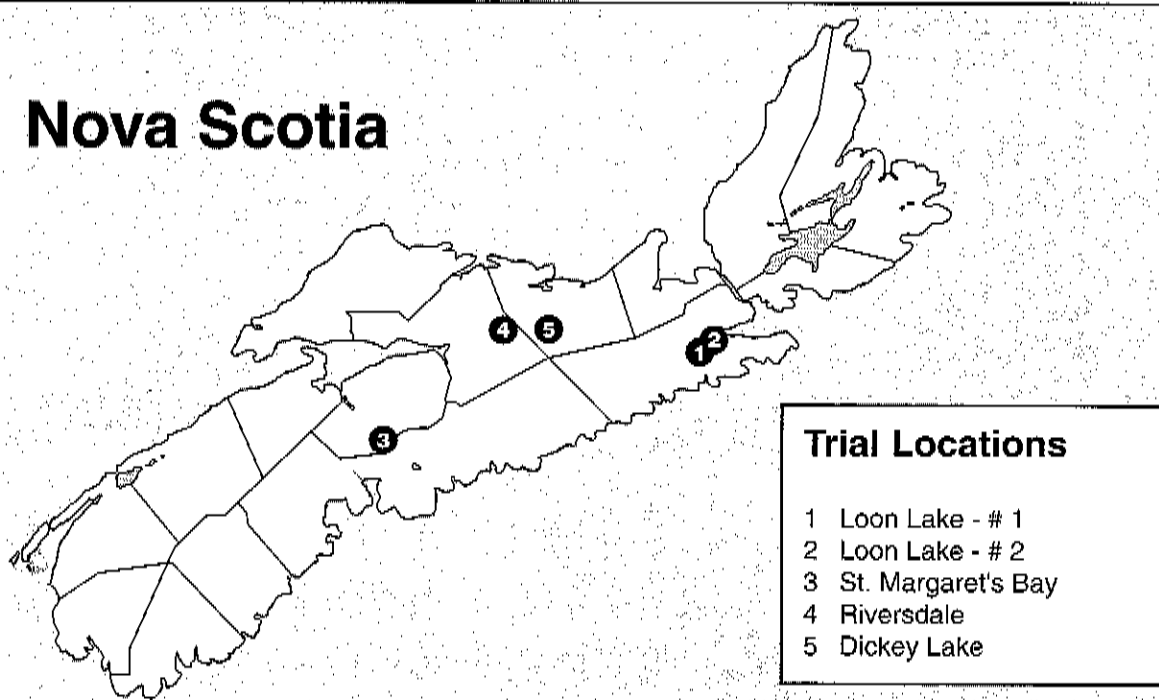


Figure 1. Location of Christmas tree trial areas.

Table 1. Site description and initial tree crown characteristics.

Variable	Location				
	Loon Lake- # 1	Loon Lake- # 2	St. Margarets Bay	Riversdale	Dickey Lake
Soil Series	Riverport	Riverport	Gibraltar	Thom	Perch Lake
Parent Material (PM)	Shale/slate	Shale/slate	Granite	Sandstone	Shale/ slate/ sandstone
Soil Texture	Silt Loam	Silt Loam	Sandy Loam	Sandy Loam	Sandy Loam
Drainage	Imperfect	Imperfect	Well	Well	Well
Vegetation	Sphagnum	Ericaceous	Herbaceous	Herbaceous	Herbaceous
Site Fertility	Low	Low	Low	Moderate	High
Crown Height <sup>1</sup> (m)	1.0	1.0	1.2	1.0	1.1
Crown Width <sup>1</sup> (m)	0.80	0.74	0.78	0.78	0.90
Crown Density <sup>1</sup> (%)	34	37	38	36	44
Crown Volume <sup>1</sup> (m <sup>3</sup> )	0.07	0.05	0.08	0.06	0.12

<sup>1</sup> Measured after spacing and before shearing in 1985.

