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SEED ZONES FOR THE MARITIME PROVINCES

by

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"...the forester who has to plant trees of a (genetically) little-known species without benefit of provenance experiments is well advised to use (seed of) a local origin rather than take a chance on complete failure of a non-local type". J.W. Wright (1962).

Only recently has attention been paid to seed origin or seedling movement in the Maritime Provinces. To a large extent this condition results from our rather insignificant efforts at artificial forest regeneration in the past. With the advent of mechanical logging methods, shorter rotations, and a greater demand for wood, artificial regeneration will undoubtedly play a more important role in the forestry practices of this region. This will increase the need to control seed and seedling movements within and between various parts of the forest regions.

Trees like all living organisms exhibit inheritable differences depending on the genetics of the species, natural geographical distribution, geological history, local ecological factors, etc. Differences may occur between progenies of individual trees, groups of trees, stands, or larger units, or it may be expressed at all levels.

Studies with many tree species in Europe and North America have indicated that a large proportion of the variation within a species is associated with its geographical distribution. This variation can be discontinuous (ecotypic) or continuous (clinal), or both. At the present time our knowledge of the variation patterns of our native Maritimes species is not adequate to identify the kind of variation present. The type of genetic variation is very important for the determination of the limits within which seeds or seedlings may be safely moved. If, for example, it were known that the genetic variation of a species was continuous over the whole of the Maritime Provinces, it would only be necessary to determine the maximum distance that this species could be moved from its point of origin without encountering restricting environmental changes. For example, Langlet (1936) reported that, in southern Sweden, Scots pine should not be transferred more than 250 kilometers (150 miles) north or south or 300 meters (1,000 feet) difference in elevation. If genetic variation is discontinuous, i.e. uniform within a defined area but different between areas, the species can be moved rather long distances within the area, but only a short distance outside it (Wright, 1962).

In the absence of adequate knowledge of the geographic variation of our native species, it is advisable to adopt a tentative seed-zone system which will be functional regardless of the type of genetic variation present. Under such a system seed zones should be based primarily on environmental subdivisions of the geographical area. The zones should be small enough to prevent movement of the various species a distance greater than would be acceptable, should variation prove to be continuous, yet, the seed zones should be large enough for practical use in a reforestation program.

The following is an attempt to establish a number of workable seed zones for the Maritime Provinces. Changes in zone boundaries and the addition or deletion of zones can be expected as more information becomes available from seed-source experiments and other studies.

In delineating a system of seed zones for the Maritime Provinces an examination was made of climatic data (Putnam, 1940; Canada Department Mines and Technical Surveys, 1957; Canada Department Forestry and Rural Development, 1966), a forest classification for the Maritime Provinces (Loucks, 1962), topographic maps, unpublished phenological data for the Department of Forestry and Rural Development, and maps of equivalent latitude. On the basis of these data a general seed zone map was drawn (Figure 1). Table 1 lists some of the significant features of the zones. Table 2 lists the relationship of the Seed Zones and Loucks' (1962) Ecoregions.

Seed Zone 1.

Northwestern New Brunswick: This zone is distinguished by a late spring (1-3 weeks later than zones 3 and 7), a cool summer, abundant moisture at all times of the year, and a short growing season. The climate of the central and northwestern parts of this zone is more severe than that of the areas adjacent to zones 2 and 3. It is not considered desirable to delineate a separate seed zone for this area at the present time.

Seed Zone 2.

Northeastern New Brunswick: This zone is characterized by an average spring (approximately one week later than zones 3 and 7), (see Table 1) average summer heat, adequate moisture throughout the growing season, and an average

