FOREST RESEARCH REPORT
Nova Scotia Department of Natural Resources

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NOVA SCOTIA

Report FOR 2015-2 No. 94

Survival and growth of out-planted small (Jiffy®1842) vs. regular (Jiffy®3065) plantation stock

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Introduction

Planting with small seedlings has several potential advantages compared to regular sized seedlings.

Smaller seedlings require less time to grow and take up less space resulting in lower nursery costs (Betts *et al*., 2005). In addition, reductions in handling when out-planting could result in lower establishment costs.

In Scandinavia, small seedlings have incurred less debarking weevil (Hylobius *congener*) damage (Gyldberg and Lindstrom, 1999, Lyndstrom *at al*., 2000, 2001). The seedling debarking weevil can cause high mortality (Pendrel *et al*., 1990) in plantations established within 2 years of harvest (hot planting). Because of this, plantations are typically established after a 2 year delay in high weevil population areas. This delay allows competing vegetation to dominate sites, thereby reducing growth and survival of planted trees, when competition is not controlled.

Jiffy® - Jiffy forestry pellets are soft-walled, meshed seedling containers. http://www.stuewe.com/products/datasheets/jiffy.pdf

Objective

It is predicted that if small stock can be successfully established shortly after harvest, debarking weevil damage can be avoided with the added advantage of reduced vegetation competition, while lowering reforestation costs.

The objective of this report is to assess the success of small seedlings. This objective was addressed using three trial types;

1) **Preliminary Trials:** Three sites (Figure 1: Kerrs Mill, Crowes Mills, and South Victoria) were planted with seedlings of various sizes. The main focus of these preliminary trials was to refine the small stock nursery methods and to evaluate Hylobius feeding preferences regarding seedling size, species, and season of planting.

2) **Experimental Trials**: Four trial sites (Figure 1: Lake Road, Upper Brookfield, Wentworth, West River) were planted with small seedlings (produced with refined growing methods) and regular seedlings so that the two could be compared for survival. The seedlings were planted by NSDNR staff under controlled conditions.

3) **Operational Plantings**: Nine sites (Figure 1) were planted operationally with small stock to verify experimental results. No regular sized seedlings were planted at these sites.

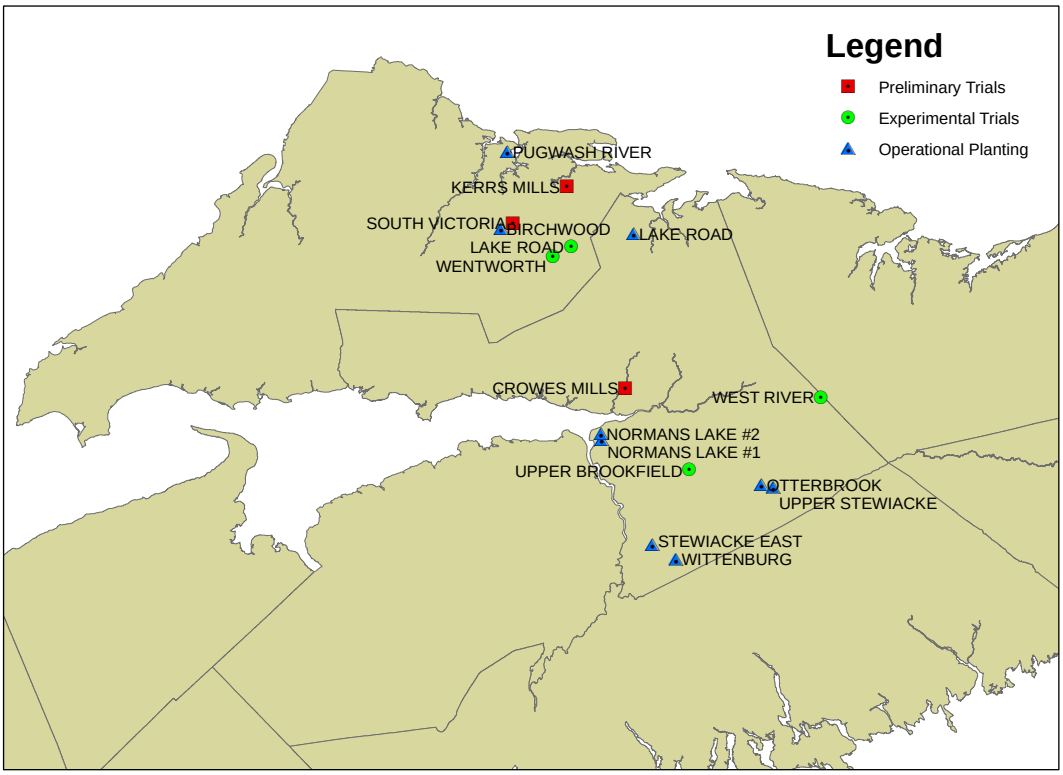

Figure 1. The locations of the preliminary trials, experimental trials, and operational plantings in Nova Scotia.

Methods

Preliminary Trials: Small, medium and regular sized seedlings of both Norway and black spruce were hot planted between 2001-2003 using a hoe pipe (Robertson and Young 1988). All seedlings were grown in Jiffy® forestry pellets (Jiffy® Forestry Pellets 2013). The intent was to test Hylobius feeding preference by seedling size, species and season of planting. Slash was moved off the treatment blocks. The experimental design included 4 replicates of 100 seedlings at each site planted at two foot (0.6m) spacing. Traps were utilized to verify debarking weevil population levels. In an effort to reduce costs, nursery growing time was minimized and the small and medium seedlings were not hardened off (Scagel *et al.* 1998) before out-planting,

Experimental Trials: Small and regular seedlings of both Norway spruce and black spruce were planted in the fall (September 26-28, 2005) and the following spring (May 15-16, 2006) at 2 foot (0.6m) spacing using hoe pipes. The small seedlings were grown in Jiffy® forestry pellets (J1842) and the regular seedlings were grown in Jiffy® forestry pellets (J3065). The intent was to test the effect of seedling size, species, and season of planting on survival and growth. The experimental design resulted in eight treatment combinations. Each combination was randomly assigned to one of eight blocks. Each block contains 100 seedlings. All study sites were operationally site prepared using barrels and chains (NSDNR 1993) and weeded with Glyphosate herbicide before planting. The plantations were established two years following harvest. Refined nursery growing methods were used, including longer growing times and hardening off seedlings before out-planting.

