



MANAGEMENT NOTES

Number 5

NORWAY SPRUCE in PRINCE EDWARD ISLAND

by William M. GLEN, 1994

INTRODUCTION

In the summer of 1993 a survey of all known Norway Spruce (*Picea abies*(L.) Karst.) plantations in the province was undertaken. This survey led to the rediscovery of a number of "lost" plantations and to this documentation of the history and growth of Norway spruce plantings in the province.

This report includes mensurational details as well as observations on the sites visited. With the exception of a 1967 plantation at Burton, Prince County all recorded plantings of Norway spruce have been relocated and assessed. (The Burton site was repeatedly burned in the 1970's which is the probable reason no Norway spruce could be found). Efforts have been made to determine the probable seed source of each plantation, through examination of surviving records and interviews with the individuals involved. (Note; following standard forest inventory practice only dominant trees are measured so as to give a measurement of species-site capability. Where sufficient trees have been planted and survived, volume assessments have also been recorded.)

PLANTATION DESCRIPTIONS

The earliest located record of Norway spruce planted in Prince Edward Island was a hedgerow of ten trees in Caledonia, Queens County. The trees were planted in 1906 by Rev. John Sutherland (the Minister of the Caledonia Presbyterian Church) next to the then new manse. The seed source is not known and as Rev Sutherland's previous posting was Australia no obvious location presents itself. He retired in 1906 and returned to Scotland. (McPherson, pers. comm., 1993; Buell, 1986)

The trees were planted on the western side of the manse on the boundary between the manse and Daniel McPherson's property. They stand on a hill top and are visible for quite a distance in most directions. The three largest trees are 23.0, 21.5, and 20.5 metres tall; and 70.5, 55.0 and 57.8 cm in diameter, respectively. Upon boring the trees, stem rot was found and it is suggested that it was caused by the root damage in both the manse garden on one side of the

hedgerow and the arable field on the other. Butt damage was noted on the arable field side of the trees probably caused by farm equipment. These trees had also been pruned to a height of three metres. A small quantity of Norway spruce natural regeneration was noted near the hedgerow.

Circa 1920 a hedgerow now consisting of seven trees was planted on the Jones property between Bunbury and Mount Herbert, Queens County. These trees were planted near the house on farmland and have reached large sizes. The heights range from 19.25 metres up to 23 metres and diameter 64-96 cm. Upon boring these trees early indications of rot were found. These trees carry branches to the ground and have become 'specimen trees' and a notable asset to the owner's property.

These two early plantings, of Norway spruce as hedgerows, give an indication of the sizes which the trees can reach in the province.

In 1938 Ernest Smith, a 1934 graduate of the Forestry Faculty of the University of New Brunswick, was appointed Superintendent of the Prince Edward Island National Park. He imported planting stock from the Acadia Forest Research Station near Fredericton, New Brunswick and used it to establish a number of plantations including Norway spruce. (Guardian 1938; Smith, pers. comm., 1993). Records from Acadia have been examined but no information has been found regarding the seed source.

The two Norway spruce plantations established at Dalvay, Queens County were on abandoned farmland with no site preparation. The trees were planted circa 1946 and have had no follow-up maintenance. The volume growth of the two plantations has been good with 370 m³/ha and 363 m³/ha as of 1993. The stands are of good health and growing well. In comparison, white spruce (Picea glauca (Moench) Voss) stands of both planted and natural origin and similar age are declining with stand collapse beginning to occur.

The National Park made seedlings available to anyone requesting them and a few hundred were sent out (by mail) each year. (Smith, pers. comm., 1993). In the Brighton area of Charlottetown a number of garden plantings have been observed that may have come from this source.

In the late 1940's and early 1950's the neglect of the war years and the increase in harvesting of pulpwood resulted in concern regarding the province's farms and forests. In 1946 efforts were made by Mr. R.L. Cotton to establish a nursery for the beautification of Island farms. The financial support provided by Mr. Cotton resulted in Bunbury Nursery being established in 1949 under the management of Mr. R.B. Snazelle (Guardian 1954). Mr. Snazelle's 1950/51 Annual Report for the Forest Nursery Division (as Bunbury was then known) notes the importation of 3,000 Norway spruce two year old seedlings from the Quebec Department of Lands & Forests. These seedlings were set out in transplant beds and due to a dry spring were reduced in number to 2,000 trees. The surviving trees were sold to farmers in 1951. Records have not survived to show where the trees were planted although it is believed that some of the trees were planted near Mount Stewart and those near the Prince Edward Home in Charlottetown are very probably from this source (Profit, pers. comm., 1993; Brehaut, pers. comm., 1993). The Prince Edward Home trees planted in 1954 now have dominant heights of 16.5 metres (Brehaut, pers. comm., 1993).

In 1953 a number of plantations including Norway spruce were established by the P.E.I. Forest Service on abandoned farmland at Iona, Queens County. The other species were red Pine (Pinus resinosa Ait) and white Pine (Pinus strobus L.). Stock for these plantations was imported from the Acadia Forest Experimental Station near Fredericton and the Western Forest Nursery at

Fryeburg, Maine. Which species came from each source have not been determined. Enquiries to both nurseries have not provided any details. The Norway spruce had good survival, have grown well and the dominant heights are 19-19.5 metres; red pine 14.5-16.0; white pine 17.3. A permanent sample plot (P.S.P.) was established in 1988 and remeasured in 1992.

| P.S.P. | 1988 | | 1992 | |
|------------|------------------------------|----------------------------------|------------------------------|----------------------------------|
| | Volume m ³ /ha | Basal Area m ² /ha | Volume m ³ /ha | Basal Area m ² /ha |
| Sub plot A | 247.5 | 42.9 | 303.8 | 50.4 |
| Sub plot B | 170.16 | 26.7 | 222.4 | 32.7 |

A few trees were established at Mount Stewart in the same year and have now reached heights of 18.5 - 18.75 metres.

In 1953 4,000+ seedlings were planted at the Federal Department of Agriculture Illustration Farm owned by Mr. T.A. Hicken at Alliston, Kings County. The trees were red pine, white pine, Norway spruce and white spruce provided by the Forestry Branch, Dept. of Resources and Development in Fredericton, New Brunswick (Acadia Forest Experiment Station). The seed sources are unknown. The following year, 400 Scots pine (*Pinus sylvestis* L.) were also planted (Black 1953, 1954). The plantation of interest is composed of a number of rows of each of the five species and provide good comparisons of growth. The average dominant heights in 1993 were:

| | | | |
|------------|-------------|---------------|-------------|
| Red Pine | 14.0 metres | Norway spruce | 17.3 metres |
| White Pine | 16.0 metres | Scots pine | 13.5 metres |

Note: The white spruce grew to a height of 2-5 metres and died due to unknown causes.