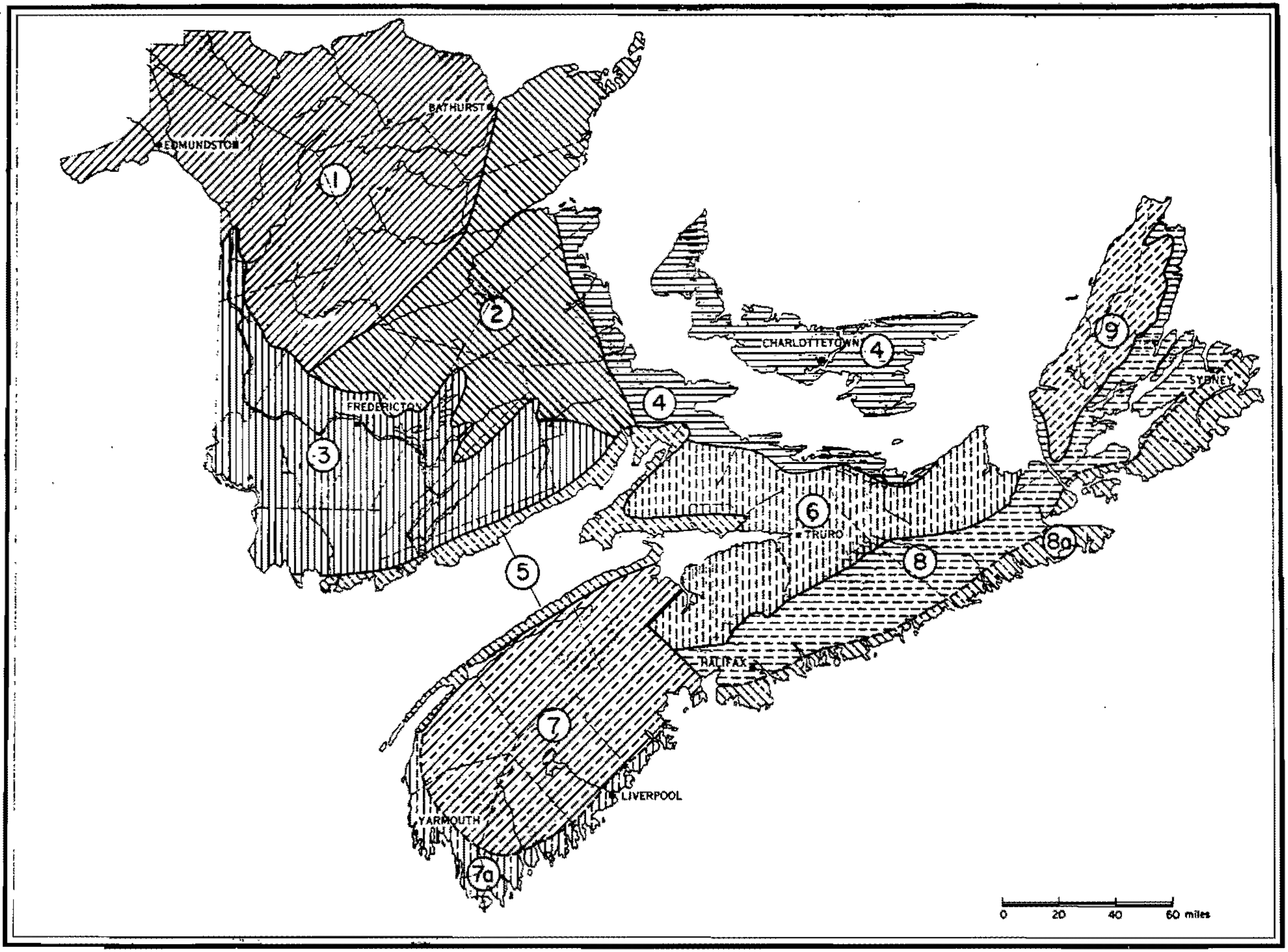

Fig. 1. Seed zones of the Maritime Provinces.

length of growing season. Climatically the zone is similar to, but somewhat more severe than, zone 3. Zones 2 and 3 have been separated because of the long north-south axis of the combined zones (three degrees at latitude). It is felt that selection in response to differences in photoperiod could be important over this distance (see Wright, 1962).

Seed Zone 3.

Southern New Brunswick: This zone is characterized by an early spring (earliest in the Maritime Provinces), warm summers, adequate moisture (a slight water deficiency may be experienced along the Saint John River valley), and a relatively long growing season.

Seed Zone 4.

Prince Edward Island - Eastern Shore: This zone is distinguished by an average spring (about one week later than zones 3 and 7), adequate summer heat, and an adequate to slightly deficient moisture supply during a long growing season. Exposure to wind is an important ecological feature of this zone. The Northumberland district boundary of Loucks' Maritime Lowland Ecoregion (excluding the portion north of Miramichi Bay) forms the boundary between seed zone 4 and zones 2, 5 and 6.

