

# A STUDY OF NORTHERN WHITE CEDAR AND JACK PINE IN NOVA SCOTIA

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## ABSTRACT

The distribution of Northern White Cedar and Jack Pine in Nova Scotia has been investigated and mapped. Cedar is mainly centered in Annapolis and Digby Counties, where it occurs both as a lake-side and old-pasture tree in small, localized stands. Only one case of a planted seed source for old-pasture stands has been established. Jack Pine is more widespread in larger stands, occurring principally in the central part of the province, Cumberland, Colchester, and Halifax Counties. This species is commonly found on burned rock barren and sand plain sites, but also occurs as an old pasture tree. The trees, shrubs and herbs associated with Cedar and Jack Pine are those characteristic of the type of site on which these species are found. The soils supporting both tree species are highly acid, those of Cedar being less acid. The amount of exchangeable calcium in the soils supporting Cedar is significantly higher than in those supporting Jack Pine. No significant difference was found in the amount of exchangeable magnesium. It appears that drainage rather than pH or calcium content of the soils may be the limiting factor in the distribution of Cedar in Nova Scotia. This species exists as a post climax community about lake shores, and rarely as a pioneer forest stage in succession on old pastures. Jack Pine is found to be a pioneer tree on burned areas, particularly on rock barrens, and also possibly forms part of a physiographic climax on poorly drained sites.

Northern White Cedar and Jack Pine have been known to occur locally in Nova Scotia (Roland, 1947; Fernald, 1950), but considerable disagreement exists as to what geographic areas each occupies within the province, and also what factors may control this local distribution. The present study was undertaken in an attempt to determine more precisely the distribution of these species, their ecological status, and the influence which certain edaphic factors, namely pH value, exchangeable calcium and magnesium content of the soil, and drainage might have upon this localized distribution.

The Northern White Cedar (*Thuja occidentalis* L.) occurs from the Maritime Provinces, northern and western New England and New York State in the east, to Wisconsin, Minnesota, and Saskatchewan in the west, and from North Carolina, Tennessee, Ohio, Northern Indiana, and northeastern Illinois in the south to the south end of James Bay in the north. It is considered to reach its best development in northern Maine, northwestern New Brunswick, and the Gaspé Peninsula (Fernald, 1919)