Operational Plantings: Nine sites were operationally hot planted at 2,000 trees/ha with small seedlings using pottiputkis (Robertson and Young, 1988) on small private lands managed by GroFor (4 in the fall of 2006, and 5 in the spring of 2007). The small seedlings were grown in Jiffy® forestry pellets (J1842). Two hundred seedlings at each site were flagged and measured. The 200 seedlings were laid out in 20 lines of 10 seedlings. The lines were distributed throughout the plantation. Survival and growth of small seedlings were tracked in these trials. Refined growing methods were used (same as for Experimental trials).

Results

Preliminary Trials

Three study sites were hot planted in Nova Scotia with various seedling sizes (Table 1 and 2). Hylobius lure traps were set up at Kerrs Mills and Crowes Mills indicating high levels of Hylobius.

Table 1. The site and stock type characteristics for preliminary trials.

				Small		Medium		Regular	
Location	Year Harv.	Year Plant	Season Plant	Age	Plug (mm)	Age	Plug (mm)	Age	Plug (mm)
Kerrs Mills	2000	2001	Fall	11weeks	J18x42	18weeks	J30x65	1+0	J30x65
Crowes Mills	2001	2002	Spring	8weeks	J18x42	1+0	J18x42	1+0	J30x65
South Victoria	2002	2003	Spring	10weeks	J18x42			1+0	J30x65
South Victoria	2002	2003	Fall	7weeks	J30x65			1+0	J30x65

Table 2. The average root collar diameters (Dia) and heights (HT) of the various stock types at time of planting for preliminary trials.

Location	Small				Medium				Regular			
	Black Spruce		Norway Spruce		Black Spruce		Norway Spruce		Black Spruce		Norway Spruce	
	Dia (mm)	HT (cm)	Dia (mm)	HT (cm)	Dia (mm)	HT (cm)	Dia (mm)	HT (cm)	Dia (mm)	HT (cm)	Dia (mm)	HT (cm)
Kerrs Mill	0.49	5.6	0.63	5.5	0.88	12.2			1.48	16.4		
Crowes Mills	0.31	1.0	0.52	1.6	0.95	7.5	1.42	6.2	2.35	16.4	3.00	21.0
South Victoria (spring)	0.32	3.5	0.55	4.2					2.05	26.2	3.23	25.3
South Victoria (fall)	0.19	3.1	0.31	3.3					2.14	19.4	2.27	18.1

Hylobius Damage

There were two trends evident regarding Hylobius damage. (i) There was generally less Hylobius induced mortality/damage detected in the small seedlings compared to the larger seedlings (Figure 2,3,4). For example, at Crowes Mills (Figure 3) 32% of the black spruce regular sized seedlings died from Hylobius feeding compared to 2% of the small black spruce. (ii) At Crowes Mills, where Hylobius damage occurred, the regular sized seedlings survived feeding more frequently than the medium sized seedlings (Figure 3). This is attributed to the larger root collar diameter of the Norway spruce regular stock (Table 2: Regular=3.00mm, Medium=1.42mm). Despite being debarked around the root collar, the larger seedlings are less frequently completely girdled (NSDLF, 1988).

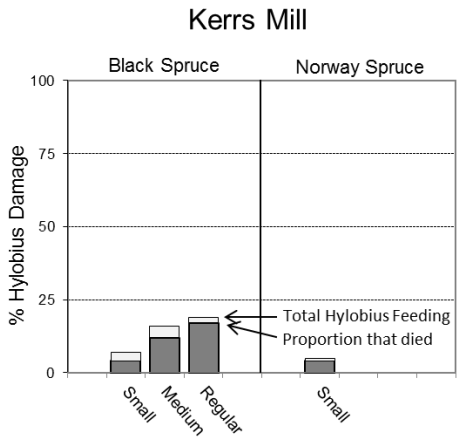

Figure 2. The hylobius induced mortality/damage to small, medium, and regular sized seedlings one year after hot planting at Kerrs Mill in Nova Scotia (planted fall 2001, assessed fall 2002).

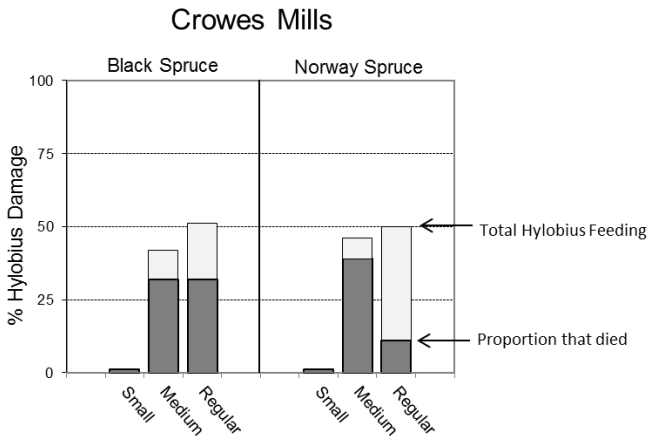

Figure 3. The hylobius induced mortality/damage to small, medium, and regular sized seedlings at the end of the first growing season after hot planting at Crowes Mills in Nova Scotia (planted spring 2002, assessed fall 2002).

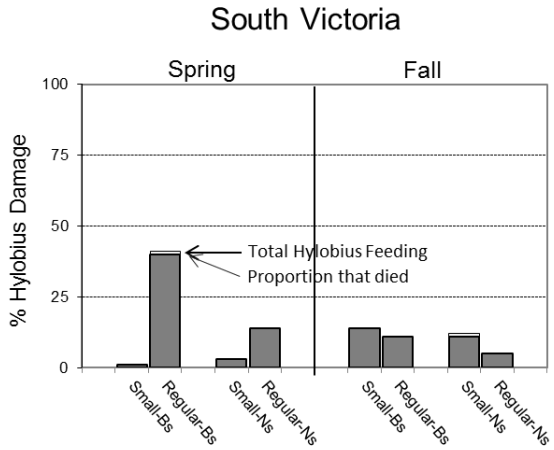

Figure 4. The hylobius induced mortality/damage to small and regular sized seedlings at the end of one growing season after hot planting at South Victoria in Nova Scotia.
Spring: planted June 2003 - assessed Fall 2003
Fall: planted Sept 2003 - assessed Fall 2004.

Survival and Height

Over all species the average survival of the small stock was 41%, medium was 53%, and regular was 68% (Table3). The poor survival of the small and medium spring-planted stock was mainly due to the seedlings not being hardened off (Scagel *et al.* 1998) at the nursery prior to planting. This caused them to be susceptible to frost and drought.

Table 3. Comparing the survival and height of small, medium, and regular sized seedlings 5 years after planting on preliminary trial sites.