Seed Zone 5.

Fundy Bay: This seed zone is characterized by a late spring (1-2 weeks later than zones 3 and 7), cool summers, abundant moisture during all seasons, a long growing season, and relatively mild winters. Coastal fog and exposure to wind are important ecological features of the zone. In general the zone consists of a narrow strip of land around the Bay of Fundy. The actual width of the strip (approximately 10 miles) is variable, and is determined by the depth of penetration of coastal effects (especially fog and wind) which in turn are influenced by local topography.

Seed Zone 6.

North-central Nova Scotia: Considerable variation in elevation, exposure, and soil exists within this region. In general the zone experiences an average spring (about one week later than zones 3 and 7), warm summers, abundant moisture during the growing season, and a moderately long growing season. Exposure to wind, is usually not serious. For want of a better boundary and for ease of administration, the southern boundaries of Antigonish, Pictou, Colchester, and Hants Counties have been used to separate seed zones 6 and 8. The eastern boundary of Hants County separates zones 6 and 7.

Seed Zone 7-7a.

Southern Nova Scotia: This zone is distinguished by an early spring, warm summers, adequate moisture during all seasons (moisture deficiencies may occur in the Annapolis Valley), and a long growing season. Winds of hurricane force are not uncommon in the zone and are of ecological significance. Sub-zone 7a is differentiated from zone 7 by a strong coastal influence. Spring is approximately one week later in this sub-zone, exposure to wind is often extreme, and winters are relatively mild. Because of the limited merchantable forest area in the sub-zone, it has not been given zone status, and yet, because of the probable disadvantage of using seed from this coastal area for reforestation of inland areas, it has been delineated.

Seed Zone 8-8a.

Eastern Nova Scotia: This zone is characterized by a late spring (average two weeks later than zones 3 and 7), a tendency toward cool summers, adequate moisture during all seasons, a fairly long growing season, and moderate exposure to wind. The climate of sub-zone 8a is strongly influenced by coastal factors. The relationship of zone 8 and sub-zone 8a is the same as that of zone 7 and sub-zone 7a.

Seed Zone 9.

Cape Breton Hills and Highland: The characteristics of the seed zone are a very late spring (2-3 weeks later than zones 3 and 7), cool summers, abundant moisture during all seasons, a short growing season, and moderate to extreme exposure.

The climate of the north central core of this zone, the Cape Breton Plateau, is considerably more severe than that of other parts of the zone. For all intents and purposes this area will not be considered as part of the zone. It is doubtful if establishment of merchantable forests by means of artificial regeneration will ever reach significant proportions on the plateau. Seeds should not be collected from the plateau for use in other parts of the zone.

The river valleys along the northwestern shore of Cape Breton enjoy a climate that is considerably milder than is typical of seed zone 9. Seeds collected from trees growing in these valleys should not be used for reforestation in the more severe parts of the zone. Reforestation in the valleys should be done with local "valley" seeds or with seeds obtained from a climatically milder zone such as zone 6 or 8.

Seed Collection and Seed Movement within and between Seed Zones

General.

All seed collections for general reforestation purposes should be made from better-than-average trees growing in better-than-average stands. Seeds should not be collected from inferior trees nor from average trees growing in inferior stands.

Seed collections should be made from trees or stands of trees growing on sites similar to the average planting sites. For example, white spruce seeds should not be collected from trees growing on infertile exposed sites when it is envisaged that most planting of the species will be done on moderately fertile protected sites. The converse is also true. As inbreeding usually has a deleterious effect on seedling growth, seed collections should not be made from isolated trees or small isolated stands.

The seed zones delineated in this paper are probably detailed enough for most, if not all, of the tree species native to the Maritime Provinces. It is very likely more detailed than is necessary to adequately control the movement of species exhibiting limited variation, i.e. red pine.

The following is a brief summary of our present knowledge of the genetic variation of some of our more important native coniferous species. Tentative recommendations concerning the geographic movement of seeds and seedlings of these species within and between seed zones is also given.

White spruce.