# Appendix I

**A time series of photographs, depicting well-formed light, moderate and high density Christmas trees sheared for 5 years, located on high to low fertility sites.**

Dicky Lake (High Fertility)

Light

Moderate

High

1986



1987



1988



1989



1990



## Dicky Lake (High Fertility)

Initial Foliar Density	Block 10 - Tree #1	Block 6 - Tree #3	Block 20 - Tree #1
	Light	Moderate	High
1986			
Density(%)	42	57	78
Height(m)	0.8	0.8	1.1
Width(m)	0.5	0.7	1
Needle Length(mm)	17	21	19
Crown Volume(m <sup>3</sup> )	0.02	0.06	0.2
Nitrogen(%)	2.39	2.3	2.39
Phosphorus (%)	0.21	0.19	0.21
Potassium (%)	0.83	0.74	0.83
1987			
Density(%)	82	65	87
Height(m)	0.9	1	1.3
Width(m)	0.8	1	1.1
Needle Length(mm)	21	26	22
Crown Volume(m <sup>3</sup> )	0.11	0.15	0.32
Nitrogen(%)	2.36	2.24	2.36
Phosphorus (%)	0.21	0.19	0.21
Potassium (%)	0.69	0.76	0.69
1988			
Density(%)	72	76	93
Height(m)	1.2	1.1	1.5
Width(m)	0.9	1.1	1.3
Needle Length(mm)	19	21	25
Crown Volume(m <sup>3</sup> )	0.18	0.24	0.57
Nitrogen(%)	2	2.01	2
Phosphorus (%)	0.19	0.17	0.19
Potassium (%)	0.66	0.65	0.66
1989			
Density(%)	73	73	90
Height(m)	1.6	1.4	1.8
Width(m)	1.1	1.3	1.5
Needle Length(mm)	19	23	20
Crown Volume(m <sup>3</sup> )	0.37	0.45	0.89
Nitrogen(%)	1.76	1.57	1.76
Phosphorus (%)	0.18	0.15	0.18
Potassium (%)	0.75	0.74	0.75
1990			
Density(%)	75	68	84
Height(m)	1.8	1.9	2.2
Width(m)	1.2	1.4	1.6
Needle Length(mm)	16	24	21
Crown Volume(m <sup>3</sup> )	0.51	0.66	1.24
Nitrogen(%)	1.85	1.86	1.85
Phosphorus (%)	0.16	0.14	0.16
Potassium (%)	0.74	0.67	0.74

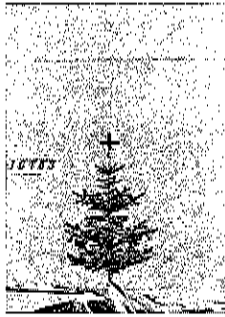
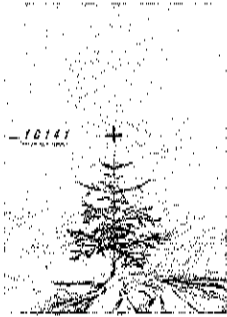
Riversdale (Moderate Fertility)

Light

Moderate

High

1986



1987



1988



1989



1990



## Riversdale (Moderate Fertility)

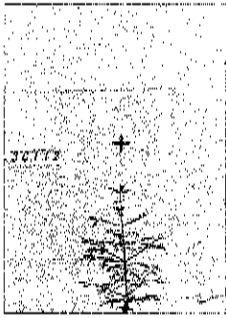
Initial Foliar Density	Block 14 - Tree #1	Block 15 - Tree #3	Block 10 - Tree #1
	Light	Moderate	High
1986			
Density(%)	52	52	67
Height(m)	0.7	0.9	1.2
Width(m)	0.9	0.7	1.3
Needle Length(mm)	16	15	19
Crown Volume(m <sup>3</sup> )	0.07	0.06	0.33
Nitrogen(%)	2.21	2.16	2.31
Phosphorus (%)	0.16	0.16	0.19
Potassium (%)	0.58	0.54	0.65
1987			
Density(%)	69	72	74
Height(m)	0.8	0.9	1.2
Width(m)	0.9	0.9	1.1
Needle Length(mm)	25	15	19
Crown Volume(m <sup>3</sup> )	0.12	0.14	0.28
Nitrogen(%)	2.31	2.22	2.27
Phosphorus (%)	0.18	0.16	0.18
Potassium (%)	0.59	0.56	0.64
1988			
Density(%)	78	85	83
Height(m)	1.2	1.2	1.6
Width(m)	1.1	1	1.2
Needle Length(mm)	33	24	22
Crown Volume(m <sup>3</sup> )	0.27	0.27	0.46
Nitrogen(%)	2.16	2.3	2.3
Phosphorus (%)	0.16	0.15	0.16
Potassium (%)	0.63	0.6	0.56
1989			
Density(%)	80	83	85
Height(m)	1.6	1.7	1.7
Width(m)	1.4	1.3	1.3
Needle Length(mm)	27	21	24
Crown Volume(m <sup>3</sup> )	0.66	0.63	0.64
Nitrogen(%)	2.29	2.08	2.13
Phosphorus (%)	0.19	0.18	0.18
Potassium (%)	0.69	0.58	0.77
1990			
Density(%)	82	82	88
Height(m)	2	1.9	2
Width(m)	1.5	1.6	1.6
Needle Length(mm)	21	18	22
Crown Volume(m <sup>3</sup> )	0.97	1.05	1.18
Nitrogen(%)	1.76	1.57	1.66
Phosphorus (%)	0.16	0.15	0.15
Potassium (%)	0.59	0.49	0.57