			Survival (%)			Height (cm)		
Location	Season	Species	Small	Medium	Regular	Small	Medium	Large
Kerrs Mill	Fall	Bs	57	64	64	124	143	151
		Ns	58			77		
		Avg.	**58**	**64**	**64**	**101**	**143**	**151**
Crowes Mills	Spring	Bs	28	45	56	68	90	132
		Ns	19	38	69	18	45	89
		Avg.	**24**	**42**	**63**	**43**	**68**	**111**
South Victoria	Spring	Bs	20		55	63		105
		Ns	31		82	38		81
	Fall	Bs	56		83	55		73
		Ns	61		90	35		60
		Avg.	**42**		**78**	**48**		**80**
		Avg.	41	53	68	64	105	114

Experimental Trials

Seedling Size

Figure 5 and Table 4 shows the average size of the small (J1842) and regular seedlings (J3065) prior to planting for the experimental trials and operational plantings. The small seedlings had smaller plugs, were shorter, and had smaller root collar diameters than the regular stock. The small and regular stock were both grown in jiffy® forestry pellets. Pellet sizes were 18x42 mm for the small and 30x65 mm for the regular stock. All seedlings were grown at the Northern Pulp nursery in Nova Scotia. The small seedlings for the experimental trials were larger than for the preliminary trials in root collar diameter and height. They were hardened off before out-planting

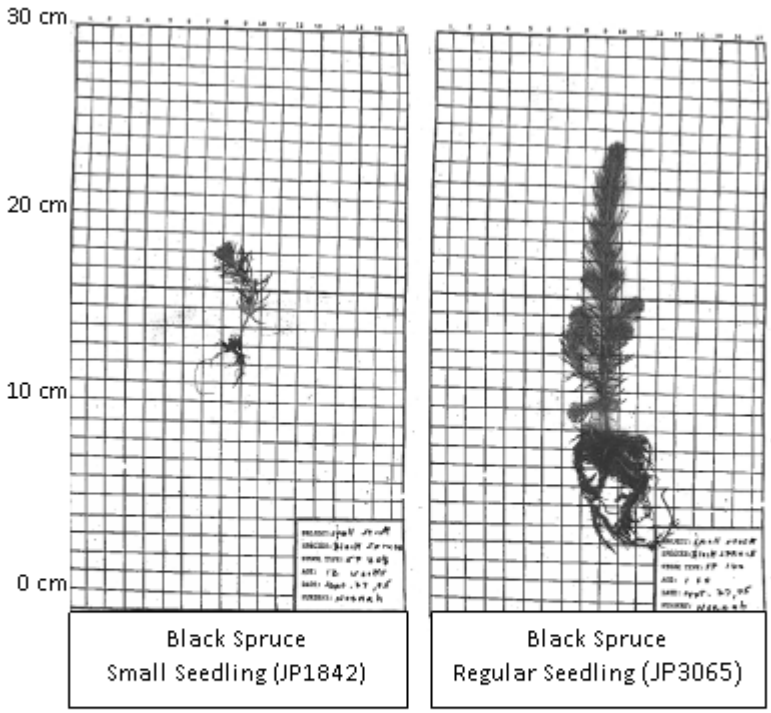

Figure 5. The images represent the average black spruce small seedling relative to the average black spruce regular seedling.

Table 4. The age and size of small seedlings vs. regular seedlings for the experimental trials and the operational plantings.

	Age	Plug	Black Spruce		Norway Spruce	
		Diameter x Depth (mm x mm)	Height (cm)	Root Collar Diameter (mm)	Height (cm)	Root Collar Diameter (mm)
Small Seedlings	12 weeks	18x42	6	0.8	6	1.3
Regular Seedlings	1+0	30x65	17	1.8	18	2.4

Survival

Figure 6 shows the average survival over all experimental trial sites broken down by species, season of planting and stock size. In all cases the average survival was lower for small stock. Overall, the survival of small seedlings was 18% less than regular (fall=24%, spring= 12%)(Table 5). The survival of small seedlings planted in the fall was 60% and regular was 84%; the survival of small seedlings planted in the spring was 77% and regular was 89%. The poor survival of small stock planted in the fall was mainly due to frost heaving (NSDNR, 1992) at the West River site (see frost heaving section page 8). Despite the overall results, there were some cases where the small stock performed as well as regular stock. For example, at Lake Road when black spruce was planted in the spring, survival was 3% higher and average height 10cm taller than the normal stock. Results for each individual site are presented in the appendices (Appendix 1, 2 & 3),

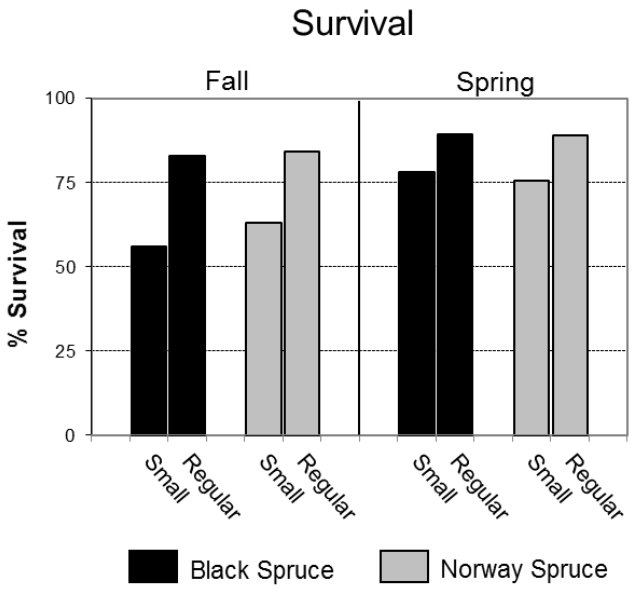

Figure 6. The five year survival of small seedlings compared to regular seedlings planted in the spring and fall on four sites.

Table 5. The five year survival of small seedlings compared to regular seedlings on the four experimental trial sites.

	Fall	Spring	Total
Small Seedlings	60%	77%	69%
Regular Seedlings	84%	89%	87%
Difference	24%	12%	18%

Frost Heaving

The highest level of frost heaving occurred at West River. Fourty-four percent of the seedlings were heaved at West River compared to 8% or less at the other sites (Table 6 and Appendix 1). Previous studies have associated increased frost heaving with planting in mineral soil microsites on heavier soils (NSDNR, 1992). At West River 34% of the seedlings were planted in mineral soil microsites, compared to 7% or less at the other sites. This may have accounted for the higher levels of frost heaving at West River.

Table 6. The soil composition and planting microsite of the four experimental trial sites in relation to frost heaving.