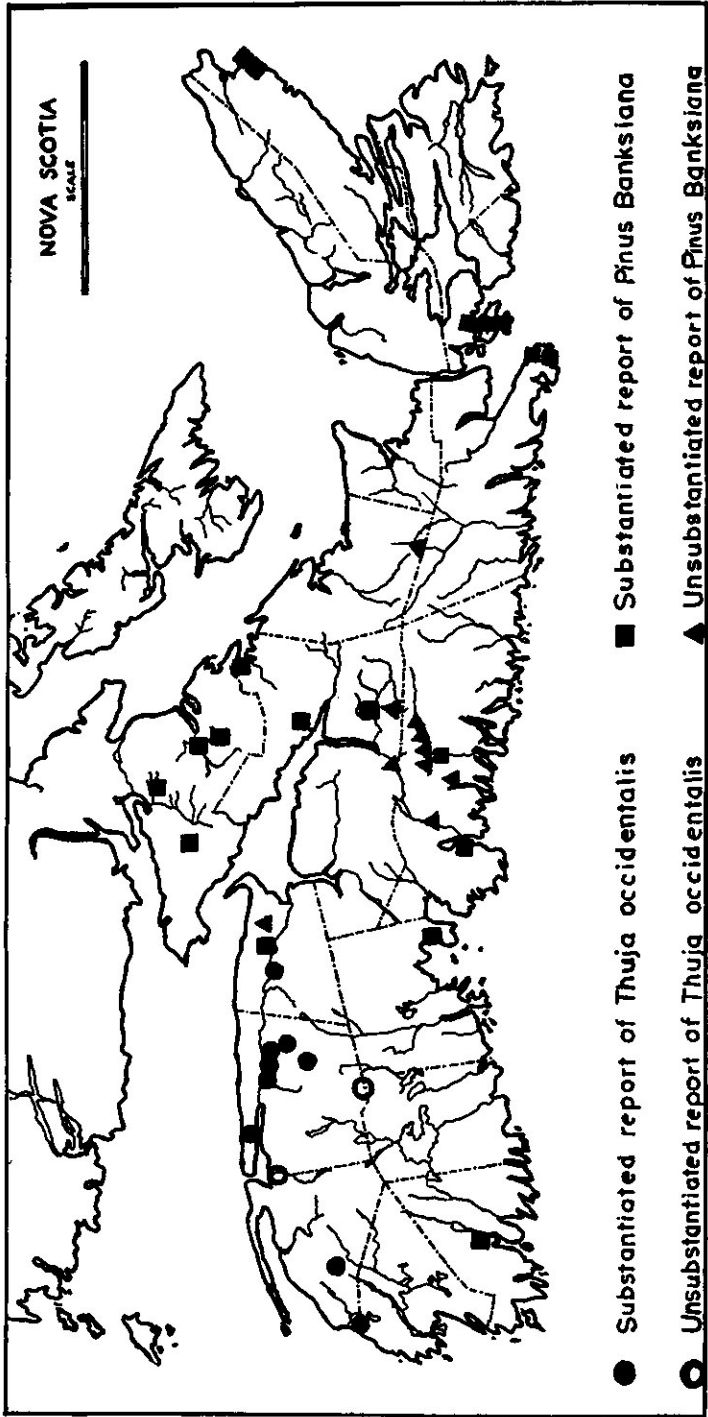
The first record of White Cedar in Nova Scotia is contained in reports of Titus Smith Jr. who noted it locally in the Annapolis Valley about 1801 (Gorham, 1955). Lindsay (1877) lists it as occurring in Cumberland County. Fernald (1922) reported stations in Digby and Yarmouth Counties. Roland (1947) states that it is scattered in the backwoods of Digby and Yarmouth Counties, and on old fields in Annapolis County.

Jack Pine (*Pinus Banksiana* Lamb.) ranges from Nova Scotia and New Brunswick in the east to northeast British Columbia in the west, and from western Maine, northern New York State, northwestern Indiana and Minnesota in the south to southeast Yukon and northern Quebec in the north. The species reaches its best development west of Lake Winnipeg (Fernald, 1919).

Possibly one of the earliest reports of Jack Pine in Nova Scotia was that of Holland in 1767, who mentioned a forest containing small pine on Janvrin Island, west of Isle Madame (Harvey, 1935; Bentley and Smith, 1956). The species was reported by Titus Smith Jr. (Clark, 1954; Gorham, 1955) in 1801 as occurring on high hills of rock in the province. Roland (1947) states that the species is common and spreading rapidly in Cumberland County, and rare in the Annapolis Valley and scattered eastward.

### Methods.

Information in regard to the possible locations of Jack Pine and White Cedar other than those reported in the literature was secured in a number of ways. The presence of Cedar was indicated in local place names, i.e. Cedarwood Lake, Cedar Lake, Cedar Brook. In some cases the presence of old planted White Cedar about old home sites indicated a local source nearby. Historical records were used, particularly in the case of Jack Pine. The most fruitful sources of information were the Forest Rangers and District Foresters of the Provincial Department of Lands and Forests. In all some ten locations for Cedar were established (Map 1). Jack Pine was reported from twenty-nine locations of which nineteen represent substantiated records (Map 1). Eight each of Cedar and Jack Pine stands was studied in detail, these stands being selected to give the widest possible distribution in the province. The particular stands studied are listed below:



Map 1.

White Cedar	Jack Pine
Cedar Lake, Annapolis County	Bayhead, Colchester County
Cedar Lake, Digby County	Cambridge, Kings County
Cedarwood Lake, Digby County	Martinique, Richmond County
Hillsburn, Annapolis County	Thompson Sta., Cumberland Co.
Lawrencetown, Annapolis County	Dover, Guysborough County
Ledgehill, Annapolis County	Gibraltar Rock, Halifax County
Rockland, Kings County	New Haven, Victoria County
West Paradise, Annapolis County	Rocky Lake, Aspotogan, Lun. Co.