Loon Lake #1  
Moderate

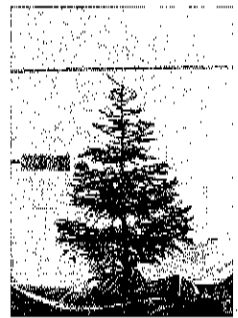
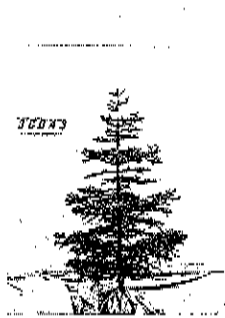
Light

High

1986



1987



1988



1989



1990





## Loon Lake # 1 (Low Fertility)

Initial Foliar Density	Block 11 - Tree #2	Block 4 - Tree #3	Block 18 - Tree #3
	Light	Moderate	High
1986			
Density(%)	41	44	60
Height(m)	0.8	1.2	1.1
Width(m)	0.8	0.8	0.9
Needle Length(mm)	15	14	16
Crown Volume(m <sup>3</sup> )	0.05	0.09	0.14
Nitrogen(%)	1.7	1.7	1.7
Phosphorus (%)	0.17	0.16	0.16
Potassium (%)	0.63	0.58	0.58
1987			
Density(%)	50	59	66
Height(m)	0.8	1.2	1
Width(m)	0.8	0.9	1
Needle Length(mm)	17	14	17
Crown Volume(m <sup>3</sup> )	0.06	0.13	0.16
Nitrogen(%)	1.66	1.62	1.62
Phosphorus (%)	0.17	0.15	0.15
Potassium (%)	0.53	0.5	0.5
1988			
Density(%)	57	63	77
Height(m)	1	1.5	1.4
Width(m)	0.9	1	1.1
Needle Length(mm)	21	18	22
Crown Volume(m <sup>3</sup> )	0.11	0.25	0.31
Nitrogen(%)	1.6	1.55	1.55
Phosphorus (%)	0.15	0.14	0.14
Potassium (%)	0.58	0.51	0.51
1989			
Density(%)	62	67	70
Height(m)	1.1	1.6	2.1
Width(m)	1	1.1	1.2
Needle Length(mm)	19	15	21
Crown Volume(m <sup>3</sup> )	0.16	0.34	0.51
Nitrogen(%)	1.3	1.42	1.42
Phosphorus (%)	0.14	0.14	0.14
Potassium (%)	0.57	0.51	0.51
1990			
Density(%)	59	66	70
Height(m)	1.4	1.9	2.2
Width(m)	1	1.3	1.5
Needle Length(mm)	14	14	16
Crown Volume(m <sup>3</sup> )	0.22	0.55	0.85
Nitrogen(%)	1.05	1.14	1.14
Phosphorus (%)	0.12	0.12	0.12
Potassium (%)	0.47	0.4	0.4

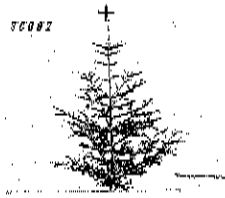
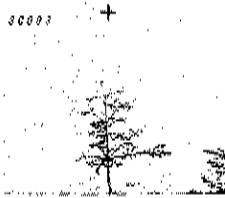
Loon Lake # 1

