

Field Survey of Plantations in Kings and Annapolis  
Counties, Nova Scotia

by

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## ABSTRACT

The report presents a detailed description of 77 plantations in Annapolis and Kings counties, Nova Scotia. Survival, growth and common injuries are discussed. Observations were made on spacing, the use of simazine and the application of furrow planting methods. The results of the survey are presented in tabular form.

The report also deals with the evaluation of introduced species in a demonstration area where several provenances of Norway spruce, red pine and hybrid larch were planted in designed experiments. It was observed that variability of soil structure was largely responsible for differences in survival and height growth between trees and provenances. In addition, extensive porcupine populations in the area caused heavy losses in hybrid larch and Norway spruce. The results suggest that proper consideration must be given to selection of sites, and susceptibility to injuries, when plantations of introduced species are to be established.

## RÉSUMÉ

Description détaillée de 77 plantations dans les comtés d'Annapolis et de Kings, Nouvelle-Ecosse. Discussion de la survie, de la croissance et des blessures communes. Observations de l'écartement, de l'usage de la simazine et de l'application des méthodes de plantage par sillons. Des tableaux réunissent les résultats du relevé.

Les auteurs évaluent aussi certaines espèces exotiques sises dans une aire dite de démonstration où plusieurs provenances d'Épinette de Norvège (Picea abies), de Pin rouge (Pinus resinosa) et de Mélèzes hybrides existent en plantations expérimentales. La variabilité de structure des sols s'avéra surtout responsable de différences de survie et croissance en hauteur chez a chaque provenance. En outre, les Porc-épics très nombreux dans cette région causèrent de fortes pertes en Mélèzes hybrides et en Épinettes de Norvège. On devra choisir avec soin les stations, et tenir compte de la vulnérabilité de ces espèces aux blessures de Porc-épics lors du choix de plantations d'espèces exotiques.

## INTRODUCTION

This is the second report on a recent assessment of plantations in southwestern Nova Scotia to evaluate and develop planting techniques for sites and conditions where regeneration problems exist. The first report was written by the present authors in 1972 (Maritimes Forest Research Centre, Int. Rep. M-74) and included the field survey of plantations in Queens and Lunenburg counties.

In the summer of 1972, a total of 77 plantations covering 511.5 acres in Kings and Annapolis counties were assessed for survival, and measured for height growth, and where possible dbh. In this report, preliminary results are presented, in tabular form (Appendix A, Tables 10 and 11).

## THE STUDY AREA

### *General Description*

Kings and Annapolis counties (Figs. 1, 2, and 3) are parts of the Atlantic Uplands (Loucks 1962) and lie in the western mainland of Nova Scotia. Kings County has an area of about 842 square miles and Annapolis County 1,302 square miles. The counties contain the fertile valleys of the Annapolis and Cornwallis Rivers commonly called the Annapolis Valley.

The chief owners of forest plantations in the two counties are the Nova Scotia Department of Lands and Forests and Bowaters-Mersey Paper Co. Ltd. which has forested lands in the eastern part of Annapolis County. Several owners of small forest properties have established Christmas tree and farm plantations. Kejimikujik National Park in the interior of Annapolis County is an important recreation area and tourist attraction.

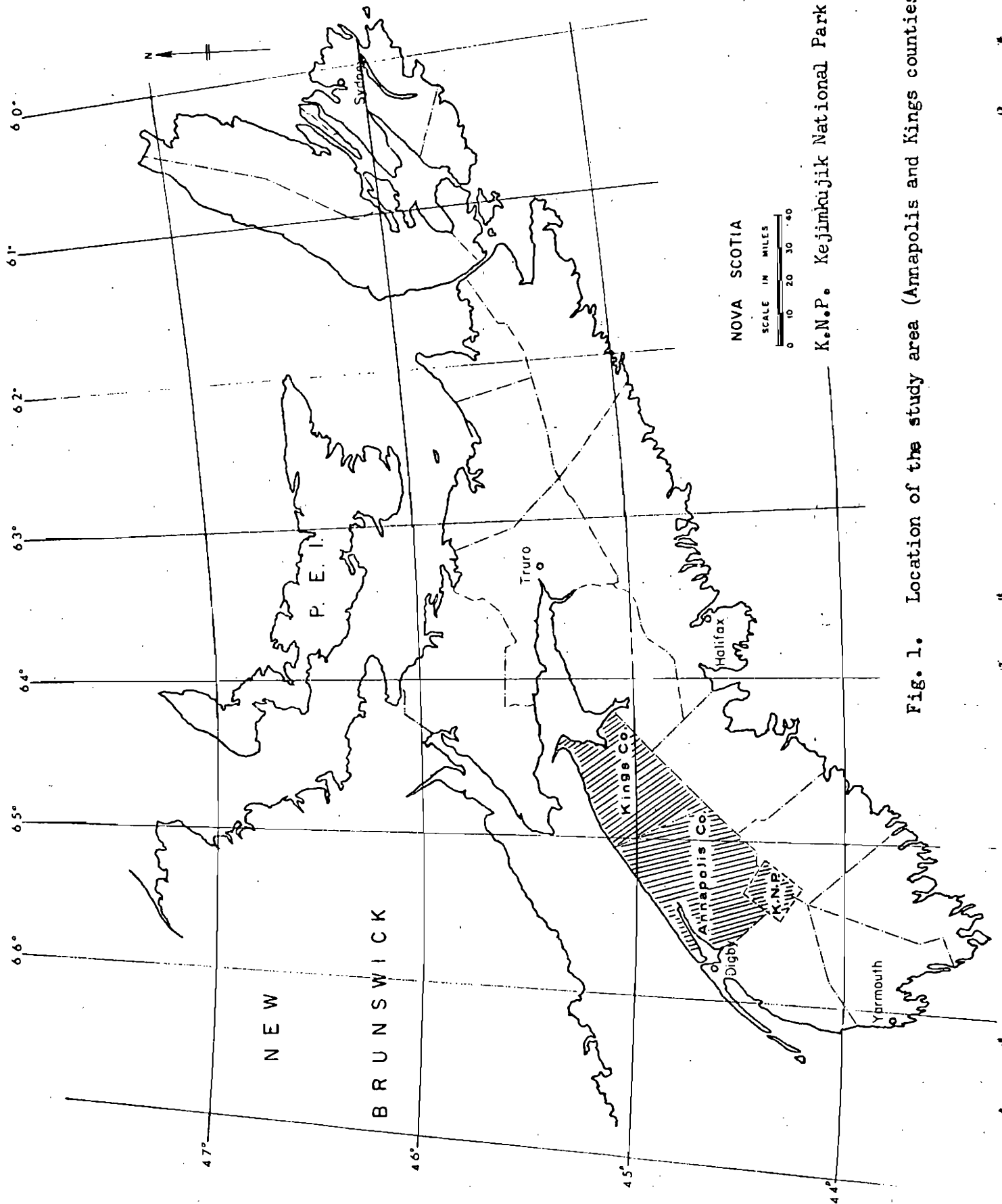


Fig. 1. Location of the study area (Annapolis and Kings counties).