Because of the extremely localized and restricted nature of some of the stands, no extensive sampling could be done. A combined descriptive and quantitative method of study was used. The selected areas were examined as a whole, and notes were taken on the forest cover, topography, drainage, elevation, and as far as possible, the historical background of these and the immediate surrounding areas. The more detailed quantitative portion of the study was made on five forty foot square quadrats in each sample area. These were laid down so as to include Cedar or Jack Pine. Within these quadrats the vegetation was noted in detail, all tree species were recorded for diameter breast height, height and age. Shrub and herbaceous ground cover, and seedling trees were recorded in two one meter square quadrats placed in opposite corners of the larger quadrat. Here the seedlings were counted and their ages determined, the ground cover species noted, and the abundance of each recorded. Soils were sampled by digging soil pits, five per sample area. Profile development was noted, and soil samples collected from the A2 and B layers. pH determinations were made on the spot using a standard colorimetric method. In cases where the soil profile was not well defined, soil samples were taken at depths of six and twelve inches. The soil samples were later analysed in the laboratory for the exchangeable bases, calcium and magnesium, in milli equivalents per 100 grams of soil; here too, the pH of the samples was redetermined using the electro-metric method.

### Northern White Cedar

Cedar has been found to occur in two types of habitat, the lake-side or swamp type, and the old-field or old-pasture type. Of the eight stands of Cedar sampled, three were of the former type: Cedar Lake, Annapolis County, Cedar Lake and Cedarwood Lake, Digby County; and five were of the latter type: Hillsburn, Rockland, Ledgehill, Lawrencetown and

West Paradise. All the stands of this latter type were located on sloping sites at the foot of a somewhat higher elevation.

In general, the lake-side Cedar stands appeared to be long established, containing old trees and reproducing themselves. The old-pasture stands on the other hand were younger and of a more doubtful origin. The Hillsburn stand was the most extensive of these, occupying most of an area two miles long by one mile in width. According to the local inhabitants, the Cedar here originally seeded in from a Cedar swamp higher up on the slope which was not located during the study. The area now occupied by the Cedar was said to have been cleared and burnt some forty to forty-five years ago, at a time when no cedar was present in the cut area. This explanation for the origin of the stand seems to be substantiated by the fact that no tree in the sample was more than 35 years old, and that the neighbouring brook is designated as Cedar Brook on maps of the area. The Rockland sample was somewhat similar in origin and nature. This stand occupied an area of some four acres in what is now a pasture, but which was clear cut thirty-one years previous to the study. A few old Cedar trees in excess of 100 years of age on the western edge of the stand had survived the cut. These trees had seeded in, in the direction of the prevailing winds with the youngest trees now being some three hundred yards to the east.

The stand at Ledgehill occupied an area of approximately two acres in a pasture which had been cleared originally some sixty years previous to the study, and which had again been partially cut five years ago. According to local sources, the Cedar had spread from planted trees at an abandoned farm in the vicinity, but no evidence of these could be found. West Paradise and Lawrencetown were similar in immaturity to the above, in the case of Lawrencetown (Plate I, Fig. 2) the oldest of the trees was found by a brookside. Evidence from local people and from the presence of old well rotted cedar stumps indicates the presence of Cedar in these areas for at least two generations.

Cedar in the lake-side habitat tended to occur in a mixed stand, with the trees often in a narrow band at the water's edge, or on the ice rampart at the edge of the lake-side forest, but not forming the dominant species (Plate I, Fig. 1). The

**PLATE I.**



**Figure 1. Cedarwood Lake. Large cedar trees on the ice rampart overhanging the water. Scatter herbs and young striped maple in shaded foreground.**



**Figure 2. Lawrencetown. A clump of tall cedar trees on the valley floor. Shaded background has scattered herbs. Unshaded foreground has rich herb cover.**

old-pasture Cedar on the other hand was local in nature, with the trees tending to occur in nearly pure stands and being the dominant species.