Light

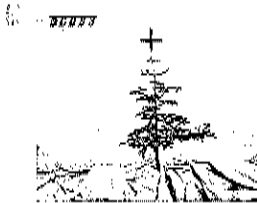
Moderate

High

1986



1987



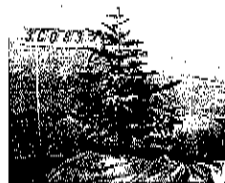
1988



1989



1990



## Loon Lake # 1 (Low Fertility)

Initial Foliar Density	Block 8 - Tree #3	Block 9 - Tree #2	Block 19 - Tree #2
	Light	Moderate	High
1986			
Density(%)	38	48	56
Height(m)	0.6	1.1	1.2
Width(m)	0.7	1	1.1
Needle Length(mm)	15	22	18
Crown Volume(m <sup>3</sup> )	0.03	0.14	0.19
Nitrogen(%)	1.6	1.91	1.97
Phosphorus (%)	0.18	0.17	0.17
Potassium (%)	0.63	0.68	0.64
1987			
Density(%)	47	73	75
Height(m)	0.6	1.2	1.3
Width(m)	0.9	1	1.2
Needle Length(mm)	17	19	18
Crown Volume(m <sup>3</sup> )	0.05	0.21	0.37
Nitrogen(%)	1.46	1.66	1.54
Phosphorus (%)	0.15	0.15	0.14
Potassium (%)	0.48	0.56	0.54
1988			
Density(%)	48	76	78
Height(m)	0.7	1.7	1.6
Width(m)	0.9	1.2	1.1
Needle Length(mm)	15	24	19
Crown Volume(m <sup>3</sup> )	0.06	0.45	0.36
Nitrogen(%)	1.66	1.54	1.76
Phosphorus (%)	0.16	0.14	0.14
Potassium (%)	0.52	0.54	0.49
1989			
Density(%)	63	72	81
Height(m)	0.8	1.6	1.5
Width(m)	0.9	1.3	1.6
Needle Length(mm)	19	27	18
Crown Volume(m <sup>3</sup> )	0.1	0.47	0.76
Nitrogen(%)	1.37	1.27	1.41
Phosphorus (%)	0.15	0.15	0.13
Potassium (%)	0.5	0.59	0.53
1990			
Density(%)	58	76	77
Height(m)	0.9	2.1	2.1
Width(m)	1	1.6	1.6
Needle Length(mm)	15	22	15
Crown Volume(m <sup>3</sup> )	0.12	1.01	1.01
Nitrogen(%)	1.15	1.11	1.21
Phosphorus (%)	0.15	0.14	0.12
Potassium (%)	0.35	0.43	0.41

## **Appendix II**

**A time series of photographs depicting Christmas trees,  
initially with crown defects, sheared for 5 years.**

Dickey Lake (High Fertility)

Block 1

Block 17

1986



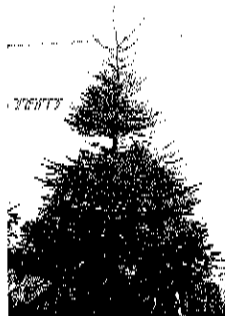
1987



1988



1989



1990



## Dicky Lake (High Fertility)

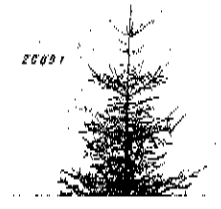
	Block 1 Tree #2	Block 17 Tree #1
1986		
Density(%)	64	62
Height(m)	1.2	1.5
Width(m)	1.2	1.4
Needle Length(mm)	15	15
Crown Volume(m <sup>3</sup> )	0.29	0.48
Nitrogen(%)	2.29	2.36
Phosphorus (%)	0.19	0.2
Potassium (%)	0.77	0.78
1987		
Density(%)	73	79
Height(m)	1.3	1
Width(m)	1.3	1
Needle Length(mm)	24	21
Crown Volume(m <sup>3</sup> )	0.39	0.19
Nitrogen(%)	2.32	2.24
Phosphorus (%)	0.19	0.19
Potassium (%)	0.59	0.76
1988		
Density(%)	77	85
Height(m)	1.8	2.1
Width(m)	1.4	1.7
Needle Length(mm)	24	18
Crown Volume(m <sup>3</sup> )	0.66	1.28
Nitrogen(%)	1.87	2.01
Phosphorus (%)	0.18	0.17
Potassium (%)	0.59	0.65
1989		
Density(%)	78	88
Height(m)	2	2.4
Width(m)	1.4	1.9
Needle Length(mm)	25	20
Crown Volume(m <sup>3</sup> )	0.8	1.99
Nitrogen(%)	1.69	1.57
Phosphorus (%)	0.16	0.15
Potassium (%)	0.64	0.74
1990		
Density(%)	79	87
Height(m)	2.3	2.5
Width(m)	1.6	1.9
Needle Length(mm)	18	19
Crown Volume(m <sup>3</sup> )	1.21	2.05
Nitrogen(%)	1.58	1.86
Phosphorus (%)	0.14	0.14
Potassium (%)	0.63	0.67