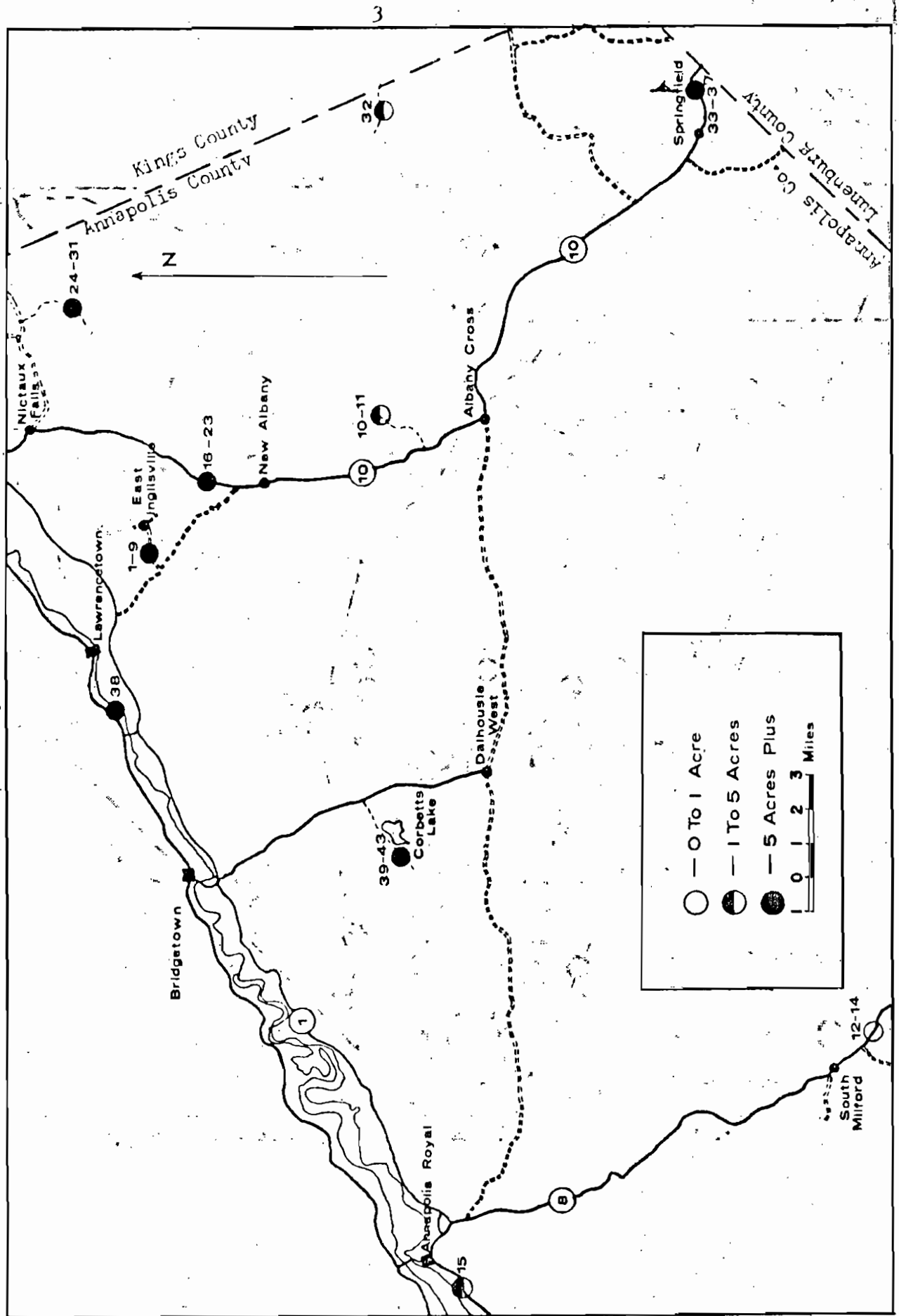


Fig2. Locations of plantations surveyed in Annapolis County

Table 1. Descriptions of common soil types at the planting sites\*

	Bridgetown (Bn)	Gibraltar (Ga)	Nictaux (N)	Wolfville (Wv)
Description of surface and sub-soil	Dark brown sandy loam over yellowish red sandy loam	Light brown sandy loam over light yellowish-brown sandy loam	Very dark gray, loose, coarse loamy sand over reddish-brown loamy sand, sometimes cemented	Brown to dark brown loam over reddish brown loam
Parent material	Sandy loam till and granitic material; shallow	Pale yellow, coarse sandy loam till; firm; stony	Water deposited stratified gravel or coarse silica sand; deep	Dark red to dark reddish-brown loam to sandy clay loam, till; moderately deep
Topography and drainage	Variable from gently undulating to strongly rolling; well drained	Gently to moderately undulating; well to rapidly drained	Level to undulating; well to excessively drained	Moderately undulating; well drained
Present land use	Agriculture	Forestry	Partly agriculture partly forestry	Agriculture
Land capability	Fair cropland	Unsuitable cropland; stony and shallow	Poor crop land; dry and stony	Good crop land

\* from MacDougall et al., 1969.

southwestern Nova Scotia. For instance, within the Ga soil series there are considerable variations in texture, color, depth, compaction or cementation depth, and type of humus that provide different conditions for plantations. In this study, the survival and growth are related to the given soil names. However, a mapping specific to forest soils would give an additional explanation of the relationships between survival, growth, and the above soil characteristics.

The remaining soil series, Nictaux (N), Wolfville (Wv), Morristown (Mn), Canning (Cg), with the exception of Rockyland (R) cover good agriculture lands and do not represent a significant number of plantations.

Most of the plantations, 76%, are on the Gibraltar soil series, 12% on Bridgetown, 6% on Nictaux, and 3% on Wolfville. The remaining 3% are on Morristown, Canning, and Rockyland soil series.

### *Vegetation*

Forest vegetation covers 78% of Annapolis County, and 58% of Kings County. The composition of the tree species is similar in both counties. Most are softwood, in descending order of abundance; red spruce, balsam fir, white pine, white spruce, hemlock, black spruce, and a few red pine and tamarack. The dominant hardwood is red maple, then white birch, red oak, aspen (chiefly largetooth aspen), yellow birch, beech, sugar maple, alder, wire birch, and a few white ash.

According to Loucks (1962) most of the forest can be classified into the red spruce-pine zone, although the south of Annapolis County especially the area of the Kejimikujik National Park, falls within the sugar maple-hemlock-pine zone. The hardwood-hemlock-pine forest association is characteristic of the transitional Acadian forests. It is probably one of the original climax forest types for the southwestern part of the peninsula. Excellent stands of mature hemlock still exist in the National Park, in spite of a long history of logging and fires in Nova Scotia (Dobson R. et al., 1970. File report, Kejimikujik National Park).

Red spruce thrives best on well-drained hillsides and drumlins. White spruce often replaces red spruce on the fresh sites and the former is an active colonizer of abandoned farmland except where excessive moisture favors alder and black spruce. White pine is dominant on glaciofluvial sands, and together with some red pine, form extensive mature second-growth stands on the valley floors adjacent to lakes and rivers (MacDougall *et al.*, 1969). In areas that have been cut over and have not burned, the soil remains well drained; aspen, wire birch, and white birch grow in association with a ground flora of crowberry, hudsonia, bearberry, and sweet-fern. On fire barrens, wire birch, red maple, red oak, and white birch succeed the initial heath species, such as blueberry, pin cherry, witherod, bracken, sheep laurel, and sweet-fern.

### *Methods*

Surveys were carried out between July and September 1972. Most of the plantations assessed were established as informal trials or for operational purposes but some were formal experiments. In each plantation except the experiments, 10% of the trees, that is, every tenth tree was measured for height, and where appropriate, dbh. In rows selected randomly by using a table of random numbers, estimates were made of survival and infestation by fungi and other organisms. In addition, the soil quality was assessed using the ground vegetation, the dominant and associated plant species, as indicators (Table 2).

A special survey was made of the trees in provenance trials established by the Bowaters-Mersey Paper Company Ltd., Liverpool, at Corbett Lake (Durling Field), Annapolis County (Fig. 2). The method of assessing these trials will be discussed later.

Table 2. Most frequent vegetation types

Dominant <sup>a</sup> species	Topography and soil	Commonly associated species
Bracken	Summit and side slopes of morainal prominences. Usually on Ga soil series in Annapolis and Kings counties; well-drained productive forest soil, the best of Ga.  In more acidic soil  In nitrogen-rich fresh soil	Lambkill, blueberry, sweet-fern, wintergreen, sweet gale, bunchberry, and hardwoods   Blueberry or huckleberry becomes dominant  Sweet-fern becomes dominant
Lambkill	Summit and side slope washed out; Bn and Ga as above; morainal prominences on rock, some- times imperfect drainage, poorer than the above.	Blueberry, sweet-fern, bracken, wintergreen, sweet grasses, sparse strawberry, huckle- berry, and rhodora clumps.
Broom crowberry	Tops of ridges and knolls; dry shallow soil on R soil type  In depressions; peat over rocks	Bearberry, wintergreen, sparse blueberry, and stunted huckleberry; lichen is conspicuous on rocks and boulders  Rhodora becomes dominant with huckleberry on lower slopes

a. Cover of 35% or more. Common and botanical names are given in Appendix B.

RESULTS OF ASSESSMENT  
*Conventional Plantations*

A total of 512 acres were assessed: 426 acres in Kings County and 86 acres in Annapolis County. The Department of Lands and Forests have planted 450 acres in both counties since 1960. Many of the earlier plantations were established for shelter or for Christmas trees, by private owners who did not keep proper records, and only a few of the larger private plantations were suitable for examination under this study.

In Kings County, 428 acres were reforested on cutover areas. Before cutting, about 232 acres were mixedwood, 143 acres softwood, and 53 acres hardwood. The conquests of hardwoods continuously change the regenerated and reforested areas from softwood to mixedwood forest types. In addition, 80.5 acres were planted in old fields formerly used for pasture or hay and grain production. About 3.0 acres of Rockyland were reforested in the southern part of Annapolis County.

Only coniferous species were used for reforestation. The major species planted were red spruce (42%), red pine (38%), Scots pine (8%), and white spruce (4%). The remaining (8%) were white pine, pitch pine, Jack pine, black spruce, Norway spruce, Sitka spruce, European (hybrid) larch, and Douglas fir.

*Classification of Vegetation*

Attempts have been made to record the vegetation but the factors involved in the plant-succession of the reforested areas varied so widely that it was practically impossible to use parameters that would meet the requirement of this study. Therefore a less sensitive survey of existing plant associations was made, and from this survey certain conclusions were drawn about the general transitory trends of the plantation sites.

In Annapolis County about 90% of the plantations were established on abandoned agricultural land with an undeterminable history. The most noticeable feature of the vegetation on these lands is the absence of

heath plants. The ground vegetation is made up of a comparatively wide variety of herbaceous species, many of which are definitely not typical of forest flora associations. Several of these plants were introduced from western Canada and Europe in grains and feeds (Roland, 1969). Several grasses have been found in the surrounding and open areas of the old field plantations and the distribution suggests that some of these grasses probably prevailed before the trees were planted. The dominance of Poa pratensis and Phleum pratense, both forage grasses, indicate well-drained meadow lands that had been cultivated for crops but the dominance of Bromus ciliatus or Anthoxanthum odoratum indicate old meadow lands that probably had little cultivation. The above grasses, as indicators, were associated with many ground plants in variable frequencies. Several of them were identified as Nardus stricta, Agropyron repens, Prunella vulgaris, Achillea millefolium, Holcus spicata, Trientalis borealis, Cornus canadensis, Danthonia spicata, and Lathyrus pallustris. Gerardia sp. was found on moist ground with various Panicum spp. while the prostrata form of Juniperus communis frequented dry, poorly drained sites.

The remaining 10% of the plantations in Annapolis County were established on burns and cutover areas. The herbaceous vegetation was typical of coniferous woodland. The most abundant species were Pteridium aquilinum, Cornus canadensis, Gaultheria procumbens, Trientalis borealis, Solidago sp., and scattered Cladonia sp. and Polystichum sp. The low shrub population, Kalmia angustifolia, was found mostly on open ground. Camptonia peregrina was present in scattered clumps in sunlit openings and Vaccinium angustifolium had lighter coverage than the above species. Gaylussacia baccata was found mostly on dry and barren-like exposures.

In Kings County most of the plantations are on burns and second-growth cutovers. Three ground plant communities were recognized and classified by their dominant species: Pteridium aquilinum, Kalmia angustifolia, and Corema Conradii (Table 2).