		Soil Composition			Planting Microsite	
	Soil Type[1]	Silt	Clay	Total	Exposed Mineral Soil	% Frost Heaving
West River	ST6	36%	22%	58%	34%	44%
Upper Brookfield	ST6	33%	23%	56%	7%	8%
Lake Road	ST3L	41%	11%	52%	5%	7%
Wentworth	ST2	32%	11%	43%	3%	2%

[1]Soil Type - soil types are described in Keys *et al.* 2010.

Further examination of frost heaving at West River shows higher frost heaving rates occurred when trees were planted in mineral soil microsites compared to humus microsites for both spring and fall planting seasons and small and regular stock sizes (Figure 7). For example, when small seedlings were planted in the fall on mineral soils, 80% heaved compared to only 18% for those planted in humus.

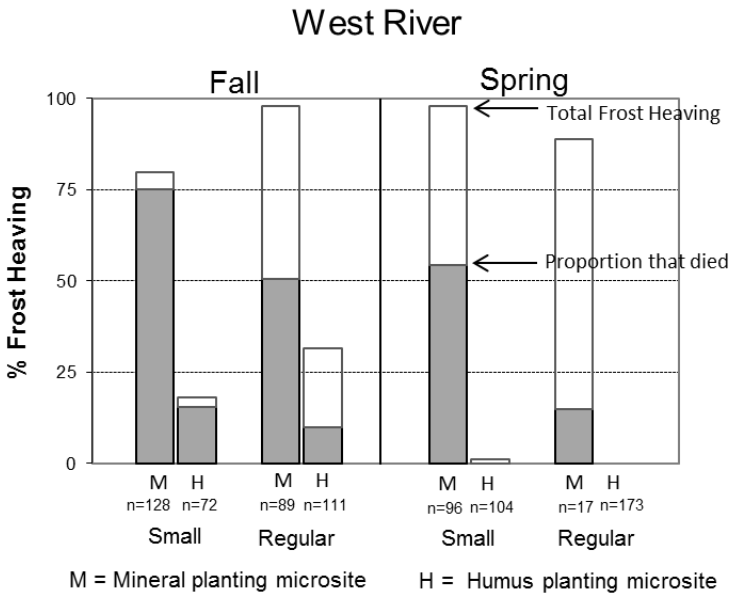

Figure 7. The frost heaving that occurred at West River.

Although the rate of frost heaving was consistently higher for mineral soil microsites, the rate of mortality for heaved seedlings was not uniform across seedling size and planting season. The small seedlings planted in the fall, died more frequently when frost heaving occurred. For example at West River, 94% of the frost-heaved small-seedlings planted in the fall died compared to only 52% for the regular sized seedlings planted in the fall and only 17% for regular sized stock planted in the spring (Figure 7). The smaller seedlings could not survive frost heaving as frequently as the regular sized seedlings due to their smaller root systems. This situation was compounded when small seedlings were planted in the fall, since they did not have as long a period for root growth compared to those planted in the spring. Planting small stock in the fall on mineral sites, where fine soils are present, is especially risky due to the potential for frost heaving mortality.

If West River is excluded, the survival of small seedlings planted in the fall was 71% and regular seedlings was 88%; the survival of small seedlings planted in the spring was 80% and regular was 87% after 5 years (Figure 8).

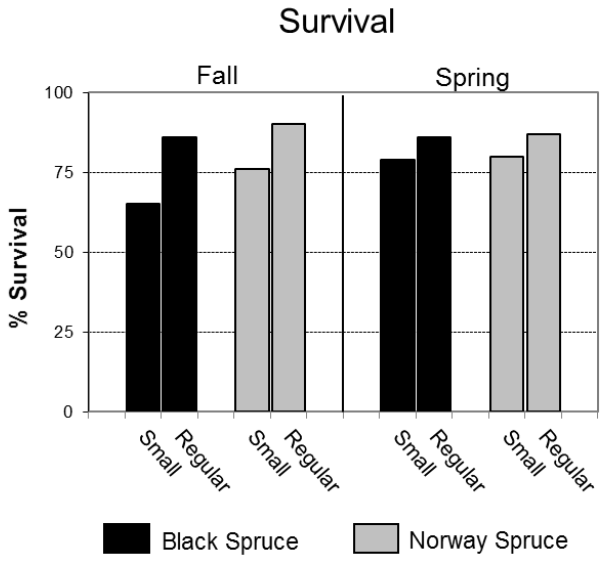

Figure 8. The five year survival of small seedlings compared to regular seedlings planted in the spring and fall on three sites (West River excluded).

Height

After 5 years, the regular seedlings averaged 20 cm taller than the small seedlings (Figure 9 and Table 7). The average height of the small black spruce seedlings were 104 cm compared to 121 cm for regular seedlings; the Norway spruce small seedlings were 62 cm compared to 85 cm for regular seedlings (Table 7). The height difference between regular and small seedlings has increased by 6 cm for black spruce and 11 cm for Norway spruce over the five years of growth. Initially the small seedlings were 11-12 cm smaller than regular size seedlings.

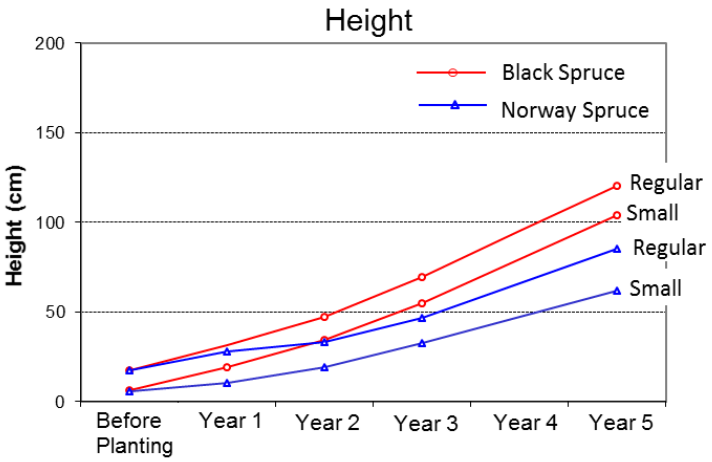

Figure 9. The average height of the small seedlings compared to the regular seedlings 5 years after planting on 4 sites.

Table 7. The five year height of small seedlings compared to regular seedlings on the four experimental trial sites.