Dickey Lake (High Fertility)

Block 8

Block 9

1986



1987



1988



1989



1990



Dicky Lake (High Fertility)

	Block 8 Tree #3	Block 9 Tree #1
1986		
Density(%)	56	54
Height(m)	0.9	1.7
Width(m)	0.4	1
Needle Length(mm)	24	20
Crown Volume(m <sup>3</sup> )	0.02	0.22
Nitrogen(%)	2.34	2.36
Phosphorus (%)	0.21	0.2
Potassium (%)	0.82	0.78
1987		
Density(%)	74	72
Height(m)	1.1	1.7
Width(m)	0.8	1.2
Needle Length(mm)	28	22
Crown Volume(m <sup>3</sup> )	0.14	0.42
Nitrogen(%)	2.18	2.22
Phosphorus (%)	0.19	0.18
Potassium (%)	0.65	0.59
1988		
Density(%)	79	85
Height(m)	1	1.7
Width(m)	0.9	1.5
Needle Length(mm)	21	20
Crown Volume(m <sup>3</sup> )	0.15	0.8
Nitrogen(%)	1.73	1.95
Phosphorus (%)	0.15	0.16
Potassium (%)	0.6	0.63
1989		
Density(%)	79	82
Height(m)	1.7	1.7
Width(m)	1	1.3
Needle Length(mm)	25	25
Crown Volume(m <sup>3</sup> )	0.35	0.62
Nitrogen(%)	1.63	1.77
Phosphorus (%)	0.16	0.12
Potassium (%)	0.7	0.69
1990		
Density(%)	76	81
Height(m)	1.8	1.7
Width(m)	1	1.7
Needle Length(mm)	22	22
Crown Volume(m <sup>3</sup> )	0.36	1.04
Nitrogen(%)	1.92	1.44
Phosphorus (%)	0.18	0.13
Potassium (%)	0.74	0.63

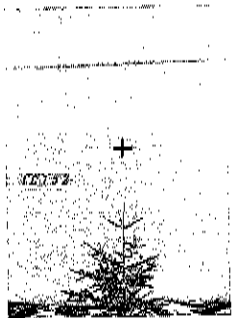


Riversdale (Moderate Fertility)

Block 15

Block 5

1986



1987



1988



1989



1990



## Riversdale (Moderate Fertility)

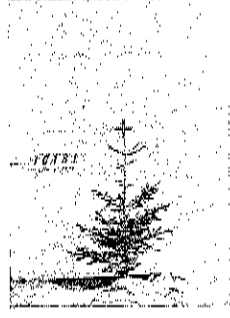
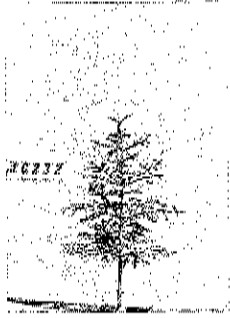
	Block 15 Tree #2	Block 5 Tree #1
1986		
Density(%)	53	53
Height(m)	0.7	1.5
Width(m)	0.9	1.2
Needle Length(mm)	15	17
Crown Volume(m <sup>3</sup> )	0.07	0.3
Nitrogen(%)	2.16	2.21
Phosphorus (%)	0.16	0.16
Potassium (%)	0.54	0.58
1987		
Density(%)	63	69
Height(m)	0.8	1.6
Width(m)	1.1	1.5
Needle Length(mm)	15	18
Crown Volume(m <sup>3</sup> )	0.15	0.65
Nitrogen(%)	2.22	2.31
Phosphorus (%)	0.16	0.18
Potassium (%)	0.56	0.59
1988		
Density(%)	79	83
Height(m)	1.2	1.9
Width(m)	1.1	1.5
Needle Length(mm)	24	23
Crown Volume(m <sup>3</sup> )	0.27	0.93
Nitrogen(%)	2.3	2.16
Phosphorus (%)	0.15	0.16
Potassium (%)	0.6	0.63
1989		
Density(%)	76	85
Height(m)	1.7	2.6
Width(m)	1.4	1.9
Needle Length(mm)	21	20
Crown Volume(m <sup>3</sup> )	0.66	1.97
Nitrogen(%)	2.08	2.29
Phosphorus (%)	0.18	0.19
Potassium (%)	0.58	0.69
1990		
Density(%)	79	86
Height(m)	2	1.9
Width(m)	1.5	2.2
Needle Length(mm)	18	18
Crown Volume(m <sup>3</sup> )	0.93	2.08
Nitrogen(%)	1.57	1.76
Phosphorus (%)	0.15	0.16
Potassium (%)	0.49	0.59