White spruce, Picea glauca (Moench) Voss., has a ubiquitous distribution in the Maritime Provinces. Seed source tests (Holst, 1960, Nienstaedt, 1957), progeny tests (Holst and Teich, 1967) and inbreeding studies (Mergen, Burley and Furnival, 1965) have shown that this species is genetically variable at both the individual tree and population levels. Geographic variation is important. There is some evidence that a maritime ecotype exists in this species (Nienstaedt, 1957). Seed source tests presently established in the Maritimes and elsewhere should yield information concerning the quantity and pattern of genetic variation.

For general reforestation purposes, seed and seedling movements should be restricted to within the seed zones. In times of seed shortage, movement between adjacent, similar zones will probably be acceptable. Movement of seeds or seedlings originating in the coastal zones 4, 5, 7a and 8a to interior zones should be avoided.

The selection of superior stands to be developed as seed production areas is promising as this species responds well to fertilizer and other flower inducing treatments (Holst, 1961).

Black spruce.

Black spruce, Picea mariana (Mill.) B.S.P., is distributed throughout the Maritime Provinces. Seed source tests (Morgenstern, 1966) and inbreeding studies (Fowler, 1967) indicate that the progenies of both individual trees and populations exhibit inheritable differences. Geographic variation is important. In addition, hybridization and introgression with red spruce has increased the genetic variability of this species in at least some parts of the Maritimes (Morgenstern and Farrar, 1964). Seed and seedling movement should be restricted to within seed zones. Movement between adjacent zones will probably be necessary in emergencies. As with white spruce, coastal, highly exposed forms should be avoided as seed sources for inland zones.

It is doubtful if the selection and development of seed production areas will be advisable for this species because of the difficulty of seed collection from standing black spruce trees. This species is quite precocious. The establishment of seedling seed orchards such as described by Wright and Bull (1963) should be very promising. At the present time, an adequate supply of good seed could be obtained by reserving some of the best black spruce stands, cutting these in good seed years, and collecting the cones from the felled trees.

Red spruce.

Red spruce, Picea rubens Sarg. With the exception of parts of northwestern New Brunswick and Cape Breton and the coastal area of southern Nova Scotia, red spruce is found throughout the Maritime Region. Little is known about the genetic variation of the species. In the Maritimes, hybridization and introgression with black spruce has very likely contributed to the genetic variability of the species. It is also evident from observations of provenance tests established in the Maritimes, that geographic variation is present (McLeod, 1961; MacGillivray, 1967c). Nursery studies and small test plantings indicate that this species will be difficult but not impossible, to use in a general reforestation program.

Where red spruce is used for reforestation, seed movements should be restricted to within zones or, in emergencies between adjacent zones. The reservation and treatment of extremely good stands for seed production areas should be considered in zones where red spruce planting is envisaged.

Balsam fir.

Balsam fir, Abies balsamea (L.) Mill, is found in all parts of the Maritimes region. Although the species is an important forest tree in many areas, it is doubtful if it can be considered to be an important reforestation species except for special purposes such as Christmas trees. It is also of potential importance as a species for direct seeding. No detailed information on the genetic variability of this species is available, but measurements and observations of young seed source experiments indicates that geographic variation is present (MacGillivary, 1967b). Bracted balsam fir, A. balsamea Var. phanerolepis is most common in coastal areas (Myers and Bormann, 1963).

The establishment of seed production areas or seed orchards is not warranted at the present time except for special purposes such as the production of seed for superior Christmas trees.

Tamarack.

Tamarack, Larix laricina (Du Roi) K. Koch. is found scattered throughout the Maritimes Region with the exception of northwestern New Brunswick. At the present time, tamarack is not being fully utilized by the forest industries. Because of its rapid juvenile growth (Roe, 1952; MacGillivray, 1967a), good form (Roe, 1957), high wood density (s.g. .53; Brown, Panshin and Forsaith, 1949), and the ease of handling in forest nurseries, it is probable that the importance of this species will increase in the future. Our present knowledge of the genetic variation exhibited by tamarack is limited. Recently established provenance test (Pauley, 1965) and other studies (Chandler and Mavrodineau, 1965) indicate that geographic and individual tree variation are important.

In the absence of more information on the genetic variation of tamarack, seed and seedling transfer should be restricted to within seed zones wherever possible. In light of the strong genetic control over stem form and branching exhibited by the closely related European larch, Larix decidua Mill. (Søegaard, 1954), a similar genetic control can be expected in tamarack. Therefore, special emphasis should be placed on collecting seeds from the best trees growing in the best stands available within each seed zone where tamarack planting is anticipated.