Red maple, pin cherry, and wire birch found on most of the old burns, appeared to enhance the survival of the planted trees,

particularly the spruces, by providing sufficient shade. However, where shrubby vegetation was abundant it utilized the soil nutrition and water so heavily that the planted trees died or remained stunted for years.

### *Spacing, Age Class, and Survival*

In most of the planted areas, trees were not spaced regularly because of slash, brush, and other obstructions, particularly in Kings County. Spacing and the number of trees per acre varied with conditions of the planting sites. The percentage distribution of the spacing used for the three main species is presented in Table 3.

The planting records have shown that the number of seedlings planted per acre ranged from 333 to 1000 for red pine, 200 to 666 for red spruce and 500 to 1000 for white spruce. The average for the three main species was 500 seedlings per acre. This was not sufficient to ensure a yield of a second crop equal to that of the original stand, even where the planted stock was supplemented with natural regeneration. It is suggested that an average of 1200 seedlings per acre be planted on cutovers where low survival is expected because of severe competition. A distribution chart of surviving species planted in Annapolis and Kings Counties is presented in Figure 4.

Age-class of the seedlings was a significant factor in survival. Four-year-old stock, transplanted at least once, exhibited the best results. Such seedlings generally have adequate root systems and are big enough to compete with herbs on old fields, and with shrubs and hardwood sprouts in cutovers (Appendix A and Table 3).

Early spring planting was most successful for red and white spruce in old fields and resulted in an average of 80 per cent survival. On the other hand, a trial of several late summer and autumn plantings at Torbrook, Annapolis County (Pl. record no. 31) in 1965 achieved highest survival with planting on 30 October, obviously due to the wet weather immediately after planting. This observation suggests that successful planting is much more dependent on weather in the fall than

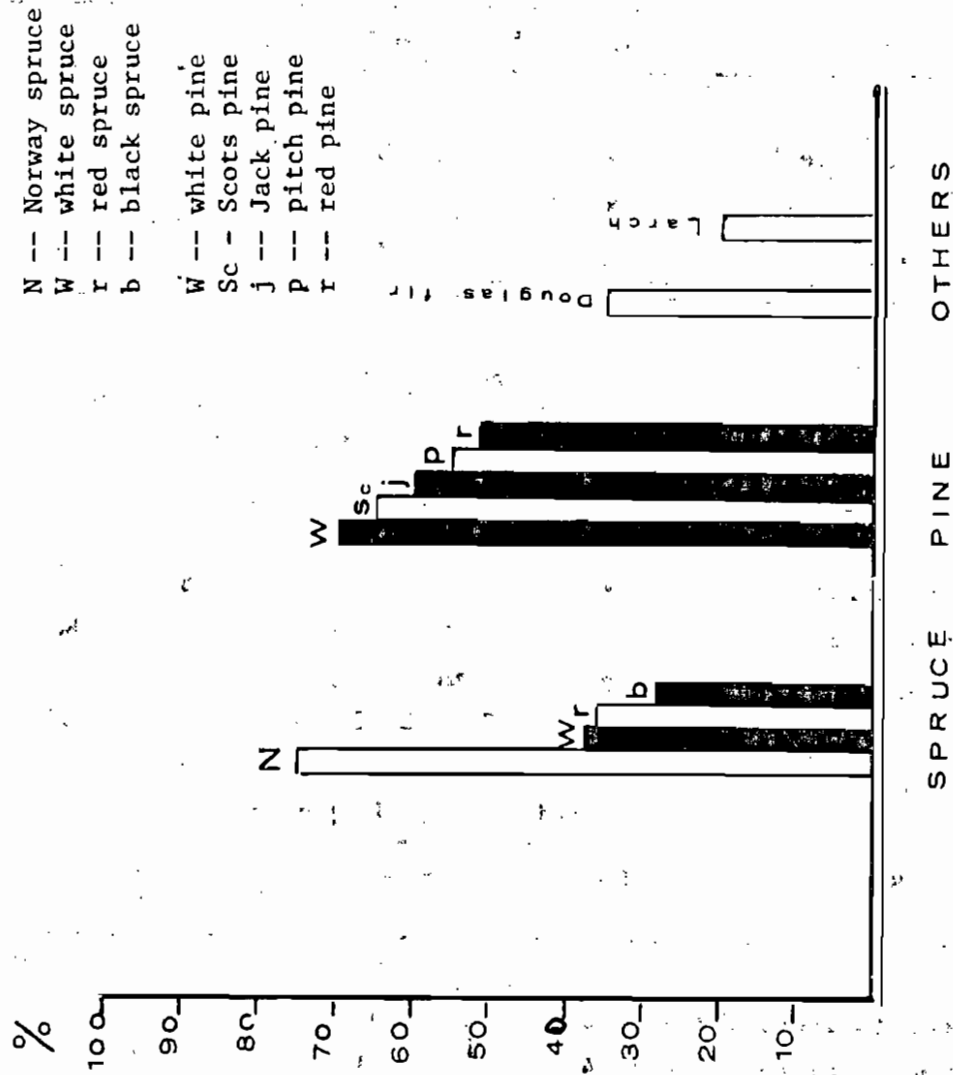
Table 3. Percentage distribution of spacing and age classes for the three main species.

Species	Spacing (ft)							Irreg.
	4x4	5x6	6x6	6x8	6x10	8x8	8x10	
White spruce	x	x	3	1	1	15	27	50
Red spruce	x	x	x	1	x	1	4	93
Red pine	1	1	2	1	x	40	8	48

Species	Age of Planting Stock					Most successful age-class
	2-2	3-0	3-1	3-2	4-0	
White spruce	x	25	25	15	35	3-1
Red spruce	x	18	x	2	80	4-2
Red pine	22	70	x	x	8	2-2

Species	Suitability in percentage			Total number of plantations
	Good	Moderate	Poor	
Pines (sP, wP, rP)	36	30	34	47
Spruce (wS, rS)	4	41	55	27

Figure 4. Survival percentage of species planted in Gibraltar soils, Kings and Annapolis counties



it is in spring. However, in general, there were no observed differences in survival between spring and fall planting.

Simazine, which was used in some plantations to reduce weed competition, may be beneficial if used with proper precautions. It was observed that in several plantations simazine was not properly applied. Presumably it was used during the period of bud flushing, and was responsible for high mortality of red spruce and white spruce in the plantations at Inglisville and Stoddarts, in 1972. Lighter damage was recorded on white pine and red pine (Table 4). Young tissues of spruces could accumulate a higher concentration of chemicals than the faster differentiating tissues of pines, and the high concentration of poisonous chemicals could cause burn-like symptoms and chlorosis in the delicate new or first-year shoots, which in most cases, results in death by wilting.

#### *Height Growth*

Conclusions drawn for height growth were based on trees planted in Gibraltar soil because most planting was carried out in this soil type. However, differences in slope, aspect, ground vegetation, microclimate, nursery factors, treatment of planting stock from nursery to plantation site, and planting methods may have influenced height growth more than soil differences in the variable Gibraltar soil series. The variations of height growth are illustrated by the standard error ( $S_{\bar{x}}$ ) for each plantation listed in the plantation records and collected separately in a file report (1973). It was observed that younger i.e. smaller planting stock grew more slowly than older i.e. larger planting stock.

The yearly trend in growth of the three main species is shown in Fig. 5. A strong relationship between height and year-since-planting (up to 17 years) was shown by red pine and white spruce but not by red spruce. The slow growth of red pine and white spruce immediately after planting is common, and is known as "planting check". The quality of site, mainly unbalanced drainage of the soil and weed competition can be

Table 4. Simazine damage to trees in five-year-old plantations

Location	Species	Year of planting	Simazine damage(%)
Inglisville	red spruce	1968	46
	white spruce	1968	47
Stoddarts	white spruce	1968	40
	white spruce	1967	37
	white pine	1967	25
	red pine	1967	12

Note: The trees were probably 3- or 4-years old when planted in 1967 and 1968.

	$\bar{x}$	$\bar{y}$			
	year	cm	b	r	
rP	9.46	14.95	1.72	.828**	
rS	7.31	12.48	.10	.104ns	
wS	9.60	15.30	1.06	.909**	

ns-not significant

\*\*-significant at 0.01 level

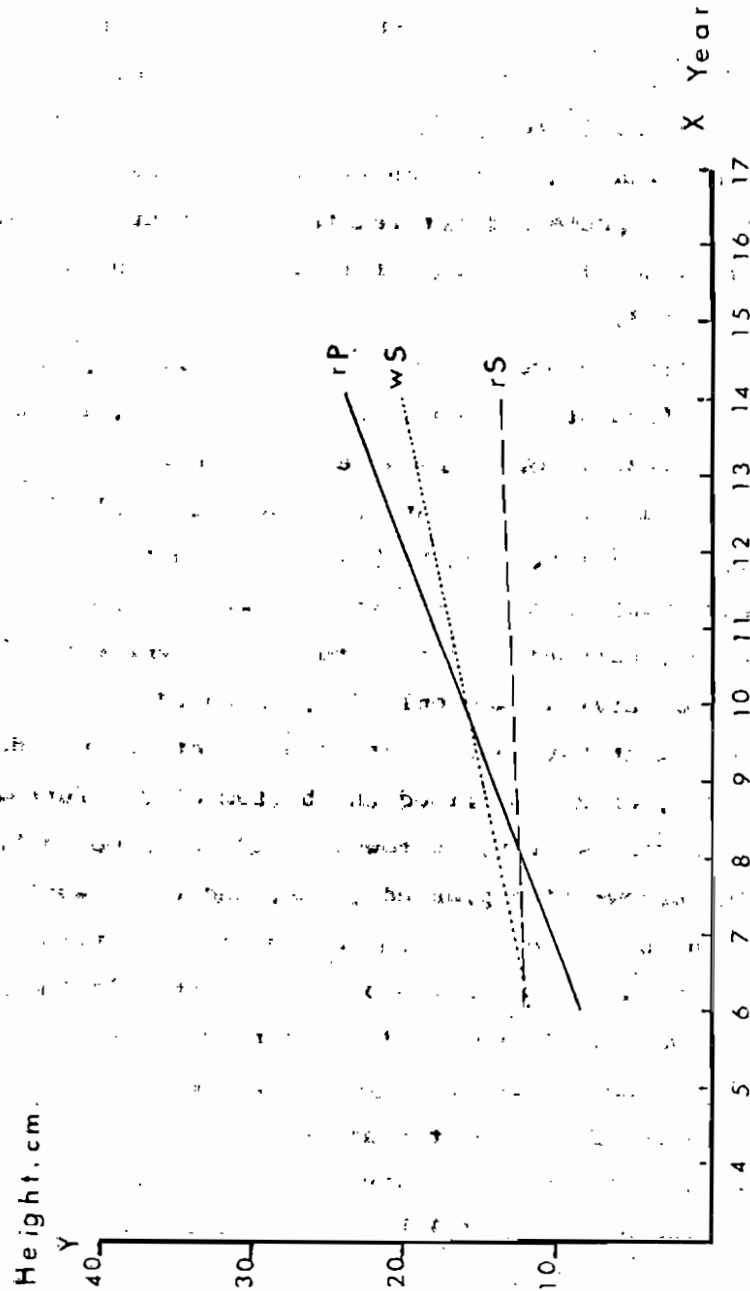


Fig. 5: Sample regressions of height on age for red pine, red spruce, and white spruce