	Black Spruce	**Norway Spruce**	**Total**
Small Seedlings	104 cm	62 cm	83 cm
Regular Seedlings	121 cm	85 cm	103 cm
Difference	17 cm	23 cm	20 cm

Competition

At year 5, a greater proportion of the small seedlings are experiencing moderate to severe competition compared to the regular seedlings (Figure 10).The highest competition indices occurred at West River, Lake Road, and Wentworth (Table 8: West River small =95, Lake Road small=74, and Wentworth small=73). The largest competitor(s) at (i) Lake Road is grey birch (ii) at Wentworth is pin cherry, (iii) at Upper Brookfield is red maple, white birch and blackberry and (iv) at West River is aster and goldenrod (Table 8). A photo of each site at year 1 is in appendix 4. All four experimental trial sites were manually weeded removing competing trees. Upper Brookfield was site prepared with herbicides and Lake Road was sprayed with herbicides once after it was planted.

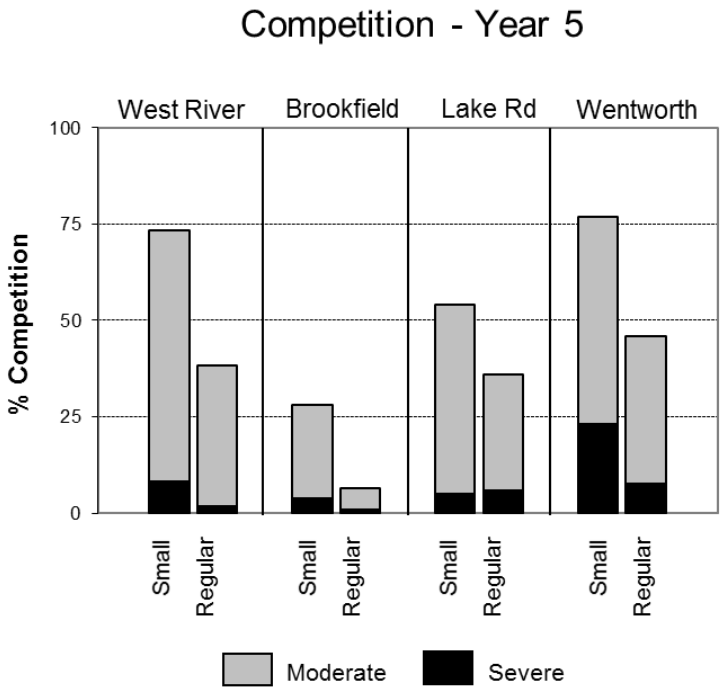

Figure 10. The percent of seedlings experiencing moderate and severe competition at the four trial sites.

West River

	Year 1						Year 5					
	Competition		Small		Regular		Competition		Small		Regular	
	% Cov	Ht	Ht Planted	Comp. Index	Ht Planted	Comp. Index	% Cov	Ht	Ht Planted	Comp. Index	Ht Planted	Comp. Index
Yellow birch	4	20	13	6	26	3	5	100	68	7	83	6
White birch							5	70		5		4
Aster	20	40		64		31	35	70		36		30
Goldenrod	10	40		32		16	35	70		36		30
Raspberry	5	30		12		6	10	40		6		5
Black Berry							10	30		4		4
Grass	15	30		36		18						
Total				150		74				95		78

Upper Brookfield

	Year 1						Year 5					
	Competition		Small		Regular		Competition		Small		Regular	
	% Cov	Ht	Ht Planted	Comp. Index	Ht Planted	Comp. Index	% Cov	Ht	Ht Planted	Comp. Index	Ht Planted	Comp. Index
Red maple	4	65	14	19	31	8	5	80	94	4	114	4
White birch	5	73		27		12	5	100		5		4
Blackberry	5	70		25		11	5	80		4		4
Raspberry	20	70		102		45						
Grass	12	50		44		19						
Bristly Aralia	18	55		72		32						
Grey birch	1	80		6		3						
Total				294		129				14		11

Lake Road

	Year 1						Year 5					
	Competition		Small		Regular		Competition		Small		Regular	
	% Cov	Ht	Ht Planted	Comp. Index	Ht Planted	Comp. Index	% Cov	Ht	Ht Planted	Comp. Index	Ht Planted	Comp. Index
Grey Birch			14		28		35	100	60	58	67	52
White birch	5	30		11		5	5	100		8		7
Sedge	9	45		29		15	5	90		8		7
Pin cherry	5	30		11		5						
Bristly Aralia	24	25		43		22						
Red maple	1	40		3		1						
Raspberry	1	50		4		2						
Total				100		51				74		66

Wentworth

	Year 1						Year 5					
	Competition		Small		Regular		Competition		Small		Regular	
	% Cov	Ht	Ht Planted	Comp. Index	Ht Planted	Comp. Index	% Cov	Ht	Ht Planted	Comp. Index	Ht Planted	Comp. Index
Pin cherry	42	65	19	146	35	79	40	170	109	62	148	46
White birch	5	40		11		6	5	170		8		6
Raspberry	3	50		8		4	5	60		3		2
Bristly Aralia	40	33		70		38						
Red maple	1	50		3		1						
Total				237		128				73		54

Table 8. The competition index at year 1 and year 5 at the four trial sites. Competition index takes into account the percent cover of the competition and also the height of the competition relative to the height of the planted stock.

$\sum_{i=species}$ (% Competition Cover$_i$ x Competition Height$_i$) / Height Planted

Operational Plantings

Nine sites were operationally planted with only small seedlings; the results are presented in Figure 11 and 12. The same nursery growing methods were used as in the Experimental Trials. The 5-year survival of the small stock planted in the fall averaged 62% compared to 76% for those planted in the spring (Figure 11). The average height of the small seedlings across all sites was 83 cm five years after planting (Figure 12). The results for each individual site are also presented in appendix 5. The survival and growth results for the operational plantings is similar to those for the experimental trials. The survival of small stock in fall operational plantings was 62% compared to 60% for the experimental trials, and spring operational plantings was 76% compared to 77% for the experimental trials. The average height of operationally planted small stock and the experimental trials were both 83cm after 5 years.