In the spring of 1953 two seed beds were sown with Norway spruce at the new P.E.I. Forest Service nursery at Beech Grove. The seed was probably acquired from Herbst Brothers, seedsmen, of New York. Unfortunately, their records do not indicate the source but most of the seed they sold was acquired from plantations in Essex and Clinton counties in New York State, which was probably of German origin (Herbst, pers comm., 1993).

In 1954 10,000 Norway spruce 4+0 seedlings were acquired from the Nova Scotia Forest Nursery at Lawrencetown in the Annapolis Valley. (Surviving records of N.S. Lands and Forests for 1954 do not contain information on the seed origin of the stock (Frame, pers. comm., 1993).) These trees were planted on unprepared ground at Goose River/Ashton in Kings County with similar numbers of Scots and lodgepole pine (*Pinus contorta* Dougl.). The choice of site was ericaceous barrens which was appropriate for the pines but not for the spruce. Norway spruce goes into 'check' and often fails when planted in these conditions if the ericaceous plants are not controlled. (Hibberd, 1986). As a result the Norway spruce plantation was a failure, but a number of trees have survived and range in height from 1.2 metres to 11.5 metres growing in a mixture of white birch, (*Betula papyrifera* Marsh.), and grey birch, (*B. populifolia* Marsh.), and white and black spruce (*Picea mariana* (Mill) B.S.P.).

Thirteen thousand trees from the two beds sown in 1953 were outplanted by the P.E.I. Forest Service in 1957 as 2+2 stock. The planting sites were Clinton, St. Eleanor's, and Grand

River (now Camp Tamawaby Demonstration Woodlot) in Prince County and Souris in Kings County. In 1958 plantings were carried out at Afton Road, Queens County; Grand River, and Souris (now New Harmony Demonstration Woodlot). (The stock for the 1958 plantings was probably 2+3 as no further seeding was carried after 1953 until 1963). Growth in these plantations have been variable; good volume and quality on the western sites and moderate to poor volume and quality in the rest.

| Location | Planting Year | Volume in 1993 m³/ha | Maximum Height 1993 metres |
|------------------|----------------------|----------------------------------------|-----------------------------------|
| Clinton* | 1957 | 332.0* | 14.35 |
| St. Eleanor's | 1957 | 358.5 | 15.35 |
| Tamawaby Demo | 1957 | 259.0 | 18.5 |
| Souris West | 1958 | 227.3 | 10.4 |
| New Harmony Demo | 1958 | 180.0 | 12.35 |
| Afton Road | 1958 | 131.0 | 9.0 |
| Tamawaby Demo | 1958 | 176.1 ** | 14.85** |

* mixed plantation alternate rows of balsam fir and Norway spruce (with volumes 72.6 m³ and 259.4 m³/ha respectively)

** 1991 measurement

The 1958 Camp Tamawaby plantation was thinned in December, 1991 and produced 36 m³/ha (11.0 m³/ha of pulpwood, 8.8 m³/ha of studwood and 16.2 m³ of fuelwood). The 1957 Tamawaby plantation was thinned circa 1981 but volume yields were not recorded.

In the spring of 1961 the Canadian Forestry Service in cooperation with the P.E.I. Forest Service established a Norway spruce observational provenance test on an old field site at York Point, Queens County. The test was composed of 12 sources from Europe, Nova Scotia and New Brunswick. The stock was grown at the Acadia Forest Experiment Station and shipped to P.E.I. as 2+2 stock. The test was later abandoned due to poor survival probably caused by a grass fire. The identification of the remaining trees is possible due to the presence of aluminum stakes. Dominant heights are 13.5 to 15.0 metres.

A small plantation was established at the Agricultural Experimental farm next to the North River causeway, Queens County on a moist old field site circa 1963. It was composed of Norway spruce and Scots pine. Many of the pine were cut as Christmas trees, but the spruce have done well. (No record of the planting can be found in the Experimental Station reports.) Dominant heights of the spruce are 17.0, 16.75, and 16.5 metres. This stand is on the shore of North River and next to the Trans Canada Highway and shows no damage from salt spray from either source.

Another small plantation was established in Freetown, Prince County circa 1963 and now has dominant heights of 10-10.5 metres and a volume of 155 m³/ha.

The P.E.I. Forestry Service did not seed any Norway spruce again until 1963 and then continued to sow beds of Norway spruce until the mid 1970's. The stock was out planted as either 2+2 or 2+3 bareroot stock until 1971 when subsequently 3+0 stock was produced. (Anon, 1954-75).

The seed source used is believed to have been the same as noted for the 1953 sowing until

1967 (Campbell, pers. comm., 1993). In November 1966, four pounds of Norway spruce seed (seedlot # MS1132) was received from Don Fowler of Canadian Forest Service which had been collected from a 45 year old plantation at Fownes Head, New Brunswick. This plantation is probably of German origin (Fowler, pers. comm., 1993).

In 1967 plantings were made at Burton in Prince County and Auburn (now Auburn Demonstration Woodlot) and Melville in Queens County. The Burton plantation was subsequently destroyed by fire. The 1993 dominant heights of the Norway spruce at Auburn were 9.5, and 8.75 metres. The Melville planting was in two blocks in conjunction with white spruce and Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco) on a well-drained old field.

Melville Plantings

| Species | Dominant height metres | Volume m ³ /ha |
|---------------|---------------------------|------------------------------|
| Norway spruce | 10.4 | 104.7 |
| Douglas fir | 14.0 | 204.6 |
| White spruce | 9.0 | 122.7 |

Circa 1968 plantations were established at Brookvale (now Brookvale Demonstration Woodlot), Tea Hill and Rice Point, all in Queens County. All plantations were established on abandoned farmland. No evidence of site preparation was noted.

| Location | Dominant height metres | Volume m ³ /ha |
|-------------|---------------------------|------------------------------|
| Brookvale | | |
| Front stand | 15.3 | 226.2 |
| Rear stand | 14.5 | 289.7 |
| Rice Point | 11.5 | 309.1 |
| Tea Hill | 11.8 | - |

The Rice Point site was also planted with white spruce and Scots pine in a three row pattern with one row of each species. This plantation is also of note due to its adjacency to the Northumberland Strait. No salt or wind damage was observed on the Scots pine, white or Norway spruce. This was in contrast to a white pine plantation established 200 metres further inland which shows considerable salt damage.

Rice Point

| Species | Dominant height metres | Volume m ³ /ha |
|---------------|---------------------------|------------------------------|
| White spruce | 8.8 | 242 |
| Scots pine | 9.5 | 82 |
| Norway spruce | 11.5 | 309 |

Circa 1970 a plantation was established at Bangor, Kings County on an old field. The site

shows evidence of single furrow ploughing. The trees have been seriously browsed by rabbits\hares (Lepus americanus (Erxleben)) which resulted in patches of mortality and growth reduction. The 1993 dominant height was 7.0 metres and volume 107 m³/ha.