Tamarack produces cones at an early age. Seedling seed orchards, such as described by Wright and Bull (1963), should be considered for this species.

White pine.

White pine, Pinus strobus L., is found scattered throughout most of the Maritime Provinces. It is scarce or absent in northwestern New Brunswick and parts of Cape Breton. It is also scarce in seed zones 5, 7a and 8a. Damage caused by the white pine weevil, Pissodes strobi (Peck.) and white pine blister rust, Cronartium ribicola Fish. makes it doubtful if this species can be considered important for reforestation except in areas where these factors can be controlled or where they are unimportant.

Seed source tests of white pine (Sluder, 1963; Funk, 1965; Fowler and Heimburger, 1967) indicate considerable geographic genetic variation for this species. Inheritable differences between individual trees is also important (Patton and Riker, 1958; Sullivan, 1966; Johnson, 1945; Fowler, 1965c). There is some evidence that there is a maritime ecotype (strain) of white pine (Mergen, 1963; Fowler and Dwight, 1964). Unfortunately, evidence of genetic variation of white pine within the Maritime Region is lacking. From studies in other regions, there is evidence that white pine moved north of its place of origin will grow more rapidly and survive almost as well as local white pine. For example, trees originating in the southern Applachians are winterhardy and grow well in southern Ontario at least for the first 10 years (Fowler and Heimburger, 1967).

In the absence of seed source information for the Maritimes it is advisable to restrict seed and seedling movements to within seed zones. If interzonal transfers are necessary they should be made from south to north. Trials of white pine from southern origins, such as high elevation southern Appalachians or Pennsylvania are warranted in the milder parts of the Maritimes (i.e. zones 3, 4 and 7).

White pine is well suited for seed production area management (Hocker, 1962). The reservation of exceptionally good stands for seed production areas is advisable.

Red pine.

Red pine, Pinus resinosa Ait., is found scattered throughout most parts of the Maritimes Region. Seed source (Rudolf, 1957; Hough, 1967) and inbreeding experiments (Fowler, 1965 a and b) have shown this species to be relatively uniform genetically. Geographic variation, although present, is small and the pattern of variation is obscure (Wright, Bull and Mitschelen, 1963). No detailed studies of red pine using several Maritime seed sources have been carried out. There is an indication that seed from the area near Stanley, Nova Scotia is inferior to seed from other areas when used in the Sandilands of Manitoba (Roller and Cayford, 1957).

Interzonal movements of red pine between zones 2, 3 and 4 and between zones 6, 7 and 8 are acceptable. It is doubtful if any extensive planting of red pine will be carried out in zones 1, 5 or 9. Until further information from seed source tests, presently established in the Maritimes, becomes available, it is advisable to avoid seed collected from the atypical, lowland red pine stands found in the area near Stanley, Nova Scotia. Red pine seeds should be collected from good healthy upland stands. The species is very well suited for seed production area management (Holst, 1961).

Jack pine.

Jack pine, Pinus banksiana Lamb., is found scattered throughout the eastern half of New Brunswick. It occurs sparsely and is of no commercial value, in western Prince Edward Island, (Gaudet and Profitt, 1958), and on the isthmus connecting New Brunswick and Nova Scotia. It is absent or scarce in the remaining parts of Nova Scotia.

Several seed source experiments (see Rudolf, 1958; Yeatman, 1965), progeny tests and controlled pollination studies (Rudolph, 1965; Fowler, 1965c) have indicated that both geographic variations and individual tree variation is extremely high for this species. Seed and seedling transfer should be restricted to within zones wherever possible. This is obviously not practical in Prince Edward Island and Nova Scotia. Jack pine seeds for use in zones 4, 5, 6, 7, 8 and 9 should be obtained from zones 2 or 3. Extensive trials of seeds from the southwestern part of the species range are also warranted, especially in zone 7. It is doubtful if the development of seed production stands is advisable. The species could be treated in a similar manner as suggested for black spruce. Stands of good quality trees should be reserved for cutting during good seed years and the cones collected from cut trees. The establishment of Seedling seed orchards, as suggested by Wright and Bull (1963), should also be considered for this species.

Exotic species.