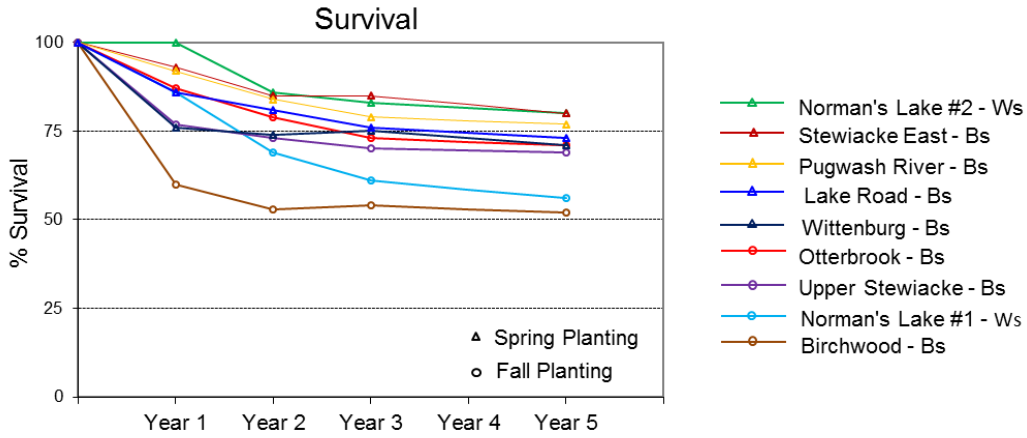

Figure 11. The survival of operationally planted small seedlings (JP1842) five years after planting on nine sites.

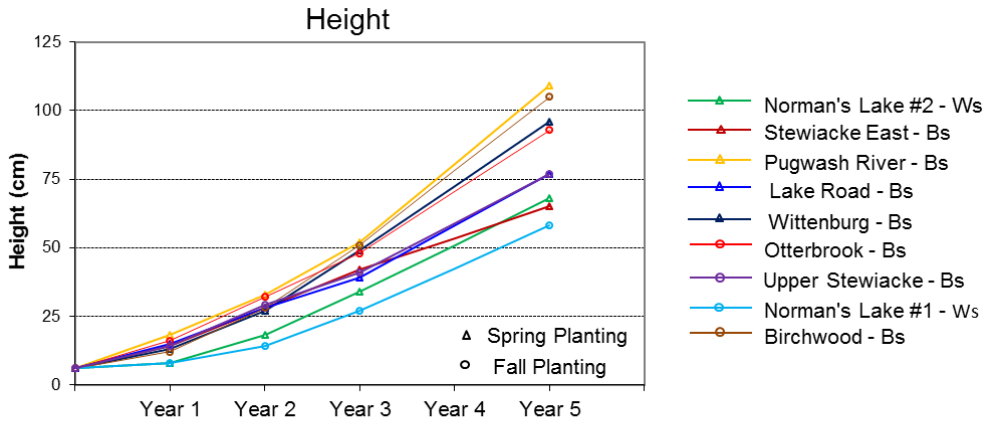

Figure 12. The height of operationally planted small seedlings (JP1842) five years after planting on nine sites.

Summary

Preliminary Trials

- Hylobius damage was more frequently detected for regular sized seedlings compared to smaller seedlings. This was particularly evident at Crowes Mills where far more regular sized black spruce seedlings died because of Hylobius compared to the small (Regular=32%, Small=2%).
- The regular sized Norway spruce seedlings survived Hylobius feeding better than the medium small sized seedlings. This is attributed to the larger root collar diameter of the Norway spruce regular stock (Regular=3.00mm, Medium=1.42mm). Despite being debarked around the root collar, the larger seedlings are less frequently completely girdled.
- The small stock suffered high mortality even with reduced Hylobius related mortality (Survival: small 41%, medium 53%, and regular 68%). The poor survival is attributed to the seedlings not being hardened off at the nursery prior to planting which made them susceptible to frost and drought. As a result, nursery growing methods for the small stock were modified for the Experimental and Operational Trials.

Experimental Trials

- After five years, the survival of small seedlings planted in the fall was 60% compared to 84% for regular seedlings. Spring planted small stock performed better; achieving 77% survival compared to 89% for regular stock.
- The poor survival of small stock planted in the fall was mainly due to frost heaving.
- Small stock that was planted on a site with fine textured soils (silt and clay) in exposed mineral soil microsites had considerable frost heaving mortality; small seedlings (spring=26%, fall =50%), regular seedlings (spring=2%, fall =26%).
- If the site with the frost heaving problem (West River) is excluded, the survival of small seedlings planted in the fall improved to 71% compared to 88% for regular seedlings. Survival for small stock further improved when planted in the spring to 80% compared to 87% for regular stock after 5 years.
- After 5 years, the regular seedlings are 20 cm taller than the small seedlings. The average height of the small seedlings was 83 cm and regular seedlings was 103 cm. This represents a 6 cm increase for black spruce and an 11 cm increase for Norway spruce over the initial height differential between small and regular stock of 11-12cm.

Operational Plantings

- After five years, the average survival of the operational small stock plantations was 62% for those planted in the fall and 76% for those planted in the spring.
- The operationally planted small seedlings were 83 cm after 5 years.
- The operational planting results were almost identical to the experimental trials, indicating experimental trial results are repeatable operationally.

Conclusions

The survival of small seedlings planted in the spring was 12% less than regular seedlings (Small=77%, Regular=89%). It is not advisable to fall plant small seedlings in exposed mineral microsites on sites with fine textured soils because of the increased risk of frost heaving. However, small seedlings were successful under certain conditions (sites not prone to frost heaving where maintenance was performed when needed). Hardening-off small seedlings at the nursery prior to planting is necessary for survival in drought and frost conditions. Hylobius seem to prefer regular sized seedlings, so the use of small seedlings in hot planting situations on sites that are prone to Hylobius shows potential. There is an opportunity for nursery and planting program savings when using smaller seedlings; however, these up-front savings should be balanced against the increase in mortality and potential for lower yields.

Acknowledgments

Thanks to Jan Ellingsen (formerly of GroFor) for bringing the idea of small stock to Nova Scotia and assisting every step of the way through this effort. Tom Matheson (formerly of Northern Pulp) was also indispensable to this project by growing the seedlings for this project and helping to develop effective nursery methods for growing small stock.