Circa 1973-5 trees were planted near Rice Point, Ebenezer, and St. Catherine's in Queens County and Cambridge in Kings County. All were established on abandoned farmland and with the exception of the Cambridge site, no site preparation is evident.

| Location | Dominant height metres | Volume m³/ha |
|-----------------|-----------------------------------|------------------------------------|
| Cambridge | 10.0 | - |
| Rice Point | 11.8 | - |
| Ebenezer | 10.8 | - |
| St. Catherine's | 11.0 | 120.0 |

Circa 1977-79 plantations were established at 48 Road in Kings County, Blooming Point and St. Patrick's Road in Queens County, and East Bideford and Porthill Station Road in Prince County.

| Location | Dominant height metres | Volume m³/ha |
|------------------------|-----------------------------------|------------------------------------|
| 48 Road | 8.0 | 36.6 |
| St. Patrick's Road | 6.3 | - |
| Blooming Point | 8.3 | 162.5 |
| East Bideford | 6.8* | - |
| Port Hill Station Road | 5.0* | - |

* 1992 measurements

No further Norway Spruce were planted in the province until a provenance test was established by the Tree Improvement Section of the P.E.I. Forestry Service in 1991. This test is composed of thirty provenances planted at both Dover, Kings County and East Bideford, Prince County. The Dover plantation was utilized to monitor the spring and autumn development (phenology) of the various seed sources.

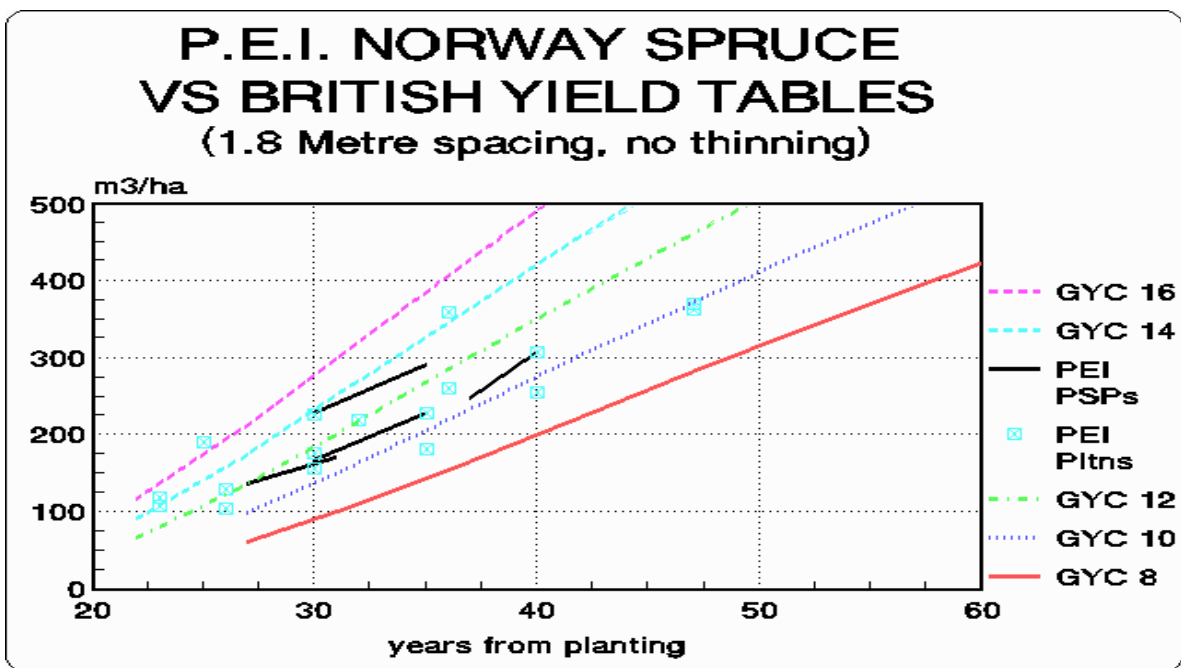
DISCUSSION

General Yield Classes

General Yield Class (GYC), as used by the British Forestry Commission, (Hamilton & Christine, 1971) has been used to categorize all the Norway Spruce plantings which were assessed, Table 1. (GYC is the maximum mean annual volume increment which a plantation will reach during a rotation. It is determined using dominant height and age).

Figure I shows five general yield curves for unthinned Norway spruce in Britain compared to P.E.I. plantations. The P.E.I. plantations are within the range covered by the British tables and the growth exhibited by the re-measured P.S.P.s shows similar volume increment to the GYC lines.

Figure I



Th

e sites which have been badly weevilled have a lower GYC than the site capability would indicate due to the reduction in tree height. This is particularly the case of Afton Road, Auburn and Souris West.

Examination of the GYC versus soil classification provided no correlations. Norway spruce has grown well on most sites although growth appears to be superior on sites with higher moisture. These observations are supported by the Nova Scotia study (Anon, 1990) and Hibberd (1986).

Thus the use of the British GYC tables appear appropriate for use in P.E.I..

The number of years required for the plantations to reach breast height averaged 6.28 years with a range from three to fourteen years. Due to the variations, breast height age is desirable for determining growth patterns although the British tables are based on years from planting. With control of competing vegetation during the establishment of the plantation, time to breast height should become more consistent making the use of total age more appropriate.