Riversdale (Moderate Fertility)

Block 23

Block 18

1986



1987



1988



1989



1990



## Riversdale (Moderate Fertility)

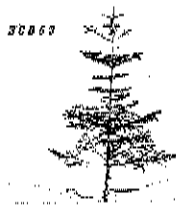
	Block 23 Tree #2	Block 18 Tree #1
1986		
Density(%)	55	48
Height(m)	0.9	1.1
Width(m)	0.8	0.6
Needle Length(mm)	13	20
Crown Volume(m <sup>3</sup> )	0.08	0.06
Nitrogen(%)	2.18	2.31
Phosphorus (%)	0.18	0.19
Potassium (%)	0.57	0.65
1987		
Density(%)	64	63
Height(m)	1.1	1.1
Width(m)	1	1
Needle Length(mm)	21	20
Crown Volume(m <sup>3</sup> )	0.18	0.16
Nitrogen(%)	2.43	2.27
Phosphorus (%)	0.18	0.18
Potassium (%)	0.6	0.64
1988		
Density(%)	77	72
Height(m)	1.4	1.5
Width(m)	1.1	1.1
Needle Length(mm)	26	24
Crown Volume(m <sup>3</sup> )	0.34	0.31
Nitrogen(%)	2.26	2.3
Phosphorus (%)	0.16	0.16
Potassium (%)	0.61	0.56
1989		
Density(%)	82	71
Height(m)	1.8	1.8
Width(m)	1.4	1.4
Needle Length(mm)	24	25
Crown Volume(m <sup>3</sup> )	0.71	0.66
Nitrogen(%)	2.03	2.13
Phosphorus (%)	0.17	0.18
Potassium (%)	0.76	0.77
1990		
Density(%)	81	76
Height(m)	2.2	2
Width(m)	1.7	1.5
Needle Length(mm)	20	19
Crown Volume(m <sup>3</sup> )	1.35	0.89
Nitrogen(%)	1.64	1.66
Phosphorus (%)	0.14	0.15
Potassium (%)	0.54	0.57

Loon Lake # 1 (Low Fertility)

Block 6

Block 18

1986



1987



1988



1989



1990



## Loon Lake # 1 (Low Fertility)

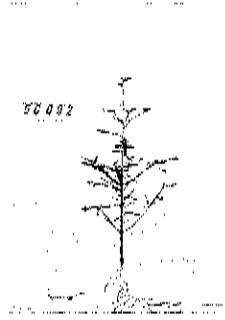
	Block 6 Tree #3	Block 18 Tree #2
1986		
Density(%)	43	50
Height(m)	1.1	1
Width(m)	0.7	0.8
Needle Length(mm)	21	16
Crown Volume(m <sup>3</sup> )	0.05	0.07
Nitrogen(%)	1.6	1.7
Phosphorus (%)	0.18	0.16
Potassium (%)	0.63	0.58
1987		
Density(%)	59	65
Height(m)	1.3	1
Width(m)	0.9	0.9
Needle Length(mm)	22	17
Crown Volume(m <sup>3</sup> )	0.16	0.14
Nitrogen(%)	1.46	1.62
Phosphorus (%)	0.15	0.15
Potassium (%)	0.48	0.5
1988		
Density(%)	66	72
Height(m)	1.5	1.4
Width(m)	1.1	1.1
Needle Length(mm)	27	22
Crown Volume(m <sup>3</sup> )	0.29	0.29
Nitrogen(%)	1.66	1.55
Phosphorus (%)	0.16	0.14
Potassium (%)	0.52	0.51
1989		
Density(%)	64	75
Height(m)	1.8	1.6
Width(m)	1.2	1.2
Needle Length(mm)	21	21
Crown Volume(m <sup>3</sup> )	0.43	0.45
Nitrogen(%)	1.37	1.42
Phosphorus (%)	0.15	0.14
Potassium (%)	0.5	0.51
1990		
Density(%)	71	72
Height(m)	2.1	1.9
Width(m)	1.5	1.5
Needle Length(mm)	16	16
Crown Volume(m <sup>3</sup> )	0.82	0.75
Nitrogen(%)	1.15	1.14
Phosphorus (%)	0.15	0.12
Potassium (%)	0.35	0.4