The tree species associated with Cedar at the lake-side sites varied considerably (Table I). In the three such sites studied, the Northern Red Oak (*Quercus rubra* L., var. *borealis* (Michx. f.) Farw.) was the dominant species in one, Hemlock (*Tsuga canadensis* (L.) Carr.) in another, while in the third Cedar was the most abundant and dominant species. Other tree species present in all three sites in varying numbers were Balsam Fir (*Abies balsamea* (L.) Mill.), Red Maple (*Acer rubrum* L.), White Birch (*Betula papyrifera* Marsh.), and Red Spruce (*Picea rubens* Sarg.), with others of the common tree species rare and scattered.

Most of the tree species present at the lake-side sites also occurred in the old-pasture stands, but in a different proportion. The typical old-pasture species, White Spruce (*Picea glauca* (Moench) Voss) and Wire Birch (*Betula populifolia* Marsh.) being much more common.

A shrub layer was present on both types of site, being absent or poorly developed only under a closed canopy. Speckled Alder (*Alnus rugosa* (DuRoi) Spreng., var. *americana* (Regel) Fern.), Huckleberry (*Gaylussacia baccata* (Wang.) K. Koch), Witch-hazel (*Hamamelis virginiana* L.), Raspberry (*Rubus idaeus* L., var. *strigosus* (Michx.) Maxim.), and Low-bush Blueberry (*Vaccinium angustifolium* Ait., var. *laevifolium* House) were present in all lake-side samples but varied in abundance from mere presence to seventy-five percent coverage. These species were rare or absent from the old-pasture stands. Fly-Honeysuckle (*Lonicera canadensis* Bartr.), Sweet Gale (*Myrica Gale* L.), and Leather-leaf (*Chamaedaphne calyculata* (L.) Moench, var. *angustifolia* (Ait.) Rehd.) were less common at the lake-side and absent from the old-pasture sites. Common Juniper (*Juniperus communis* L., var. *depressa* Pursh) and Bayberry (*Myrica pensylvanica* Loisel.) were the common shrubs, being present in four out of five samples. These in turn were rare or absent in the lake-side sites. Somewhat less common on the same sites were Downy Alder (*Alnus crispa* (Ait.) Pursh, var. *mollis* Fern.), Common Wild Rose (*Rosa virginiana* Mill.) and Raspberry. Lambkill (*Kalmia angustifolia* L.) was occasionally present on both types of site.