Table 1
Norway Spruce Plantings and estimated GYC

| Location | Planting year | Dominant Height | Age | GYC |
|--------------------------|---------------|-----------------|-----|-----|
| Caledonia | 1906 | 23.0 | 87 | 10 |
| Bunbury | 1920 | 23.0 | 73 | 10 |
| Dalvay (west) | 1946 | 19.0 | 47 | 12 |
| Dalvay (Ticket Booth) | 1946 | 17.0 | 47 | 10 |
| Mount Stewart | 1953 | 18.75 | 40 | 14 |
| Iona | 1953 | 19.5 | 40 | 14 |
| Alliston | 1953 | 17.5 | 40 | 14 |
| Prince Edward Home | 1954 | 16.5 | 39 | 12 |
| Clinton | 1957 | 14.25 | 36 | 12 |
| St Eleanor's | 1957 | 15.25 | 36 | 12 |
| Tamawaby Demo Woodlot | 1958 | 17.5 | 35 | 16 |
| Afton Road | 1958 | 9.0 | 35 | 6 |
| Souris West | 1958 | 10.4 | 35 | 6 |
| New Harmony Demo Woodlot | 1958 | 12.25 | 35 | 10 |
| Clinton East | 1961 | 12.25 | 32 | 10 |
| York Point | 1961 | 15.0 | 32 | 14 |
| Freetown | 1963 | 10.0 | 30 | 8 |
| North River | 1963 | 17.0 | 30 | 20 |
| Melville | 1967 | 10.4 | 26 | 12 |
| Auburn Demo Woodlot | 1967 | 9.5 | 26 | 10 |
| Tea Hill | 1968 | 11.75 | 25 | 14 |
| Brookvale Demo Woodlot | | | | |
| front plantation | 1968 | 11.75 | 25 | 16 |
| rear plantation | 1968 | 14.5 | 25 | 20 |
| Rice Point | 1968 | 11.5 | 25 | 14 |
| Bangor | 1970 | 7.0 | 23 | 10 |
| 48 Road | 1973 | 8.0 | 20 | 12 |
| near Rice Point | 1973 | 11.75 | 20 | 20 |
| Cambridge | 1973 | 10.0 | 20 | 16 |
| St Catherine's | 1974 | 11.0 | 19 | 20 |
| Ebenezer | 1974 | 10.75 | 19 | 18 |
| Blooming Point | 1977 | 8.25 | 16 | 18 |
| East Bideford | 1978 | 6.75 | 14 | 16 |
| St Patrick's Road | 1978 | 6.25 | 15 | 14 |
| Port Hill Station Road | 1978 | 4.75 | 14 | 12 |

Comparative Volumes

Height growth of Norway spruce on most sites (15 out of 19 with comparison species) has been superior to other planted species. Table 2 provides a summary of sites with Norway spruce and other planted species of similar age. The volume of Norway spruce is compared to the volume in the other plantations and the variation was from 26% to 248%. While the sample size is small and based only on plantations that have survived, the numbers provide an indication of differences in volume production that may be expected. The Norway spruce volume growth has exceeded red pine by 11%, white pine by 9%, Scots pine by 74%, white spruce by 26%, black spruce by 48%, balsam fir by 27% and was less than Douglas fir and European larch (*Larix decudia* L.). In Nova Scotia (Anon, 1990) it was found that Norway spruce outgrew native species by 1 to 7.8 m³/ha per year.

Table 2
Norway spruce merchantable volume verses other planted species of similar age

| Location | (percent of Norway spruce volume) | | | | | | | |
|----------------|-----------------------------------|------------|------------|--------------|--------------|------------|-------------|----------------|
| | red pine | white pine | Scots pine | white spruce | black spruce | balsam fir | Douglas fir | European larch |
| Tamawaby | 81% | - | - | 62% | 52% | 69% | - | 86% |
| Dalvay | 79% | - | - | 86% | - | - | - | - |
| Iona | 109% | 60% | - | - | - | - | - | - |
| Clinton west | - | - | - | 36% | - | 55% | - | - |
| Clinton east | - | 106% | - | - | - | - | - | - |
| Souris West | 82% | 133% | - | - | - | - | - | - |
| New Harmony | - | - | - | 72% | - | 94% | - | - |
| Melville | - | - | - | 116% | - | - | 194% | - |
| Rice Point | - | 38% | 26% | 78% | - | - | - | - |
| Brookvale | 95% | 105% | - | - | - | - | 53% | - |
| Bangor | - | 106% | - | - | - | - | - | 249% |
| Blooming Point | - | - | - | 69% | - | - | - | - |
| Mean | 89% | 91% | 26% | 74% | 52% | 73% | 124% | 168% |

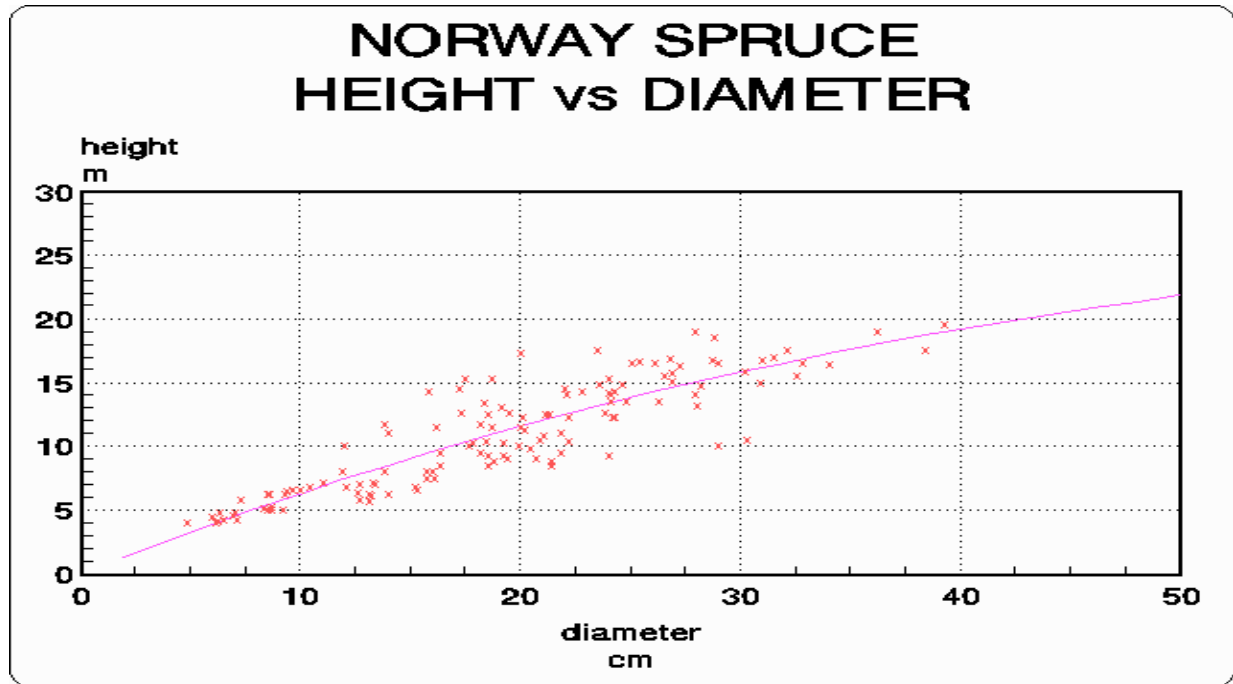
Height Diameter Relationship

The measurements of height and diameter from more than a hundred trees taken during the field survey were used to construct a height/diameter relationship for Norway spruce on Prince Edward Island.

The equation used was: Total height = A (1-Exp(co))
 $co = (-(DBH/BO)^{B1})$ Where A = 30.789
 Where BO = 40.781
 Where B1 = 1.053

The fit of the data was good as an R^2 of .972 was obtained. Figure II shows the distribution of the measurements and the generated equation.