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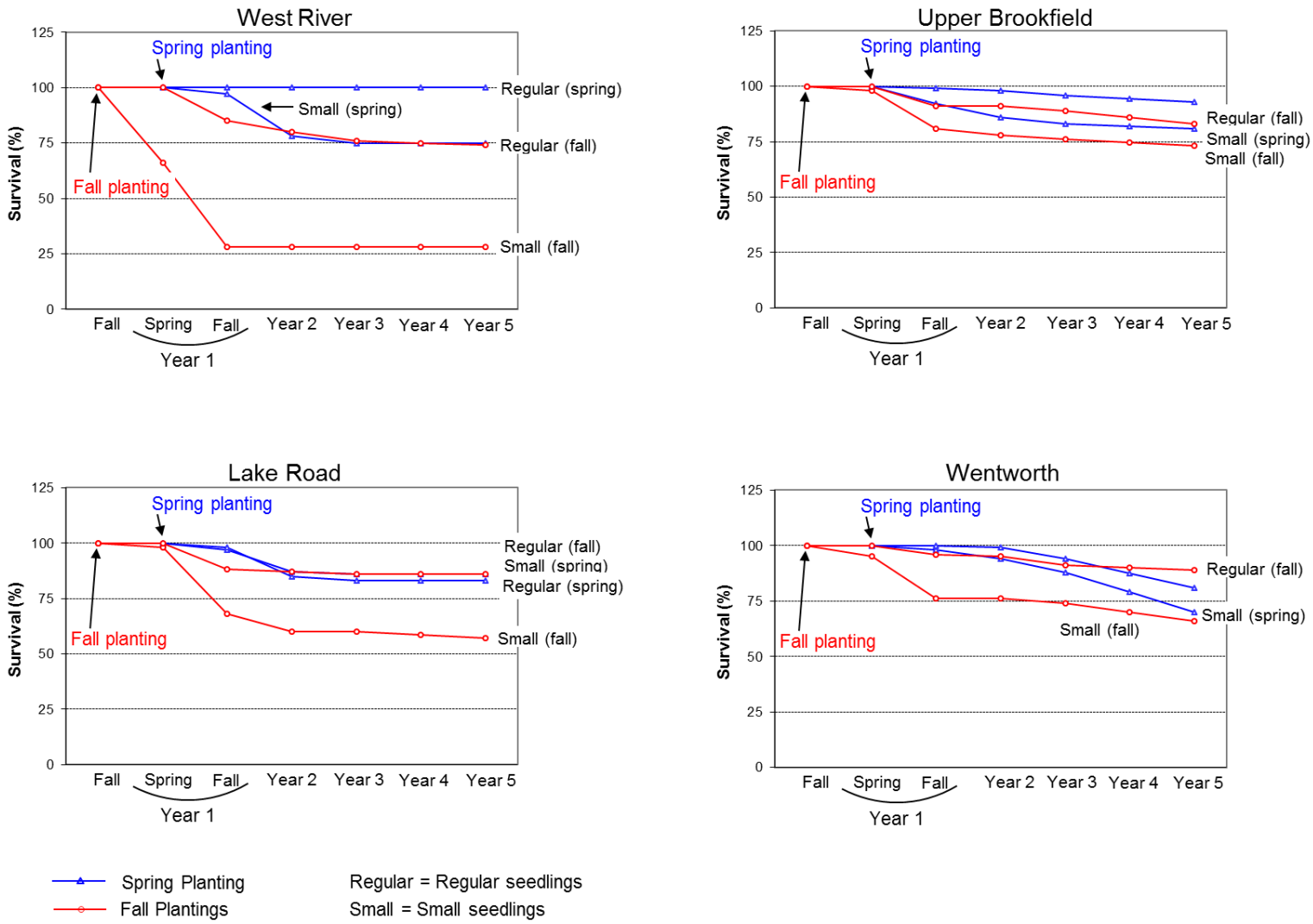
Appendix 1. Results from experimental trials.