of fundamental importance and responsible for planting check. A site which is too dry or exposed to frost can cause checking, and/or probably failure of planting. After about 8 to 10 years, the effect of site was less pronounced (Fig. 5) and the cumulative yearly height growth significantly related to the age of red pine and white spruce, whereas the yearly increment of red spruce seemed to be unchanged during the 17 years after planting. This observation may suggest that the height growth of red spruce did not relate consistently to the age of the tree but remained steady, and therefore it was not possible to define the checking period.

White spruce and white pine seedlings planted in furrows and on furrow-slices at Torbrook, Annapolis County, in an old field presumably cultivated for crops were assessed for survival and height growth. The analysed data are presented in Table 5. For both species, differences in height were highly significant five years after planting. The furrow planting had the better growth. However, survival did not show the same pattern. White spruce was adversely affected by furrow planting and survival was only 72%, compared to 84% on the furrow-slice. One reason might have been that spruce roots do not develop well in mineral soil, which comprised the bottom of the furrow.

During winter, furrow-planted trees would be more protected by snow than furrow-slice planted trees, and there would be higher moisture reserves in the furrows for the dry period of spring, which generally occurs in southwestern Nova Scotia in March. In the furrow, the ground vegetation was eliminated at least for the first two years after planting, and the weed competition was greatly reduced. It was observed that furrow planting is frequently advantageous to survival and growth of white pine on well-drained sites of old fields in Annapolis county whereas slice planting will be more beneficial for white spruce.

#### *Common Injurious Agents*

Levels of damage from fungi, insects, animals, and other biotic factors are presented in Table 6. Further details are included in the file report of plantation records (1973).

Table 5. Survival and height values for white spruce and white pine seedlings in a plowed site at Torbrook, Annapolis County. (Planted: spring 1967)

Species	In furrow			On furrow slice			F - value of height differences (ANOVA) $F_{.01} = 6.76$
	Df	Survival %	Height $\bar{x}$ cm	Df	Survival %	Height $\bar{x}$ cm	
White spruce	318	72	80.25	318	84	60.20	Significant at 0.01 % level $F = 63.43$
White pine	217	95	153.09	217	78	121.89	Significant at 0.01 % level $F = 35.83$

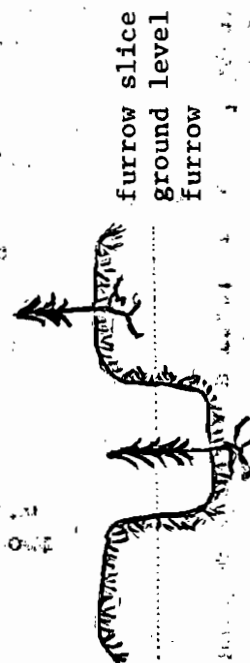


Table 6. Damaged stems by percent and causal agent

Species	Needle Cast	Root Rot	Aphids	Pine Shoot Moth	Larch Sawfly	Budworm	WP Weevil	Browsing	Porcupine	Late Frost
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## Percentage or rating

Pines	11	Tr	20	23			H	16	30	Tr
Spruces (Red, White)		15	46			Tr		16		23
Norway spruce			L			Tr	M		H	
Larch					L				H	

Note: Needle Cast (or Sooty Mold Fungi)

Aphids inc. Scale insects, pine tortoise scale and eastern spruce gall aphid on ns

Browsing mostly by rabbits or deer

Tr = trace, L = light, M = moderate, H = heavy

When a particular type of injury was found in several plantations, the number of damaged stems are shown as percentages of all stems. However, when a tree species was restricted to one or two plantations its specific incidence was rated as Tr - trace, L - light, about 1/4 of the trees; M - moderate, about 1/2 of the trees; H - heavy, more than 1/2 of the trees damaged or infested.

Trees planted under unfavorable environmental conditions were especially prone to aphid damage. Improper drainage of the soil could cause temporary damage to the conducting system of the tree that could lead to hydrolysis, wilting, and to a breakdown of chlorophyll. Such disease-inducing factors then constitute the cause and effect of infections, usually by aphids, ants, and black mold. For example, most of the red pine, red spruce, and white spruce heavily infested by aphids were found in poorly drained, shallow soils. The trees exhibited poor shape and growth on these soils. They were too long in the stage of "planting check" which caused reduced height growth and decreased survival. These observations suggest that site selection, particularly for spruces, requires very careful consideration and a knowledge of soil quality in the region. In Annapolis County, porcupine damage was significant on red pine and the exotics such as Norway spruce, hybrid larch, black pine, Japanese red pine, and particularly on Scots pine (Figs. 6, 7, and 8). This suggests that red pine and exotics should not be planted in areas where the existence of a large porcupine population is suspected, otherwise the trees will face serious damage which in most cases, will lead to the destruction of the whole plantation.

More extensive weevil damage was observed on planted white pines (Fig. 9) than on trees of natural regeneration. This indicates that trees of natural regeneration are less susceptible to weevil infestation than planted trees, probably because the planting sites are unsuitable for white pine.

#### *Experimental Plantations*

An experimental planting program was carried out by Bowaters-Mersey Paper Co. Ltd. at Corbett Lake from 1956 to 1959. As L. Holt,

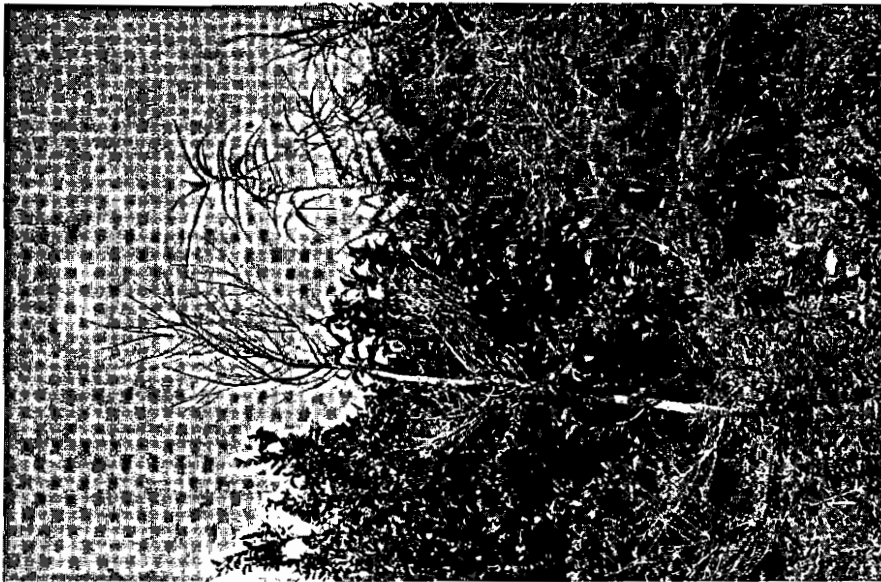


Fig. 7. Porcupine damage on larch at Corbett Lake, Exp. #202-C.



Fig. 6. Porcupine damage on red pine (white arrow). Tip blight and needle cast (black arrow).

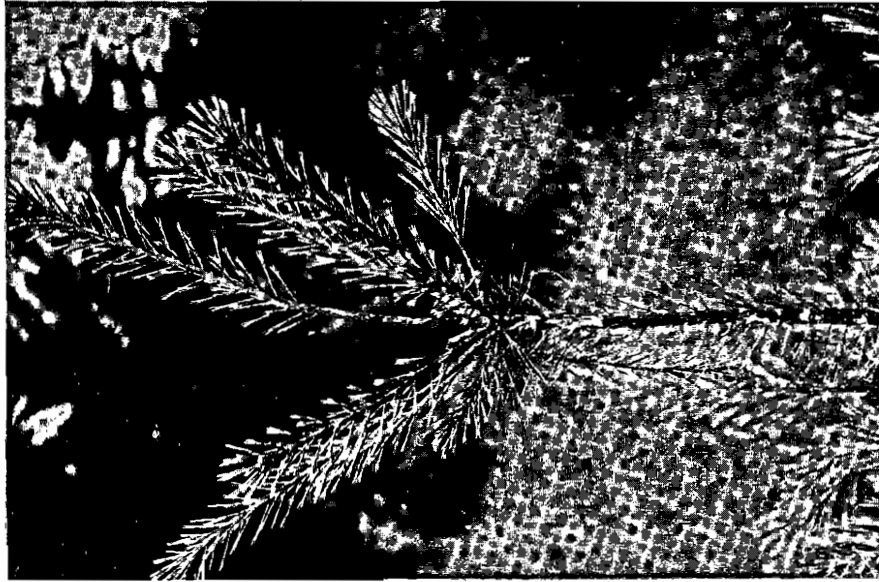


Fig. 9. White pine weevil on white pine seedling.