The relatively mild, coastal areas of the Maritimes appear to offer excellent opportunities for the establishment of certain exotic tree species. With the exception of mature Norway spruce, *Picea abies* (L.) Karst. plantations in seed zones 4 and 5 (Hughes and Loucks, 1962) and some near mature plantations in zones 6 and 7, and sitka spruce, *Picea sitchensis* (Bong.) Carr. in zone 7, most of the exotic plantations in the Maritimes are too young for adequate evaluation. Unfortunately, the seed origins of these older exotic plantings are not known and thus it is not possible to obtain additional seeds of the same sources.

As the exotic plantations mature, they should be evaluated as to their suitability for reforestation. The plantations that prove to be exceptionally promising should be reserved as seed production areas. The movement of seeds from these seed production areas, except on an experimental basis, should be restricted to the seed zone in which the plantation is located and to eclogoically similar areas in adjacent zones. As results from test plantations and provenance tests of exotic species are obtained, exotics will very likely play an important role in reforestation in the Maritimes Provinces.

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Table 1. Climatic variables of the Maritime Provinces by seed zones

Seed zone	Precipitation, inches* Annual	Precipitation, inches* July-August	Water deficiency inches*	Frost-free period, days*	Spring phenology days later than Fredericton+	Equivalent latitude, range‡	Degree-days, number*
1	38-40	10-12	0	90-110	7-21	48-51	1800-2600
2	34-38	8-10	0	110-130	6-14	46-48	2200-3000
3	38-40	8-10	0-1	110-130	0-10	45-47	2600-3000
4	36-40	8-10	0-1	130	7-14	46	2600-3000
5	45	10	0	130	7-16	45-47	2600-3000
6	40-50	8-10	0	120-130	7-15	45-48	2600-3000
7	45-50	10	0-1	120-130	0-10	44-47	2600-3000
7a	55	12	0	130	?	43-45	2600-3000
8	45-50	10	0	120-130	10-20	45-48	2200-2600
8a	55	12	0	130	10-21	45-46	2200-2600
9	40-50	10	0	120	15-30	46-50	2200-2600

* Canada Department of Forestry and Rural Development (1966).
\+ Canada Department of Forestry and Rural Development - unpublished data (1967).
‡ 400 feet of elevation is equivalent to one degree of latitude.

Table 2. Relationship of Seed Zones to Ecoregions and Districts**

Seed Zone	Ecoregion	Districts
1	Gaspé - Cape Breton N.B. Highlands Maritime Uplands	Green River Nepisiguit, Tuadook Glasier Lake, Gounamitz, St. Quentin, Gulquac - Rocky Brook, Napadogan.
	Restigouche - Bras d'Or	Edmundston, Plaster Rock, Restigouche, Jacquet River, Sevogle.
2	Maritime Lowlands	Allardville, Nashwaak - Miramichi, Bantalor, Harcourt, Petitcodiac and north part of Northumberland Shore.
3	St. John River Magaguadavic - Hillsborough	Carleton Pokiok, Magaguadavic, Mount Pleasant, Grand Lake, Sussex.
	Maritime Lowlands Maritime Uplands	Oromocto Kierstead, Lepreau, most of Fundy Mountain.
4	Maritime Lowlands	Prince Edward Shore, all except north part of Northumberland shore.
	Magaguadavic - Hillsborough	Hillsborough
5	Fundy Bay	Musquash, Chignecto, North Mountain.
6	Maritime Lowlands	Oxford, Windsor - Truro, St. Mary's River
	Maritime Uplands	Cobequid Mountain, Pictou Uplands and north part of Musquodobit Hills.
	Magaguadavic - Hillsborough	West part of East River - Antigonish.
7	Clyde River - Halifax	All districts except eastern part of Fisher Lake - Halifax.
7a	Atlantic Shore	Cape Sable

Table 2. Relationship of Seed Zones to Ecoregions and Districts** (Cont'd)

Seed Zone	Ecoregion	Districts
8	Maritime Lowlands Maritime Uplands Restigouche - Bras d'Or	Sheet Harbour South part of Musquodoboit Hills Guysborough - Bras d'Or
8a	Atlantic Shore	Eastern Shore
9	Maritimes Upland Gaspé - Cape Breton Cape Breton Plateau	Cape Breton Hills Cape Breton Highlands

** Ecoregions and districts as delineated by Loucks (1962)