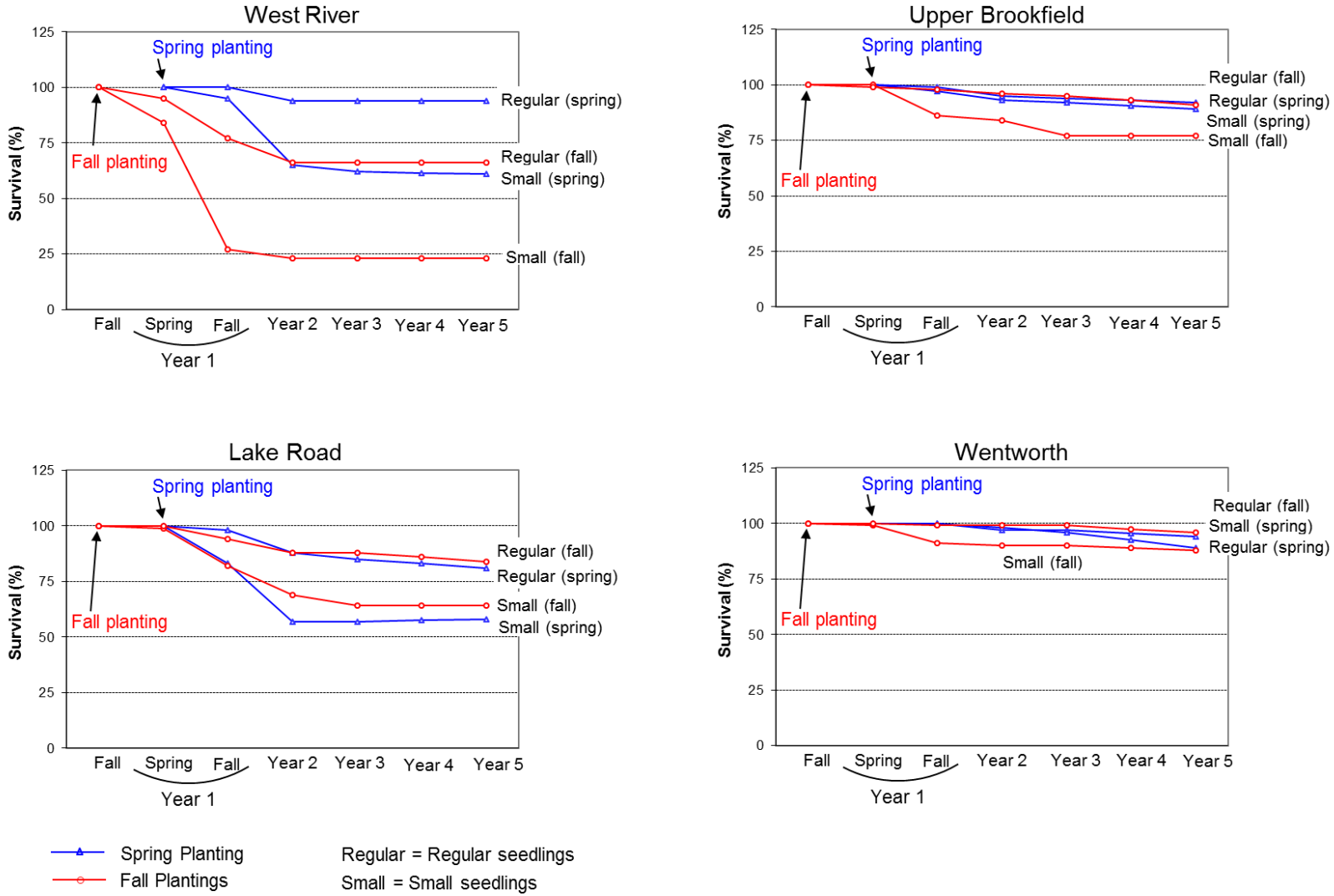
Location	Stand #	Block	Season of planting	Species	Stock Type	# Trees	Survival (%) Year 1	Year 2	Year 3	Year 5	Height (cm) Year 1	Year 2	Year 3	Year 5	Damages % Frost Heaved	Frost Heaving (% that died)	Browsed (%)
West River	0502	8	Fall	Bs	Small	100	28	28	28	28	18	29	48	95	45	40	25
		2	Fall	Bs	Regular	100	85	80	76	74	20	33	49	74	69	22	85
		1	Fall	Ns	Small	100	27	21	19	23	7	13	24	51	69	60	36
		4	Fall	Ns	Regular	100	77	66	66	66	23	25	36	68	52	29	84
		3	Spring	Bs	Small	100	97	78	75	75	16	27	42	67	53	23	87
		6	Spring	Bs	Regular	100	100	100	100	100	32	42	60	102	14	0	93
		5	Spring	Ns	Small	100	95	65	62	61	9	15	29	60	42	28	77
		7	Spring	Ns	Regular	100	100	94	94	94	27	24	40	86	10	3	96
U Brookfield	0503	8	Fall	Bs	Small	100	81	78	76	73	18	34	50	97	9	6	16
		2	Fall	Bs	Regular	100	91	91	89	83	30	45	61	136	16	5	3
		1	Fall	Ns	Small	100	86	84	77	77	9	19	33	76	15	7	19
		4	Fall	Ns	Regular	100	98	96	95	91	34	44	55	100	12	0	92
		3	Spring	Bs	Small	100	92	86	83	81	18	36	53	118	0	0	32
		6	Spring	Bs	Regular	100	99	98	96	93	34	51	75	145	1	0	6
		5	Spring	Ns	Small	100	97	93	92	89	10	23	43	85	9	1	42
		7	Spring	Ns	Regular	100	99	95	94	92	27	33	46	76	2	1	58
Lake Road	0504	8	Fall	Bs	Small	100	68	60	60	57	21	32	51	84	6	3	47
		2	Fall	Bs	Regular	100	88	87	86	86	29	47	71	96	21	4	42
		1	Fall	Ns	Small	100	82	69	64	64	12	18	25	42	16	9	38
		4	Fall	Ns	Regular	100	94	88	88	84	31	31	38	56	6	2	80
		3	Spring	Bs	Small	100	97	87	86	86	15	29	47	74	0	0	25
		6	Spring	Bs	Regular	100	98	85	83	83	30	39	51	64	9	3	48
		5	Spring	Ns	Small	100	83	57	57	58	8	20	25	40	1	1	16
		7	Spring	Ns	Regular	100	98	88	85	81	20	25	31	50	0	0	73
Wentworth	0505	8	Fall	Bs	Small	100	76	76	74	66	25	44	70	149	8	0	40
		2	Fall	Bs	Regular	100	96	95	91	89	39	66	99	173	0	0	8
		1	Fall	Ns	Small	100	91	90	90	88	17	23	41	63	3	0	75
		4	Fall	Ns	Regular	100	99	99	99	96	32	52	75	136	2	0	96
		3	Spring	Bs	Small	100	98	94	88	70	21	43	76	147	0	0	11
		6	Spring	Bs	Regular	100	100	99	94	81	39	56	88	175	1	0	9
		5	Spring	Ns	Small	100	100	97	97	94	12	24	42	76	1	1	65
		7	Spring	Ns	Regular	100	100	98	96	89	29	34	53	108	0	0	98
Total			Fall	Bs	Small	400	63	61	60	56	21	35	55	106	17	12	32
			Fall	Bs	Regular	400	90	88	86	83	30	48	70	120	27	8	35
			Fall	Ns	Small	400	72	66	63	63	11	18	31	58	26	19	42
			Fall	Ns	Regular	400	92	87	87	84	30	38	51	90	18	8	88
			Spring	Bs	Small	400	96	86	83	78	18	34	55	102	13	6	39
			Spring	Bs	Regular	400	99	96	93	89	34	47	69	122	6	1	39
			Spring	Ns	Small	400	94	78	77	76	10	21	35	65	13	8	50
			Spring	Ns	Regular	400	99	94	92	89	26	29	43	80	3	1	81

Survival – Black Spruce



Appendix 2. The five-year survival of black spruce small seedlings compared regular seedlings planted in the fall and spring on four experimental trial sites (West River, Upper Brookfield, Lake Road, Wentworth) in Nova Scotia.

Survival – Norway Spruce



Appendix 3. The five-year survival of Norway spruce small seedlings compared to regular seedlings planted in the fall and spring on four experimental trial sites (West River, Upper Brookfield, Lake Road, Wentworth) in Nova Scotia.

Appendix 4
Photo left top: Upper Brookfield (Year 1)
Photo left: Lake Raod (Year1)
Photo above centre: West River (Year 1)
Photo above right: Wentworth (Year 1)

Appendix 5. Results of operational plantings of small seedlings.

Season of planting	Location	Stand #	Stock Type	Species	# Trees	Survival (%)				Height (cm)					Damages		
						Year 1	Year 2	Year 3	Year 5	Ht @ planting	Year 1	Year 2	Year 3	Year 5	% Frost Heaving	Frost Heaving (% that died)	% Browsed
Fall	Birchwood	0602	Small	Bs	200	60	53	54	52	6	12	28	51	105	1	1	4
	Normans Lake #1	0603	Small	Ws	200	86	69	61	56	6	8	14	27	58	33	23	7
	Otterbrook	0604	Small	Bs	200	87	79	73	71	6	16	32	48	93	14	8	5
	U Stewiacke	0605	Small	Bs	200	77	73	70	69	6	14	29	41	77	11	8	0
					800	78	69	65	62	6	13	26	42	83	15	10	4
Spring	Norman's Lake #2	0703	Small	Ws	200	100	86	83	80	6	8	18	34	68	0	0	16
	Stewiacke East	0704	Small	Bs	200	93	85	85	80	6	14	28	42	65	19	4	3
	Wittenburg	0705	Small	Bs	200	76	74	75	71	6	13	27	49	96	0	0	13
	Pugwash River	0706	Small	Bs	200	92	84	79	77	6	18	33	52	109	0	0	12
	Lake Road	0707	Small	Bs	200	86	81	76	73	6	15	28	39	77	0	0	37
					1000	89	82	80	76	6	14	27	43	83	4	1	16
			Avg. across all sites		1800	84	76	73	70	6	13	26	43	83	9	5	11