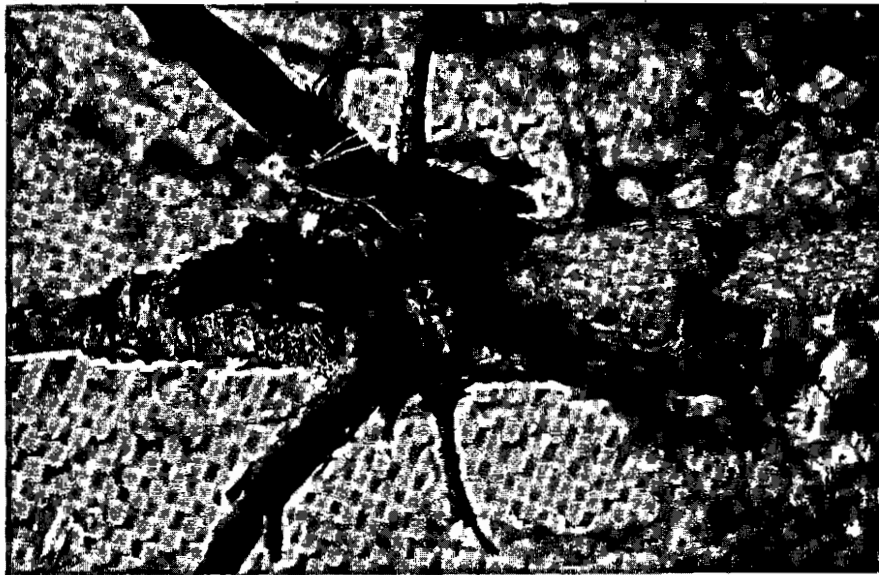


Fig. 8. Porcupine damage on Scots pine.  
Page Lake, #32.

Woodland Manager of the Company, pointed out at the time of planting, the main objective was to try different species of trees which may be suitable for reforestation in southwestern Nova Scotia.

The planting area was about 30 acres of abandoned farm land. Two sets of subplots (A and B in Fig. 10) were planted 0.5 mile apart, about 700 feet elevation, and oriented in an east-west direction. The soil type of the planting area was a grayish brown, coarse sandy loam over granite bedrock. Soil samples were taken from both subplots for analysis. The results are shown in Figure 10. On the basis of the analysis, W. Scott, (Personal Communication, 1973), stated that "Chemical analysis would suggest a reasonable site for red pine in terms of soil fertility. The acidity is not low, ranging from pH 4.7 to 5.4. Base levels are adequate. Total nitrogen levels in the Ah are high, particularly when compared to most Ap horizons of agricultural soils in the area. A compacted till occurred within 10 inches of the soil surface. This horizon was sufficiently compacted to preclude root penetration and restrict water movement."

Subplot A is located on a gentle slope and subplot B is on the ridge of an undulating hill. In the former, the soil is deeper and better drained. The soil at subplot B is shallow.

The ground vegetation is dominated by hay and sweet grasses reflecting the agricultural history. The area surrounding subplot A represents a black spruce - balsam fir - aspen forest but sugar maple, beech, yellow birch, red spruce, and white spruce predominate on the hills around subplot B.

Before planting, a tractor and plow ran furrows across the fields at 6-foot intervals. Along each furrow, trees were planted 5-feet apart, except where rock outcrops interfered.

In the years 1956, 1958, and 1959 a total of 10,000 trees, including Norway spruce, larch varieties, red pine, Japanese red pine and black pine were planted. The Japanese red pine and black pine were planted without replications in one block of the subplot B. Only a few trees survived the very heavy porcupine damage and, therefore, the plantation has not been assessed as an experiment. However, it is suggested that some trees of both species be kept for demonstration and

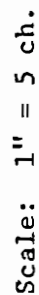


Fig. 10. Location of plantations surveyed at Corbett Lake, Annapolis County

for a seed source. On 2 November, 1956 a small quantity of seed of pindrow fir, Himalayan white pine, and deodar cedar were sown directly in subplot A but the seeds apparently did not germinate. Planting stock and seeds of the above species were obtained from the Canadian Forestry Service, Petawawa Forest Experiment Station, Chalk River, Ontario.

Red pine seedsource trial (Exp. #180).

This trial was established in subplots A and B (Fig. 10) in 1956. The total area of the plantation was about 1.7 acres and consisted of 10 different seedlots each in a separate block without replication (Table 7). The age-class of the transplants was 2-2 years.

In 1972, after 17 growing seasons from planting, all living trees were counted and the diameter and height growth of every fifth surviving tree were measured. The compiled data on survival, height growth, diameter, and volumes per hectare based on a common density of 1452 stems are listed in Table 7.

Statistical methods were not applied to compare differences in survival and height among seed sources because the seed sources were not replicated and the number of transplants per plot within seed sources ranged from 193 to 510.

The growing conditions in the well-drained soil of subplot A were much better for all provenances than for any provenance at the poorly drained site of subplot B. At subplot A, the trees were taller, had larger diameters, and good average survival, except for the Sault Ste. Marie provenance which suffered heavy porcupine damage (Table 7).

To provide an overall comparison between sites A and B, the height and diameter data were used to determine volumes per hectare, using Honer's (1967) formulae, and the common density of 1452 stems/hectare. Similar data are given for two 1956 plantations of red pine at Lake Paul, Kings County, grown from local seed and planted as 2-2 year old trees on cutover areas mapped as Gibraltar and Nictaux soils (Table 1 and Fig. 11). It is obvious that the well-drained site at Corbett

Table 7. Data from red pine seedsource trial (Exp. # 180) at Corbett Lake and similar plantations at Lake Paul.

Subplot	Source	Survival %	Height		Diam cm	Volume <sup>a</sup> per hectare m <sup>3</sup>
			Mean ( $\pm$ S <sub>x</sub> ) cm	Coeff Var %		
A Corbett Lake	Sturgeon Falls, Ont.	81	661 (13)	12	13.5	138
	Sault Ste. Marie, Ont.	55	637 (18)	14	14.0	109
	Chapleau, Ont.	85	530 (22)	24	11.2	96
	Hyndford, Ont.	78	543 (19)	19	11.9	89
	Thessalon, Ont.	74	558 (12)	19	10.4	82
	Average	75	585 (17)	18	12.2	104
B Corbett Lake	Vilas Co., Wisc.	74	375 (13)	19	9.0	37
	Batchewana, Ont.	70	360 (16)	25	8.6	35
	Mattawa, Ont.	63	369 (13)	19	8.1	30
	Raco, Mich.	66	351 (15)	22	8.6	30
	Geraldton, Ont.	74	338 (18)	29	8.1	27
	Average	69	360 (13)	23	8.4	32
C Lake Paul	Lawrencetown, N.S.*	70	497 (19)	26	8.6	44
D Lake Paul	Lawrencetown, N.S.**	80	460 (15)	28	7.1	35

a. Volume corrected for survival

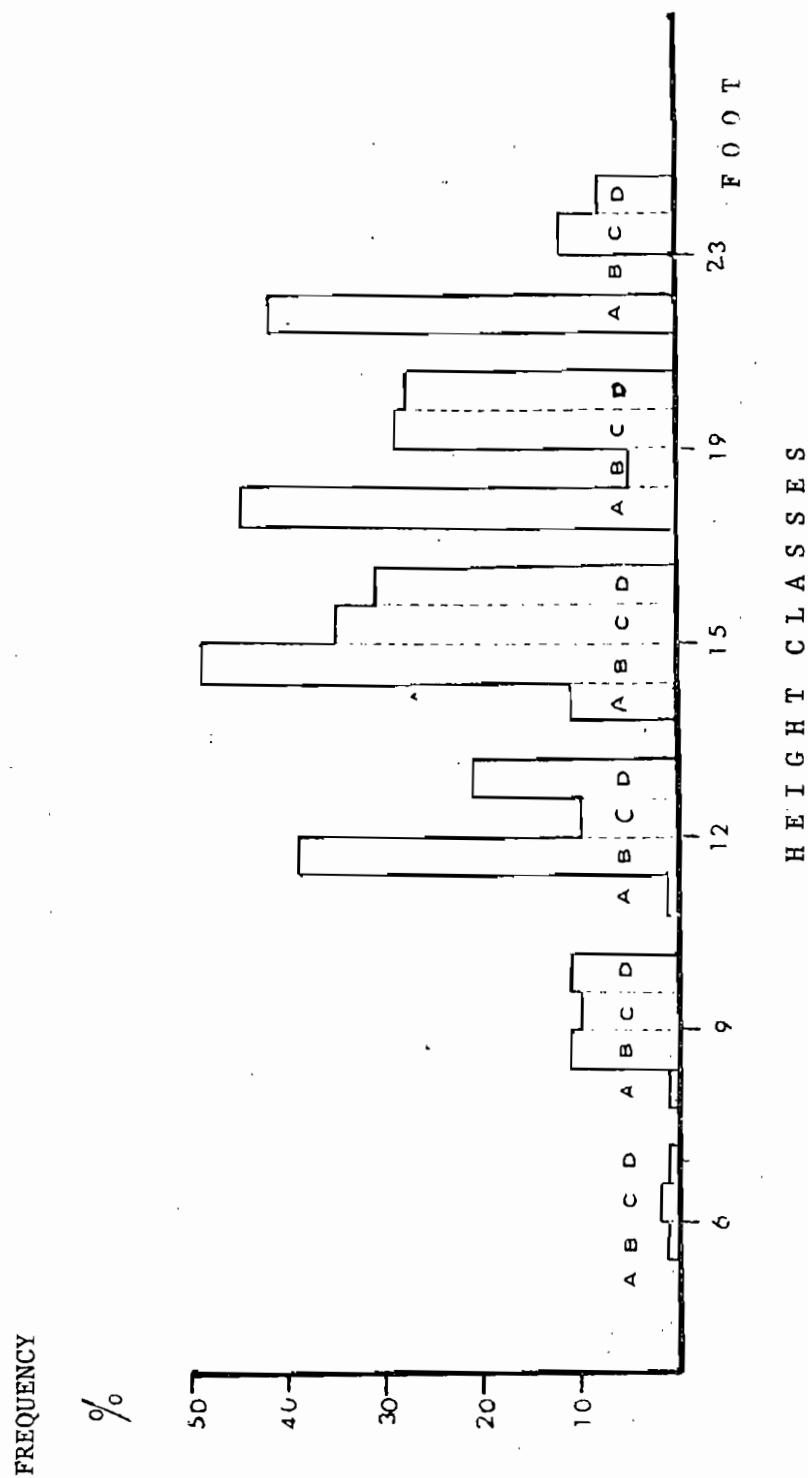
\* Planted in Gibraltar soil at Lake Paul, Kings County