Figure II



Seed Sources

The determination of the seed origins of the Norway Spruce plantations in Prince Edward Island was for the most part, unsuccessful. Fowler (1979) notes that despite this lack of information, seed sources within the province and the same climatic regions are a potentially valuable source of seed. Seed from the plantations at Camp Tamawaby have been collected and have been used in the 1993 tests and should continue to be used to provide a local comparison with other seed sources. Seed from the Allen plantation near Bingham, Maine has been used for the 1994 nursery crop, this is also probably of German origin. From limited records and the comments of Don Fowler (Fowler, pers. comm., 1993) it appears that the Norway spruce plantations on P.E.I. are probably all of German origin (seed imports by Schmacker circa 1900) and have been grown for one or more generations in North America.

Fowler (1979) noted that the Polish sources have out performed the German ones in the Maritime provenance tests and it may be surmised that the existing P.E.I. plantations may underestimate the species potential.

Seed imported from the natural range of Norway spruce should come from mid elevations of the Sudeten and Carpathian Mountains of southern Poland (Fowler & Coles 1979). These sources also had better wood properties than other origins (Chui, 1993).

Phenology

In the spring and autumn of 1993 the vegetative development of Norway spruce seedlings in the provenance test at Dover, Kings County was monitored. Most of the provenances were from the recommended part of the species' natural range in Poland and Czechoslovakia, five sources were from Canada. Each of the 31 provenances were examined on approximately a weekly basis. The degree of bud development and shoot elongation were noted (details are in the Appendix).

The May 17th assessment noted bud swelling in 14 seedlots and by May 26th it was observed in all. Shoot elongation was noted sporadically in 9 provenances on May 26th and was consistent in all except 8 by June 2nd. All provenances were actively elongating by June 15th. During the week prior to June 15th two late frosts occurred, slight damage (browning of needles) was noted sporadically in 15 provenances.

Late summer/ autumn assessments followed the same procedure and all provenances had set bud at least once by August 18th. Nineteen provenances showed signs that they had flushed a second time before August 18th but this was very sporadic (often one tree in one of four plots) and many seedlings had begun to set buds a second time by the August 18th visit. By mid September (17th) almost all the seedlings had lignified leaders, although four provenances were noted with slight frost damage as of that date.

When the phenology of a given provenance was compared to the latitude, longitude, or elevation of it's origin no correlations were found. The variation within many of the seedlots was as great as the variation between them. This is consistent with observations by Fowler & Coles (1979).

When compared to the frost risk classification for P.E.I. by Bootsma (1980), spring frosts are potentially more damaging than autumn frosts. Based on the phenology observed, frost risk class "D" (June 8th to June 18th) should be avoided when planting Norway spruce in P.E.I.

Wood Quality

A study carried out by the Wood Science and Technology Centre in Fredericton using samples from New Brunswick and Nova Scotia, (Chui, 1993), concluded that plantation grown Norway spruce was inferior in grade to naturally grown black and red spruce but was better than plantation grown white spruce. The Norway spruce plantation at St Martins, New Brunswick (planted circa 1920) which had lower specific gravity and higher growth rates than naturally grown white spruce and balsam fir but had mechanical properties comparable to them.

The mechanical properties of Polish provenances of Norway spruce appeared to be better than German provenances.

In summary the Norway spruce tested in this study indicated that wood quality was equal or superior to plantation or naturally grown white spruce and balsam fir, but has wood quality less than naturally grown red or black spruce.

Damaging Agents

Hares

Snowshoe hares (locally called rabbits) were noted as causing mortality at Bangor. At St. Catherine, Port Hill, St. Patrick's Road, and Blooming Point individual trees were repeatedly browsed (both terminal and lateral shoots are clipped) by hares so that they are not part of the stand canopy.

It appears from these observations that gaps in the older plantations may have been caused by mortality due to extensive hare browse.

Insects

The damage caused by the pine weevil (Pissodes strobi Peck) was classified into light, moderate and heavy. The provincial distribution was 53% light, 29% moderate, and 18% heavy. The heavy damage areas were all east of Charlottetown; one of the Dalvay sites, Auburn, Afton Road, Souris West, New Harmony Demonstration Woodlot and Melville.

Where white pine was planted beside or very near the Norway spruce block, it was noted that the pine was more severely damaged than the spruce (Brookvale, Rice Point, Bangor, Iona, Alliston, and Blooming Point).

No correlation between weevil damage and the P.E.I. soil series or soil capability could be found. Observation leads the author to believe that on the better sites, Norway spruce if successfully attacked by the weevil recovers better and is less likely to be successfully attacked in the first place.

The amount of weeviling was highly variable between sites, Coleman et al. (1987) notes the tolerance to weevil attack appears to be under genetic control. This, however, also appears to be influenced by environmental factors as the plantations at St. Eleanor's, Tamawaby Demonstration Woodlot, Souris West, New Harmony Demonstration Woodlot, and Afton Road are from the same seed source and the amount of weeviling varies from low (St. Eleanor's) to extreme (Afton Road). Thus collection of seed from stands low in weevil damage seems prudent.

No defoliation was noted by spruce budworm (Choristoneura fumiferana Clemens) although serious defoliation was present in white spruce stands adjacent to plantations at Alliston, Iona, and Bangor.

Old field spruce collapse / Stem rot

The plantation at Dalvay is adjacent to a white spruce plantation established about the same time. The Norway spruce is growing well, the white spruce plantation in contrast is collapsing with stem mortality and breakage. It appears from this observation that Norway spruce is not subject to the old field mortality syndrome at as young an age as white spruce, if at all. (Note stands of white spruce growing on abandoned farmland in P.E.I. collapse, for as yet unknown causes, at the age of 35-50.)

The front plantation in the Brookvale Demonstration Woodlot was thinned in the summer of 1992 and in the plantation a small number of white spruce had been planted with the Norway spruce. During the thinning it was noted that many of the white spruce had staining in the butt of the tree and that this was absent from the Norway spruce. As mentioned previously stem rot was found in

the trees at Caledonia and Bunbury. Both sites were hedgerows and probably had roots damaged by farming activities adjacent to them.

Abiotic

No damage due to snow or ice was noted in any P.E.I. plantations, nor any damage caused by salt spray either from the ocean or road salt.

Wildlife Usage

While not part of the survey the following were noted during some of the field work. Squirrels (Tamiasciurus hudsonicus (Erxleben)) or evidence of their presence was noted in the plantations at Tamawaby, St. Eleanor's, Afton Road, New Harmony, Cambridge, Rice Point, York Point, and Iona. As noted earlier, snowshoe hares were a notable presence in younger plantations. A fox (Vulpes vulpes (L.)) was seen at the western Clinton plantation; chickadees were noted in Dalvay, Brookvale, and York Point (brown capped and black (Parus atricapillus (L.) and P. hudsonicus (Bryant))). Red-breasted grosbeaks (Pheucticus ludovicianus (L.)) were noted at St. Catherine's.