St. Margaret's Bay (Low Fertility)

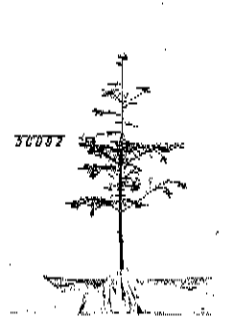
Block 8

Block 9

1986



1987



1988



1989



1990



## St. Margaret's Bay (Low Fertility)

	Block 8 Tree #1	Block 9 Tree #2
1986		
Density(%)	63	30
Height(m)	1.7	1.1
Width(m)	1.3	0.6
Needle Length(mm)	14	21
Crown Volume(m <sup>3</sup> )	0.44	0.03
Nitrogen(%)	2.1	2.3
Phosphorus (%)	0.19	0.21
Potassium (%)	0.63	0.59
1987		
Density(%)	75	42
Height(m)	2.1	1.1
Width(m)	1.4	1
Needle Length(mm)	21	19
Crown Volume(m <sup>3</sup> )	0.8	0.12
Nitrogen(%)	1.98	2.15
Phosphorus (%)	0.17	0.18
Potassium (%)	0.64	0.55
1988		
Density(%)	79	53
Height(m)	2.2	1.1
Width(m)	1.5	0.8
Needle Length(mm)	20	24
Crown Volume(m <sup>3</sup> )	0.95	0.09
Nitrogen(%)	1.91	2.01
Phosphorus (%)	0.16	0.16
Potassium (%)	0.65	0.56
1989		
Density(%)	78	59
Height(m)	3.1	1.1
Width(m)	2	0.9
Needle Length(mm)	28	24
Crown Volume(m <sup>3</sup> )	2.4	0.12
Nitrogen(%)	1.94	1.99
Phosphorus (%)	0.18	0.17
Potassium (%)	0.73	0.79
1990		
Density(%)	83	62
Height(m)	2.9	1.6
Width(m)	2	1.2
Needle Length(mm)	22	20
Crown Volume(m <sup>3</sup> )	2.41	0.37
Nitrogen(%)	1.69	1.64
Phosphorus (%)	0.16	0.14
Potassium (%)	0.63	0.66



### Appendix III

#### Glossary of terms used in Appendices I and II

Initial Foliar Density	Visual estimate of the initial foliage density (light, moderate, or high) made by examining photographs.
Density (%) (DEN)	<p>Percent of crown outline covered by foliage; determined by superimposing projected slide of the tree onto a grid pattern. The general outline of the crown was drawn by connecting lines between the tip of the branches of major whorls. Within this outline, the number of dots covered and not covered by foliage were counted. The foliage Density was then calculated as:</p> $\text{Density (\%)} = \frac{\text{AREA}_{\text{fol}}}{\text{AREA}_{\text{crown}}} \times 100$ <p>where,</p> <p>AREA<sub>fol</sub> = number of dots covered by foliage, and          AREA<sub>crown</sub> = total number of dots within crown outline.</p>
Height (CH)	Height of live crown in metres. The maximum and minimum crown heights were measured in the field and averaged.
Width (CW)	Width of the base of the live crown. The maximum and minimum widths were measured in the field and averaged.
Volume	<p>The volume of the live crown, in cubic metres, calculated according to the following formula (volume of right circular cone):</p> $\text{Volume} = \text{CW}^2 \times \text{CH} \times \text{DEN} \times 0.002618$ <p>where,</p> <p>CW = crown width (m)          CH = crown height (m)          DEN = crown density (%)</p>
Nitrogen (%) Phosphorous (%) Potassium (%)	Foliage nutrient content. Sampled from current years growth of a lateral shoot in the upper third of the crown on 3-5 trees per block.
Needle length	Length of average needle in millimetres taken from the mid-point of the shoots used for the foliar analysis.

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