\*\* Planted in Nictaux soil at Lake Paul, Kings County

Figure 11. Frequency distribution of red pine height classes after 17 years growth under various ecologic conditions

LEGEND:

- A - CORBETT LAKE A SUBPLOT (better site) (Ga)
- B - CORBETT LAKE B SUBPLOT (poorer site)
- C - LAKE PAUL (Ga)
- D - LAKE PAUL (N)



Lake produced much higher yields than the poorly-drained shallow soils. It is equally apparent that a plantation on an old-field site such as the above will yield a more uniform height growth, but not necessarily a higher crop than a plantation on a cutover such as at Lake Paul. This is also suggested by the means of the coefficient of variation for the various site conditions (Table 7).

It appears likely from the soil profile charts in Figure 12 that the compacted horizon in the soil of subplot B may be the primary cause for the decreasing yield of red pine. Soil samples taken in the summer of 1973 showed: 1) standing water despite the slope position, and 2) no root penetration of the compact horizon. Both conditions are unfavorable to red pine.

#### Red pine provenance trial (Exp. #96-A)

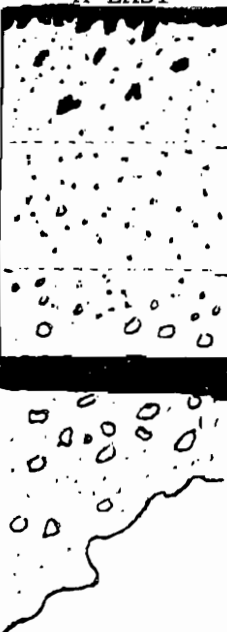
This trial is a part of a cross Canada red pine experiment and was established with 2-2 seedlings in subplot B in 1958.

It consists of five randomized blocks each containing one 49-tree plot from each of the eight provenances tested (Table 8). The total number of seedlings planted was 1960. In addition 1000 seedlings of local origin were used in two external surrounding rows and one internal dividing row.

In 1972, 15 growing seasons after planting, the plots were assessed for survival and height growth. The very low survival can be explained partly by the poorly-drained soil, the heavy porcupine damage, and insect infestation. Light needle cast on most trees, moderate European pine shoot moth damage, and stem girdling of undetermined origin caused a loss of 75% of the trees. In addition, speckled alder grew in clumps and suppressed almost all the trees planted in the most southern blocks of the area.

The results of the assessment suggest that provenances from Stanley, Hants County, the closest seedlot to the plantation site, exhibited the best survival and an average growth rate, while the Thessalon, Ontario, seedlot represented superior height growth and about average survival. Limited measurement data because of very low survival,

Figure 12. Schematic presentation of typical profile and fertility factors in various horizons of Bridgetown soil at Corbett Lake (Durling Field), Annapolis County.

A-EAST	Depth	Hori- zon	pH	Ca	K	Mg	Exch. cap.	% by W, N
	in.			m.e./100 g				
	9	Ah	4.9	1.62- 2.81	0.14- 0.41	0.26- 0.50	12.85	0.53
	9-16	Bf	5.0	0.42	0.04- 0.25	0.06	8.50	0.29
	16-20	Bf <sub>2</sub>	5.2	0.40	0.07	0.05	5.50	0.21
	20-23 compacted							
	23 +	C	5.2	0.33- 0.94	0.07- 0.30	0.05- 0.32	5.31	0.04- 0.18

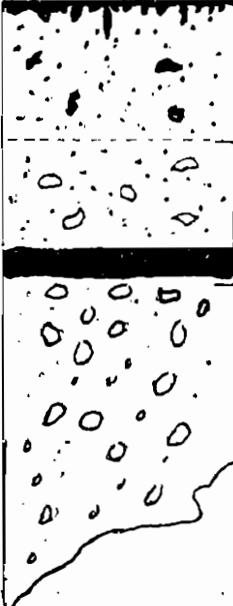
B-WEST	Depth	Hori-	pH	Ca	K	Mg	Exch.	% by	
	in.	zon		m.e./100 g			cap.		W, N
	9	Ah	4.8	1.26	0.17	0.21	13.63	0.47	
	9-12	Bf	4.9	0.17	0.05	0.05	4.57	0.08	
	12-16	compacted							
	16 +	C	4.7	0.42	0.10	0.07	10.29	0.44	

Table 8. Height and survival values of the red pine provenances at Corbett Lake, Annapolis County, 15 years after planting Experiment #96 - A

Source of seed	Long °W	Lat °N	Petawawa seedlot number	Survival %	Height (cm) ( $\pm S_{\bar{x}}$ )
Stanley, Hants County, Nova Scotia	63.0	45.0	S 2045	31	224 (6)
Grand Lake, New Brunswick	66.0	46.0	S 2046	30	215 (7)
Raco, Michigan, U.S.A.	85.1	46.4	S 1712	22	235 (9)
Petawawa, Ontario	77.3	45.9	S 1714	23	202 (8)
Thessalon, Ontario	83.5	46.3	S 1715	24	252 (9)
Sault Ste. Marie, Ontario	84.0	46.5	S 1716	28	222 (8)
Regina Bay, Ontario	94.0	49.4	S 1717	29	236 (8)
Pedley Twp., Ontario	80.0	46.3	S 1718	16	224 (12)

prevented verification of these results by statistical analysis. However, in the early stage of a plantation growing under severe conditions, capacity to survive is more important than capacity for height growth. From this standpoint, the Stanley provenance would seem to be better than the western provenances, for planting on poor site conditions as found in subplot B at Corbett Lake, Annapolis County.

Norway spruce provenance trial (Exp. #16).

The plantation was established in subplot A (the better site) in 1956. The trial consisted of four randomized blocks each containing about 200 2-2 transplants (range 183 to 210) from each of the four provenances (Table 9). One or more rows were planted around each seedlot and block, using the surplus stock from the corresponding provenance. The total number of the seedlings planted was 4,051.

Six months after planting survival was 90% but this had dropped to 81% after 17 growing seasons. The most important cause of mortality was porcupine damage. A tally of 101 trees showed 27 undamaged, 11 damaged but without dead areas, 48 damaged with dead tops, and 15 dead. Porcupine damage was the heaviest in the most-southern part of the plantation (same area of red pine trial #180 in subplot A). The most heavily damaged seedlot in each replication was the Istebna provenance while the Schwarzwald provenance was heavily damaged only in the above mentioned most-southern area; the other two seedlots were moderately attacked. Light weevil infestation was common in all blocks. Damage by spruce gall aphid was conspicuous in the Westerhof and Schwarzwald provenances but the other two appeared to be immune. Light infestation of spruce budworm was observed on the trees of Westerhof.

Dbh and tree height were measured for every fifth surviving tree. Statistical analysis (ANOVA) showed that there were differences in mean heights at the 1% confidence level among seed sources and at 5% level between replications. A range test indicated that the growth rate was best in Block 1 which was located in the lowest section of the planting area where trees had suffered the least damage from porcupines.

Table 9. Stand statistics of Norway spruce provenances at Corbett Lake  
17 years after planting

Source of seed				Height		Dbh	Yield
Location	Elev.	Long.	Lat.	Survival		Coeff of	$m^3/ha$
				$\bar{X} \pm (S_{\bar{X}})$	$\bar{X} \pm (S_{\bar{X}})$		
	m	$^{\circ}W$	$^{\circ}N$	%	m	var	
Schwarzwald, West Germany	550	9.0	48.6	82	5.22(0.21)**ab	24	8.75 51
Thuringerwald, East Germany	400	11.0	50.5	89	4.72(0.21)a	28	8.81 50
Westerhof, Harzen, West Germany	300	7.9	50.9	81	5.62(0.24)b	23	8.20 46
Istebna, Poland	580	18.9	49.5	67	5.58(0.21)b	21	8.58 42
* Austrian Alps, Greiner's Yield Table, Site Class II				100	5.11		5.60 56

Note: \*\*Mean height values followed by the same letter do not differ significantly at the 1% level.

\*Greiner's Yield Table estimates are based on fully stocked stands of 2870 stems/ha. Corbett Lake statistics are based on an original density of 3590 stems/ha reduced in accordance with mortality.

Height and diameter data were converted to volumes per hectare using Honer's (1967) formulae and the original spacing of 1.5 x 2.0 metre (3590 stems/ha.). These volumes were then reduced to allow for mortality in each seedlot (Table 9). To provide a comparison between the yield of these provenances and Norway spruce grown in Europe where the above seedlots were obtained, yield data were taken from Greiner's table for site-class II. Greiner's classification provides six distinct site classes determined on the basis of height-age relationships of trees growing in native spruce stands in Austria. This classification, in general, corresponds to the six site classes listed in the report of Nova Scotia Department of Lands and Forests on forest inventory (Anon. 1967) for 2870 stems/ha with an overall mean diameter of 8.58 cm and height of 5.24 m which provides  $47.4 \text{ m}^3/\text{ha}$  against  $56.0 \text{ m}^3/\text{ha}$  found by Greiner's volume table. The comparison, however, suggests that a Norway spruce planted on a good site in Annapolis County can produce a similar volume to those in Europe. According to Honer (1967), a native red spruce stand with identical stem numbers and measurements to the Norway spruce above, can produce  $48.0 \text{ m}^3/\text{ha}$  or  $686 \text{ ft}^3/\text{acre}$ .