Studies recording use by birds or animals of Norway spruce plantations would be useful.

SUMMARY

- 1- All recorded Norway spruce plantations, except one, have been located.
- 2- Volume growth has been superior, in most cases, to native spruces and similar to the native pines.
- 3- Seed sources should be from the Sudeten and Carpathian Mountains of southern Poland and Czechoslovakia or locally adapted sources.
- 4- Norway spruce is adaptable to a wide variety of sites but grows best on sites that are moist but well drained.
- 5- Avoid planting sites with ericaceous plants without herbicide control.
- 6- Avoid planting sites in frost risk "D" as shown on the Frost Risk map of P.E.I.
- 6- Wood quality should be superior to plantation grown white spruce and balsam fir.
- 7- British General Yield Class (GYC) Tables for Norway spruce appear appropriate for P.E.I. until local tables can be developed.

ACKNOWLEDGEMENTS

I wish to acknowledge the assistance of the following people in the preparation of this report.

Fieldwork - Jon Hutchison, Mike Bradley, Brad Duplisea,
and Elizabeth Glen

Phenology monitoring - Mary Myres

Development of the height/diameter relationship - Jon
Hutchison

Typing - Ann Ling

Editing - Jon Hutchison, Paul McKnight, Dan McAskill,
Elizabeth Glen and Jerry Gavin

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APPENDIX

Dover, Kings County Norway Spruce Provenance Test, established 1991.

| Test | Seedlot | Origin | Latitude | Longitude | elevation metres |
|------|-------------|----------------------------------|-----------|------------|---------------------|
| 1 | Iona | Iona, P.E.I. | 46 04' | 62 48'W | 100 |
| 2 | Brookvale | Brookvale P.E.I. | 46 18' | 63 25'W | 70 |
| 3 | North River | North River P.E.I. | 46 16' | 63 11'W | 5 |
| 4 | Ontario | Hudson Place Ont | 46 0' | 77 40'W | - |
| 5 | Brookvale | Brookvale P.E.I. | 46 18' | 63 25'W | 70 |
| 6 | MS2489 | Zwierzyniec Poland | 52 48' | 23 47'E | 160 |
| 7 | MS2490 | Zwierzyniec Poland | 52 42' | 23 46'E | 180 |
| 8 | MS2491 | Wigry Poland | 54 03' | 23 03'E | 170 |
| 9 | MS2492 | Przerwanki Poland | 54 10' | 22 05'E | 180 |
| 10 | MS2493 | Borki Poland | 54 06' | 22 04'E | 180 |
| 11 | MS2494 | Howe Ramuki Poland | 53 41' | 20 34'E | 160 |
| 12 | MS2495 | Niedzygore Poland | 50 13' | 16 45'E | 580 |
| 13 | MS2496 | Stronie Slaskie P. | 50 14' | 16 50'E | 820 |
| 14 | MS2497 | Wiska 10 Poland | 49 38' | 18 58'E | 710 |
| 15 | MS2498 | Istebna 11 Poland | 49 34' | 18 53'E | 630 |
| 16 | MS2499 | Istebna 12 Poland | 49 32' | 18 57'E | 600 |
| 17 | MS2500 | Rycerka 13 Poland | 49 31' | 19 01'E | 620 |
| 18 | MS2501 | Rycerka 14 Poland | 49 29' | 19 00'E | 700 |
| 19 | MS2502 | Rycerka 15 Poland | 49 29' | 19 00'E | 950 |
| 20 | MS2503 | Orwa Poland | 49 34' | 19 33'E | 1050 |
| 21 | MS2504 | Witrow/Tatry 17 P. | 49 13' | 19 48'E | 1430 |
| 22 | MS2505 | Tarnawa Poland | 49 05' | 22 52'E | 750 |
| 23 | MS2506 | Zwierzyniec Lubelski Poland | 50 34' | 22 58'E | 260 |
| 24 | MS2507 | Blizyn 20 Poland | 51 04' | 20 41'E | 310 |
| 25 | MS2508 | Kartuzy 21 Poland | 54 23' | 18 08'E | 200 |
| 26 | NS3518 | Nadlesnictwo Nowy-Targ Poland | 49 35' | 19 35'E | 800 |
| 27 | NS3520 | Benus Czech | 48 48' | 19 52'E | 650 |
| 28 | NS3566 | Bruntal Czech | 50 00' | 17 40'E | 580 |
| 29 | NS3567 | Sternberk Czech | 49 40' | 17 20'E | 350 |
| 30 | NS3570 | Vitkov Czech | 49 50' | 17 50'E | 420 |
| 31 | NS3571 | Orwa (area) Poland | 49 33'36" | 19 35'39"E | 750 |

1993 Phenology Assessment of Norway Spruce
in the 1991 Dover Provenance Test

Each of the replicates of each seedlot were assessed and are reported below using the following codes.

| | |
|--------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| - buds dormant ! Buds swelling 0-2 or 10-15 mm of shoot elongation SFD slight frost damage (browning of some needles) | 0- leader lignified (based on colour) 1- buds set leader almost completely lignified, buds brown 2- buds set, approx 25 mm of leader not lignified, not all buds brown 3- Buds set, approx 50 mm of leader not lignified, not all buds brown F- some flushed again (but most have already started to shut down by Aug 18th) |
|--------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