On the basis of volume growth, the results of this report suggests that the provenance from Schwarzwald, West Germany may well be recommended for plantations in Annapolis County under conditions similar to those at Corbett Lake. Seeds source from Istebna, Poland, were less promising than the other three provenances. This observation on Schwarzwald seed source is important because this provenance has been planted widely in Canada.

Norway spruce is an important species in European forestry and its future role in Canada cannot be neglected. However, plantation sites will have to be carefully selected and the high variability of the strains being used, must be considered. There is now sufficient experience from Europe and eastern North America to show which sites and strains to select. Numerous papers have been published on site selection of Norway spruce in the United States drawing conclusions from provenance trials established for almost fifty years and many of those conclusions are applicable here.

Larch provenance trial (Exp. #202 - C)

This experiment was established in 1959 in subplot B (the poor site), between the two red pine experiments discussed above.

The experiment consisted of four randomized blocks each containing a 100-tree plot (10 rows of 10 trees), from each of the six provenances (Table 10). One row was planted around each seedlot using seedlings from the Acadia Forest Tree Nursery in New Brunswick. The total number of seedlings planted was 3400.

Fourteen growing seasons after planting, overall survival was 20%. Height growth of every surviving tree was measured. Significant differences in survival and height growth were not found between provenances. Statistical analysis showed however that there were differences in mean heights at the 5% confidence level and in survival at the 1% level between blocks. The lowest survival and height growth was in block II located at the southern end of the experimental area. The principal cause of mortality was porcupine damage, which started in the early stage of the plantation and has continued to the present. Most of the girdled and top damaged trees have died or will die and half of the 20% surviving are in very poor condition.

The above experiment does not suggest the feasibility of establishing larch plantations in the Corbett Lake area because of the large porcupine population. Several trees undamaged by the porcupine will be maintained for further demonstration of growth rates and for a possible seed source.

Table 10. Source, survival, and height growth of the larches, 14 years after planting at Corbett Lake, Annapolis County  
Experiment # 202 - C

Species, Varieties	Source of Seed		Petawawa seedlot number	Survival %	Height, cm ( $\pm$ SE)
	Location	Long. °W	Lat. °N		
<u>Larix decidua</u> var. <u>Sudetica</u>	Wroclaw, Poland	17.1	51.3	20	418 (12)
<u>Larix decidua</u> var. <u>Polonica</u>	Blizyn, Poland	20.8	51.0	15	460 (14)
<u>Larix decidua</u> var. <u>Polonica</u>	Kroszcieńko, Poland	18.9	49.5	15	346 (12)
<u>Larix decidua</u> var. <u>Polonica</u>	Groziec, Poland	20.5	50.5	26	430 (10)
<u>Larix decidua</u> var. <u>Polonica</u>	Skarzysko, Poland	20.9	51.1	22	404 (07)
<u>Larix decidua</u>	Farum, Denmark	12.4	55.8	20	431 (09)

Note: Seed germinated in 1957 and seedling planted as 1 - 1 in 1959

## REFERENCES

- Anon. 1967. Nova Scotia provincial inventory specifications, N. S.  
Dept. Lands Forests, Truro, N. S.
- Fekete, Z. 1926. Volume Tables for Forest Engineers (inc. Greiner's  
volume table). Erdomernoki Segedtablak. Faculty Forestry,  
Sopron, Hungary.
- Holt, L. 1958. File report on experimental plantations at Corbett  
Lake. Bowaters-Mersey Paper Co., Ltd., Liverpool, N. S.
- Honer, T. G. 1967. Standard volume tables and merchantable conversion  
factors for the commercial tree species of central and eastern  
Canada. Can. Forest. Serv. Inform. Rep. FMR-X-5.
- Loucks, O. L. 1962. A forest classification for the Maritime  
Provinces. Proc. Nova Scotia Inst. Sci. Vol. 25. 2. 1959-60.
- MacDougall, J. I., Nowland, J. L. and J. D. Hilchey. 1969. Soil survey  
of Annapolis county, N. S. Rep. No. 16. Can. Dep. Agri., Truro,  
N. S.
- Roland, A. E. 1969. The flora of Nova Scotia. The Nova Scotia Museum,  
Halifax, N. S.

Appendix A: Summaries of Plantation Records

Table 11. Summary of Plantation Records for Annapolis County (See Fig. 2 for locations and Table 12 for abbreviation)

Plantation number	1	2	3	4	5	6
Species	rS	rS	rS	rP	jP	pP
Planting date	5/68	5/68	5/68	5/68	5/68	5/68
Stock age (years)	3/2	3/2	3/2	2/2	2/0	3/0
Spacing (feet)	8x8	8x8	8x8	8x8	8x8	8x8
Survival (%)			80	90	60	25
Mean height (cm)	44	44	48	91	104	70
Soil type	<u>Mn-sh</u> C-2	<u>Mn-sh</u> C-2	<u>Mn-sh</u> C-2	<u>Mn-sh</u> C-2	<u>Mn-sh</u> C-2	<u>Mn-sh</u> C-2
Area (acres)	1	1	0.8	2	1	1
Status	Poor	Poor	Fair	Good	Fair	Poor
Number planted	500	600	400	1,000	500	500
Plantation number	7	8	9	10	11	12
Species	wP	wS	wP	rP	wS	sP
Planting date	5/69	5/68	5/69	5/67	5/65	?/36
Stock age	2/2	3/2	2/2	3/0	3/2	
Spacing (feet)	10x8	8x8	10x8	7x8	6x6	6x10
Survival (%)	70		90	50	>30	65
Mean height (cm)	61	39	53	85	70	1,500
Soil type	<u>Mn-sh</u> C-2	<u>Mn-sh</u> C-2	<u>Mn-sh</u> C-2	<u>Ga</u> C-4	<u>Ga</u> C-4	<u>Ga</u> D-3
Area (acres)	1	2	4	2	1	0.2
Status	Fair	Poor	Good	Poor	Poor	Fair
Number planted	400	1,000	1,600	1,000	1,000	
Plantation number	13	14	15	16	17	18
Species	wS	sS	sP	rP	rS	wS
Planting date	?/36	?/36	?/41	?/60	?/60	?/60
Stock age						
Spacing (feet)	6x10	6x10	6x6	6x8	6x8	6x8
Survival (%)	50	70	75			
Mean height (cm)	1,600	1,450	1,635	190	135	113
Soil type	<u>Ga</u> D-3	<u>Ga</u> D-3	<u>Cg</u> D-1	<u>Ga</u> C-4	<u>Ga</u> C-4	<u>Ga</u> C-4
Area (acres)	0.2	0.2	4	0.3	0.3	0.3
Status	Fair	Good	Good	Fair	Fair	Fair
Number planted						
Plantation number	19	20	21	22	23	24
Species	rP	sP	rS	wS	dF	rP
Planting date	5/54	5/52&5/53	11/70	11/70	10/68	5/66
Stock age	3/0	3/0	4/0	4/0	5/0	
Spacing (feet)	Irr.	Irr.	Irr.	Irr.	Irr.	8x10
Survival (%)	15	15	50	20	35	50
Mean height (cm)	310	370	38	31	63	120
Soil type	R	R	<u>Ga</u> C-4	<u>Ga</u> C-4	<u>Ga</u> C-4	<u>Wv-sh</u> C-2
Area (acres)	1	1.5	8	7	2	2
Status	Poor	Poor	Fair	Poor	Fair	Poor
Number planted	1,000	1,500	5,850	5,000	1,000	

Table 11. Continued

Plantation number	25	26	27	28	29	30
Species	wP	wP	rP	rP	wS	rS
Planting date	5/67	5/67	5/65	5/66	5/66&67	5/66
Stock age	3/0	3/0	4/0	4/0	3/1	
Spacing (feet)	8x10	6x10	6x6	6x6	8x10	8x10
Survival (%)	80	80	40	30	75	70
Mean height (cm)	93	142	117	109	70	72
Soil type	<u>Wv-sh</u> D-2	<u>Wv-sh</u> D-2	<u>Wv-sh</u> D-2	<u>Wv-sh</u> D-2	<u>Wv-sh</u> D-2	<u>Wv-sh</u> D-2
Area (acres)	1	1.5	4	1.5	5	2
Status	Good	Good	Poor	Poor	Fair	Poor
Number planted	500	1,000	2,000		2,700	

Plantation number	31	32	33	34	35	36
Species	rP	bS	wS	wS	rP	rP
Planting date	9-10/65	5/64	5/68	10/67	5/68	10/67
Stock age	3/0	3/0	3/0	6/0	2/2	4/0
Spacing (feet)	8x10	6x6	8x8	8x10	8x8	8x10
Survival (%)	60	5	50	55	45	70
Mean height (cm)	98	120	38	48	81	77
Soil type	<u>Wv-sh</u> D-2	<u>Ga</u> C-4	<u>Bn</u> C-4	<u>Bn</u> C-4	<u>Bn</u> C-4	<u>Bn</u> C-4
Area (acres)	1	3	2	1	2	1
Status	Fair	Poor	Poor	Fair	Fair	Fair
Number planted	500	2,000	1,000	500	1,500	500

Plantation number	37	38	39	40	41	42
Species	wP	sP	rP	rP	nS	rP
Planting date	5/67	?/38	5/56	5/56	5/56	5/58
Stock age	3/0					2/2
Spacing (feet)	8x8	6x12	5x6	5x6	5x6	4x4
Survival (%)	75	66	75	70	80	25
Mean height (cm)	69	1,860	585	400	530	200
Soil type	<u>Bn</u> C-4	<u>N</u> C-0	<u>Bn</u> C-2	<u>Bn</u> C-2	<u>Bn</u> C-2	<u>Bn</u> C-2
Area (acres)	0.5	7.5	1.5	1	2.5	2
Status	Poor	Good	Good	Good	Good	Poor
Number planted	200		1,320	1,000	3,150	1,960

Plantation number	43
Species	hL
Planting date	5/59
Stock age	
Spacing (feet)	4.5x6
Survival (%)	20
Mean height (cm)	420
Soil type	<u>Bn</u> C-2
Area (acres)	2
Status	Poor
Number planted	2,400

Table 12. Summary of Plantation Records for Kings County (See Fig. 3 for locations and Table 13 for abbreviations)

Plantation number	1	2	3	4	5	6
Species	rP	rP	rP	sS	rP	rP
Planting date	?/56	?/56	5/67	?/37	?/60	5/68
Stock age (years)						2/2
Spacing (feet)	Irr.	Irr.	Irr.	6x6	8x8	8x8
Survival (%)	5	35	10	60	85	80
Mean height (cm)	510	360	105	1350	340	80
Soil type	<u>Ga</u>	<u>N</u>	<u>N</u>	<u>Ga</u>	<u>Ga</u>	<u>Ga</u>
	B-4	B-4	B-4	B-4	B-4	B-4
Area (acres)	13	9	5	0.6	30	7
Status	Poor	Fair	Poor	Good	Good	Good
Number planted						
Plantation number	7	8	9	10	11	12
Species	rP	nS	rS	wS	rS	rP
Planting date	?/60	?/25	?/59	?/58	?/58	5/67
Stock age (years)						3/0
Spacing (feet)	8x8	10x8	Irr.	Irr.	Irr.	8x10
Survival (%)	85	75	55	10	10	40
Mean height (cm)	300	1450	210	370	190	70
Soil type	<u>Ga</u>	<u>Bn</u>	<u>Ga</u>	<u>Ga</u>	<u>Ga</u>	<u>Ga</u>
	B-4	B-3	B-4	B-4	B-4	B-4
Area (acres)	28	0.5	20	4	3	6
Status	Good	Fair	Fair	Poor	Poor	Fair
Number planted						3,800
Planting date	13	14	15	16	17	18
Species	pP	rP	rP	wS	rP	rS
Planting date	5/66	5/66	5/66	5/66	5/68	?/64
Stock age (years)	3/0	3/0	3/0	3/0	2/2	3/0
Spacing (feet)	8x10	Irr.	Irr.	Irr.	8x8	Irr.
Survival (%)	80	70	70	10	75	5
Mean height (cm)	100	80	60	40	90	60
Soil type	<u>Ga</u>	<u>Ga</u>	<u>Ga</u>	<u>Ga</u>	<u>Ga</u>	<u>Ga</u>
	B-4	B-4	B-4	B-4	B-4	C-4
Area (acres)	1	1.5	5	3	3	26
Status	Fair	Fair	Fair	Poor	Good	Poor
Number planted	500	1,000	3,000	2,000	2,000	13,000
Plantation number	19	20	21	22	23	24
Species	rP	wP	rS	sP	rS	rP
Planting date	5/66	5/66	10/70	?/60	?/65	?/60
Stock age (years)	3/0	3/0	4/0			
Spacing (feet)	8x10	8x10	Irr.	6x8	Irr.	Irr.
Survival (%)	10	10	30	85	5	80
Mean height (cm)	25	25	35	510	55	280
Soil type	<u>Ga</u>	<u>Ga</u>	<u>Ga</u>	<u>Bn</u>	<u>Ga</u>	<u>Ga</u>
	B-4	B-4	B-4	B-2	B-2	B-4
Area (acres)	4	1	142	31	3	6
Status	Poor	Poor	Poor	Good	Poor	Good
Number planted	2,000	500	30,000		2,000	2,000

Table 12. Continued

Plantation number	25	26	27	28	29	30
Species	rP	bS	rS	rP	rS	rP
Planting date	?/65	?/61	?/61	?/63	?/64	?/63
Stock age (years)		(-) <sup>a</sup>		3/0	3/0	3/0
Spacing (feet)	Irr.	Irr.	Irr.	Irr.	8x10	Irr.
Survival (%)	60	50	40	35	10	20
Mean height (cm.)	75	100	175	160	60	125
Soil type	<u>Ga</u>	<u>Ga</u>	<u>Ga</u>	<u>Ga</u>	<u>Ga</u>	<u>Ga</u>
	B-4	B-4	B-4	B-4	B-4	B-4
Area (acres)	27	6	3	6	8	22
Status	Fair	Fair	Fair	Fair	Poor	Poor
Number planted	22,000	2,000	1,000	3,000	2,000	7,000

<sup>a</sup> wildings pulled from woods

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Plantation number	31	32	33	34
Species	rP	sP	nS	dF
Planting date	?/39	?/39	?/39	5/31
Stock age (years)				2/2
Spacing (feet)	8x8	8x8	8x8	4x6
Survival (%)	95	80	70	80
Mean height (cm.)	1,500	1,000	1,400	1,800
Soil type	<u>Bn</u>	<u>Bn</u>	<u>Bn</u>	Eroded
	B-3	B-3	B-3	
Area (acres)	0.6	0.2	0.3	6.0
Status	Good	Poor	Poor	Very good
Number planted				

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Table 13. Abbreviations used in plantation record summaries (Table 11 and 22)

Group	Abbrev.	Full
Species	dF	Douglas fir
	hL	hybrid larch
	jP	jack pine
	pP	pitch pine
	rP	red pine
	sP	Scots pine
	bS	black spruce
	nS	Norway spruce
	rS	red spruce
	sS	Sitka spruce
	wS	white spruce
Planting date	-	month/year
	?/	month unknown/year
Stock age	-	seedling/transplant
Spacing	-	feet x feet
	irr	irregular
Soil type see page 6	Bn	Bridgetown
	Cg	Canning
	Ga	Gibraltar
	Mn	Morristown
	N	Nictaux
	R	Rockyland
	Wv	Wolfville
	sh	shallow

Appendix B. Common and botanical names of species  
cited in text.

Bearberry	<u>Arctostaphylos uva-ursi</u> (L.) Spreng.
Blueberry	<u>Vaccinium angustifolium</u> Ait.
Bracken	<u>Pteridium aquilium</u> (L.) Kuhn.
Broome grass	<u>Bromus ciliatus</u> (L.)
Broom crowberry	<u>Corema conradii</u> Torr.
Bunchberry	<u>Cornus canadensis</u> L.
Common Juniper	<u>Juniperus communis</u> L.
Common timothy	<u>Phleum pratense</u> L.
Common yarrow	<u>Achillea millefolium</u> L.
Couch grass	<u>Agropyron repens</u> L.
Gerardia	<u>Gerardia</u> sp.
Goldenrod	<u>Solidago</u> sp.
Heal-all	<u>Prunella vulgaris</u> L.
Huckleberry	<u>Gaylussacia baccata</u> (Wong.) K. Koch.
Hudsonia	<u>Hudsonia</u> sp.
June grass	<u>Poa pratensis</u> L.
Lichens	<u>Cladonia</u> spp.
Mat grass	<u>Nardus stricta</u> L.
Pincherry	<u>Prunus pensylvanica</u> L.f.
Proverty grass	<u>Danthonia spicata</u> (L.) Beauv.
Sheep laurel	<u>Kalmia angustifolia</u> L.
Sweet-fern	<u>Comptonia peregrina</u> (L.) Coult.
Sweet grass	<u>Anthoxanthum odoratum</u> L.
Star-flower	<u>Trientalis borealis</u> Raf.
Velvet grass	<u>Holcus spicata</u> or <u>lanatus</u> L.
Vetchling	<u>Lathyrus palustris</u> L.
Wintergreen	<u>Gaultheria procumbens</u> L.

Witherod	<u>Viburnum cassinoides</u> L.
Woolly panic-grass	<u>Panicum</u> spp.
Alder speckled	<u>Alnus rugosa</u> (Du Roi) Spreng.
Ash white	<u>Fraxinus americana</u> L.
Aspen largetooth	<u>Populus grandidentata</u> Michx.
Beech	<u>Fagus grandifolia</u> Ehrh.
Birch white	<u>Betula papyrifera</u> Marsh.
Birch wire	<u>B. populifolia</u> Marsh.
Birch yellow	<u>B. allegheniensis</u> Britton ( <u>B. lutea</u> Michx.f.)
Common Juniper	<u>Juniperus communis</u> (L.)
Deodar (Indian cedar)	<u>Cedrus deodora</u> (Roxb.) Loud.
Fir balsam	<u>Abies balsamea</u> (L.) Mill.
Fir pindrow	<u>A. pindrow</u> Royle
Hemlock	<u>Tsuga canadensis</u> (L.) Carr.
Maple red	<u>Acer rubrum</u> L.
Maple sugar	<u>A. saccharum</u> Marsh.
Oak red	<u>Quercus rubra</u> L.
Pine black	<u>Pinus nigra</u> var. <u>poiretiana</u> (Loud) Schn.
Pine Himalayan	<u>P. wallichiana</u> A. B. Jacks
Pine Japanese red	<u>P. densiflora</u> S and Z.
Pine red	<u>P. resinosa</u> Ait.
Pine white	<u>P. strobus</u> L.
Spruce black	<u>Picea mariana</u> (Mill) BSP.
Spruce Norway	<u>P. abies</u> (L.) Karst.
Spruce red	<u>P. rubens</u> Sarg.
Spruce white	<u>P. strobus</u> L.
Tamarack (Eastern larch)	<u>Larix laricina</u> (Du Roi) K. Koch.