| Seed Lot # | May 17 | May 26 | June 2 | June 15 | Aug 18 | Aug 31 | Sept 8 | Sept 17 | Sept 22 |
|-------------|--------|--------|--------|----------|--------|--------|--------|---------|---------|
| Iona | - | 0-2 | 0-2 | 10-15 | 1 | 1 | 1 | 1 | 1 |
| | - | ! | 0-2 | 15-20SFD | 2 F | 1 | 1 | 1 | 0 |
| | ! | ! | 0-2 | 10-15SFD | 2 | 1 | 1 | 0 | |
| | ! | ! | 0-2 | 10-15SFD | 2 F | 1 | 1 | 0 | |
| Brookvale | ! | 0-2 | 0-2 | 15-20 | 2 | 1 | 1 | 1 | 0 |
| | - | ! | 0-2 | 10-15SFD | 2 | 1 | 1 | 1 | 0 |
| | - | ! | 0-2 | 10-15SFD | 3 F | 2 | 1 | 0 | |
| | - | ! | 0-2 | 10-15 | 2 F | 2 | 1 | 0 | |
| North River | ! | ! | 0-2 | 10-15 | 1 | 1 | 1 | 0 | |
| | - | ! | 2-4 | 15-20 | 2 F | 2 | 1 | 1SFD | 1 |
| | - | ! | 0-2 | 10-15SFD | 2 | 2 | 2 | 1 | 1 |
| | - | ! | 0-2 | 10-15SFD | 2 | 1 | 1 | 0 | |
| | - | ! | 0-2 | 10-15SFD | 2 F | 1 | 1 | 0 | |
| Ontario | - | ! | 0-2 | 10-15 | 3 | 2 | 1 | 1 | 0 |
| | - | ! | 0-2 | 10-15 | 3 | 2 | 1 | 1 | 0 |
| | - | ! | 0-2 | 5-10SFD | 2 | 1 | 1 | 0 | |
| | - | ! | ! | 5-10 | 2 | 2 | 1 | 0 | |
| Brookvale | ! | ! | 0-2 | 10-15 | 2 F | 1 | 1 | 0 | |
| | - | ! | 0-2 | 5-10 | 3 | 2 | 1 | 1 | 0 |
| | ! | ! | 0-2 | 10-15SFD | 2 F | 2 | 2 | 1 | 0 |
| | ! | ! | 0-2 | 10-15 | 2 F | 2 | 2 | 1 | 0 |
| MS2489 | - | - | ! | 10-15SFD | 2 | 1 | 1 | 0 | |
| | - | - | ! | 5-10 | 2 | 1 | 0 | | |
| | - | ! | 0-2 | 5-10 | 2 | 1 | 1 | 0 | |

| | | | | | | | | | |
|--------|---|-----|-----|----------|-----|---|---|------|---|
| | - | ! | ! | 5-10 | 1 | 1 | 0 | | |
| ----- | | | | | | | | | |
| MS2490 | - | ! | ! | 10-15 | 2 | 1 | 1 | 0 | |
| | - | - | ! | 5-10SFD | 2 | 1 | 1 | 0 | |
| | - | ! | ! | 10-15 | 1 | 0 | | | |
| | - | ! | ! | 10-15 | 2 | 1 | 0 | | |
| ----- | | | | | | | | | |
| MS2491 | - | ! | 0-2 | 5-15 | 3 | 2 | 1 | 0 | |
| ----- | | | | | | | | | |
| MS2492 | - | ! | 0-2 | 10-15 | 2 | 2 | 2 | 1 | 0 |
| | - | ! | 0-2 | 10-15 | 2 | 1 | 1 | 0 | |
| | - | ! | ! | 5-10 | 3 | 2 | 2 | 1 | 0 |
| | - | ! | ! | 10-15 | 2 | 0 | | | |
| ----- | | | | | | | | | |
| MS2493 | - | ! | ! | 5-10 | 2 | 1 | 0 | | |
| | - | - | ! | 5-10 | 3 | 2 | 1 | 1 | 0 |
| | - | ! | 0-2 | 5-10 | 3 | 2 | 1 | 0 | |
| | - | ! | ! | 5-10 | 2 | 1 | 0 | | |
| ----- | | | | | | | | | |
| MS2494 | - | ! | 0-2 | 5-10 | 2 F | 1 | 1 | 0 | |
| | - | ! | ! | 10-15 | 2 | 1 | 1 | 1 | 1 |
| | - | - | ! | 5-10 | 2 | 1 | 1 | 0 | |
| | - | - | ! | 5-10 | 2 | 1 | 1 | 0 | |
| ----- | | | | | | | | | |
| MS2495 | - | ! | 0-2 | 10-15 | 2 | 2 | 1 | 0 | |
| | - | ! | 0-2 | 15-20 | 2 F | 1 | 1 | 0 | |
| | - | ! | 0-2 | 10-15 | 1 | 1 | 1 | 0 | |
| | - | ! | 0-2 | 10-15SFD | 2 | 1 | 1 | 1SFD | 0 |
| ----- | | | | | | | | | |
| MS2496 | - | ! | 0-2 | 10-15 | 1 | 0 | | | |
| | - | ! | 0-2 | 5-15SFD | 2 F | 1 | 1 | 1 | 0 |
| | - | ! | 0-2 | 10-15SFD | 1 | 1 | 0 | | |
| | - | 0-2 | 2-4 | 20-25 | 1 | 1 | 1 | 0 | |
| ----- | | | | | | | | | |
| MS2497 | - | 0-2 | 2-4 | 15-20 | 2 F | 2 | 1 | 1 | 1 |
| | - | ! | 0-2 | 10-15 | 2 | 2 | 1 | 1 | 1 |
| | ! | 0-2 | 2-4 | 10-20 | 2 | 1 | 0 | | |
| ----- | | | | | | | | | |
| MS2498 | - | ! | 0-2 | 15-20 | 2 | 1 | 1 | 0 | |
| | - | ! | 0-2 | 10-15 | 2 | 1 | 1 | 0 | |
| | ! | ! | 0-2 | 15-20 | 2 | 1 | 1 | 0 | |
| | ! | ! | 0-2 | 10-15 | 2 F | 2 | 1 | 1 | 0 |
| ----- | | | | | | | | | |
| MS2499 | - | ! | 0-2 | 5-10 | 2 F | 2 | 1 | 1 | 0 |
| | - | ! | 0-2 | 10-15 | 2 | 1 | 1 | 1 | 0 |
| | ! | ! | 0-2 | 10-15 | 1 | 1 | 1 | 1 | 0 |
| | - | - | 0-2 | 10-15 | 1 | 1 | 1 | 1 | 0 |

| | | | | | | | | | |
|--------|---|-----|-----|----------|---|-----|---|---|---|
| MS2500 | - | ! | 0-2 | 10-15 | 2 | 2 | 1 | 1 | 1 |
| | - | ! | 0-2 | 5-15SFD | 2 | F 2 | 1 | 1 | 0 |
| | ! | ! | 0-2 | 10-15 | 2 | 2 | 2 | 1 | 0 |
| | - | ! | 2-4 | 5-15 | 2 | 1 | 1 | 0 | 0 |
| MS2501 | - | ! | 0-2 | 15-20 | 2 | 1 | 0 | | |
| | - | ! | 0-2 | 10-20 | 2 | F 1 | 0 | | |
| | - | 0-2 | 2-4 | 5-10 | 1 | 1 | 1 | 0 | |
| | - | ! | 0-2 | 10-15 | 2 | 1 | 1 | 0 | |
| MS2502 | - | ! | 0-2 | 5-10 | 2 | 1 | 1 | 0 | |
| | - | ! | 0-2 | 5-10 | 3 | F 2 | 1 | 1 | 1 |
| | - | ! | 0-2 | 10-15 | 2 | 1 | 1 | 0 | |
| | ! | ! | 0-2 | 10-15 | 1 | 1 | 1 | 0 | |
| MS2503 | - | ! | 0-2 | 10-15 | 1 | 1 | 1 | 1 | 0 |
| | - | ! | 0-2 | 5-15 | 2 | 1 | 0 | | |
| | ! | ! | 0-2 | 15-20 | 1 | 1 | 0 | | |
| | ! | 0-2 | 0-2 | 10-15SFD | 1 | F 1 | 1 | 1 | 1 |
| MS2504 | - | ! | 0-2 | 5-10SFD | 2 | F 1 | 0 | 0 | |
| | - | ! | 0-2 | 15-20 | 1 | 1 | 1 | 1 | 0 |
| | - | ! | 2-4 | 15-20 | 1 | 0 | 0 | | |
| | - | ! | 2-4 | 10-20 | 1 | 0 | 0 | | |
| MS2505 | - | - | ! | 10-15 | 2 | 1 | 1 | 0 | |
| | - | ! | ! | 5-10 | 3 | 2 | 1 | 0 | |
| | - | - | ! | 5-10 | 2 | 1 | 1 | 0 | |
| | - | ! | 0-2 | 10-15 | 2 | 1 | 1 | 1 | 0 |
| MS2506 | - | ! | ! | 5-10 | 2 | 2 | 2 | 1 | 0 |
| | - | - | ! | 10-15 | 1 | 1 | 1 | 1 | 0 |
| | - | - | ! | 10-15 | 2 | 1 | 1 | 0 | |
| | - | ! | ! | 10-15 | 2 | 2 | 1 | 1 | 0 |
| MS2507 | - | - | ! | 5-10 | 2 | 2 | 1 | 1 | 0 |
| | - | ! | ! | 5-10 | 2 | 2 | 1 | 1 | 0 |
| | - | - | ! | 5-10 | 2 | 1 | 1 | 0 | |
| | - | ! | ! | 5-10 | 2 | 1 | 1 | 0 | |
| MS2508 | - | ! | 0-2 | 10-15 | 2 | 1 | 1 | 1 | 0 |
| | - | ! | 0-2 | 15-20SFD | 1 | 1 | 1 | 1 | 0 |
| | ! | ! | 0-2 | 10-15 | 1 | 1 | 1 | 0 | |
| | - | ! | 0-2 | 10-15 | 1 | 1 | 1 | 0 | |
| NS3518 | - | ! | 0-2 | 10-15 | 2 | 2 | 1 | 1 | 0 |
| | ! | ! | 0-2 | 10-15 | 2 | 1 | 1 | 0 | |
| | ! | ! | 0-2 | 10-15 | 1 | 1 | 0 | | |

| | | | | | | | | | |
|--------|---|-----|-----|----------|-----|---|---|------|---|
| | - | ! | 0-2 | 15-20 | 2 | 2 | 1 | 1 | 0 |
| NS3520 | - | ! | 0-2 | 10-15SFD | 2 F | 2 | 1 | 0 | |
| | - | 0-2 | 0-2 | 10-15 | 2 F | 2 | 2 | 1SFD | 0 |
| | - | 0-2 | 0-2 | 5-15 | 2 | 1 | 1 | 0 | |
| | - | ! | 0-2 | 5-15 | 3 | 1 | 1 | 0 | |
| NS3566 | - | ! | 0-2 | 10-15 | 2 | 1 | 1 | 0 | |
| | ! | 0-2 | 0-2 | 15-20 | 2 | 2 | 1 | 1 | 0 |
| | - | 0-2 | 2-4 | 10-20 | 2 F | 1 | 1 | 1 | 1 |
| | ! | ! | 0-2 | 15-20 | 2 F | 1 | 1 | 1 | 0 |
| NS3567 | - | ! | 0-2 | 10-15 | 2 | 1 | 1 | 1 | 0 |
| | ! | ! | 0-2 | 15-20 | 2 | 1 | 1 | 0 | |
| | ! | ! | 0-2 | 15-20SFD | 2 | 1 | 1 | 0 | |
| | - | ! | 0-2 | 5-10 | 2 | 1 | 1 | 1 | 0 |
| NS3570 | - | ! | 0-2 | 15-20 | 1 | 0 | | | |
| | - | ! | 0-2 | 10-15 | 2 | 1 | 1 | 1SFD | 0 |
| | - | ! | 0-2 | 5-15 | 3 F | 2 | 2 | 1SFD | 1 |
| NS3571 | - | ! | 0-2 | 15-20 | 2 F | 2 | 2 | 1 | 0 |
| | - | ! | ! | 5-10 | 2 | 1 | 1 | 0 | |
| | - | 0-2 | 0-2 | 10-15 | 2 | 2 | 1 | 0 | |
| | - | ! | 2-4 | 10-15 | 2 | 2 | 1 | 0 | |

Norway Spruce Plantings and Weevil damage

| Location | Planting year | Weevil damage | Recovery |
|--------------------------|---------------|---------------|-----------|
| Caledonia | 1906 | moderate | moderate |
| Bunbury | 1920 | none | |
| Dalvey (west) | 1946 | heavy | poor |
| Dalvey (Ticket Booth) | 1946 | moderate | moderate |
| Mount Stewart | 1953 | none noted | |
| Iona | 1953 | light | excellent |
| Alliston | 1953 | none | |
| Prince Edward Home | 1954 | none | |
| Clinton | 1957 | moderate | excellent |
| St Eleanor's | 1957 | moderate | excellent |
| Tamawaby Demo Woodlot | 1958 | light | excellent |
| Afton Road | 1958 | extreme | very poor |
| Souris West | 1958 | heavy | poor |
| New Harmony Demo Woodlot | 1958 | heavy | poor |
| Clinton East | 1961 | light | excellent |
| York Point | 1961 | none | |
| Freetown | 1963 | moderate | moderate |
| North River | 1963 | moderate | excellent |
| Melville | 1967 | heavy | moderate |
| Auburn Demo Woodlot | 1967 | heavy | moderate |
| Tea Hill | 1968 | none | |
| Brookvale Demo Woodlot | | | |
| front plantation | 1968 | light | excellent |
| rear plantation | 1968 | light | excellent |
| Rice Point | 1968 | light | excellent |
| Bangor | 1970 | light | |
| 48 Road | 1973 | none | |
| near Rice Point | 1973 | none | |
| Cambridge | 1973 | light | moderate |
| Catherine's | 1974 | moderate | excellent |
| Ebenezer | 1974 | none | |
| Blooming Point | 1977 | moderate | good |
| East Bideford | 1978 | none | |
| St Patrick's Road | 1978 | none | |
| Port Hill Station Road | 1978 | light | |