TABLE I  
DENSITY<sup>1</sup> AND ABUNDANCE PER CENTS<sup>2</sup> OF THE PRINCIPAL TREE SPECIES  
OF CEDAR STANDS

Species	Cedar Lake		Cedar Lake, Digby		Cedarwood		Hillsburn		Lawrencetown		Ledgehill		Rockland		West Paradise		Total	
	D	A%	D	A%	D	A%	D	A%	D	A%	D	A%	D	A%	D	A%	D	A%
<i>Abies balsamea</i> .....	0.8	2.9	8.4	13.4	0.8	1.5	0.8	1.3	6.8	14.8	8.8	12.3	5.0	5.8	0.4	0.4	4.0	6.2
<i>Acer pensylvanicum</i> .....	—	—	6.0	9.6	5.4	10.0	—	—	—	—	—	—	—	—	—	—	1.4	2.3
<i>Acer rubrum</i> .....	5.2	18.6	6.2	9.9	3.2	5.9	—	—	3.8	8.3	0.2	0.6	—	—	5.0	5.4	3.0	4.7
<i>Acer saccharum</i> .....	—	—	—	—	0.6	1.1	—	—	—	—	—	—	—	—	—	—	0.1	0.1
<i>Acer spicatum</i> .....	—	—	—	—	—	—	—	—	0.2	0.4	—	—	—	—	—	—	0.1	0.1
<i>Betula lutea</i> .....	—	—	6.0	9.6	4.8	8.9	—	—	0.4	0.9	—	—	—	—	—	—	1.4	2.2
<i>Betula papyrifera</i> .....	2.6	9.3	1.8	2.9	1.8	3.3	2.8	4.5	—	—	—	—	1.0	1.2	1.0	1.1	1.4	2.2
<i>Betula populifolia</i> .....	4.2	15.0	—	—	—	—	0.2	0.3	0.6	1.3	9.8	13.7	11.2	12.8	2.6	2.8	4.0	5.6
<i>Fagus grandifolia</i> .....	—	—	—	—	1.2	2.2	—	—	—	—	0.4	0.6	—	—	—	—	0.2	0.3
<i>Fraxinus americana</i> .....	—	—	—	—	0.6	1.1	0.2	0.3	0.4	0.9	—	—	—	—	—	—	0.2	0.2
<i>Larix laricina</i> .....	—	—	0.2	0.3	—	—	—	—	—	—	0.8	1.1	1.8	2.1	0.2	0.2	0.4	0.6
<i>Picea glauca</i> .....	—	—	3.0	4.8	—	—	2.8	4.5	0.2	0.4	16.8	23.5	11.8	12.5	2.2	2.4	5.0	7.3
<i>Picea rubens</i> .....	2.4	8.6	7.4	11.8	4.4	8.1	2.8	4.5	5.6	12.2	1.4	2.0	15.4	17.7	—	—	5.0	7.7
<i>Pinus strobus</i> .....	0.4	1.4	—	—	—	—	—	—	—	—	—	—	0.2	0.2	0.2	0.2	0.2	0.2
<i>Populus grandidentata</i> .....	—	—	0.2	0.3	0.4	0.7	—	—	—	—	—	—	—	—	—	—	0.1	0.2
<i>Populus tremuloides</i> .....	—	—	—	—	—	—	—	—	—	—	0.6	0.8	0.2	0.2	—	—	0.1	0.2
<i>Prunus pensylvanica</i> .....	—	—	—	—	0.4	0.7	—	—	—	—	—	—	—	—	0.4	0.4	0.1	0.2
<i>Prunus virginiana</i> .....	—	—	—	—	—	—	—	—	—	—	0.4	0.6	—	—	—	—	0.5	0.8
<i>Pyrus americana</i> .....	0.4	1.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.1	0.1
<i>Quercus rubra</i> <i>var. borealis</i> .....	7.0	25.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.0	1.4
<i>Thuja occidentalis</i> .....	5.0	17.9	23.4	37.4	8.6	15.9	52.6	84.0	24.6	53.5	25.6	35.9	40.6	46.5	81.2	87.1	33.0	51.8
<i>Thuja canadensis</i> .....	—	—	—	—	22.0	40.6	—	—	0.2	0.4	—	—	—	—	—	—	3.0	4.4
<i>Ulmus americana</i> .....	—	—	—	—	—	—	—	—	—	—	6.4	9.0	—	—	—	—	1.0	1.3

<sup>1</sup>Density = average number of trees per quadrat.

<sup>2</sup>Abundance per cent = percentage of the number of individuals of one species in the total number of individuals of all species.



The herbs, like the shrub layer, were best developed in open areas and completely absent only in the very dense old-pasture stands. Wild Sarsaparilla (*Aralia nudicaulis* L.), Clintonia (*Clintonia borealis* (Ait.) Raf.), Bunchberry (*Cornus canadensis* L.), Strawberry (*Fragaria virginiana* Duchesne), Twin-flower (*Linnaea borealis* L., var. *americana* (Forbes) Rehd.), Wild Lily-of-the-valley (*Maianthemum canadense* Desf.), Partridge Berry (*Mitchella repens* L.), Cinnamon Fern (*Osmunda cinnamomea* L.), and Starflower (*Trientalis borealis* Raf.) were characteristically present at the lake-side sites. Of these the Wild Lily-of-the-valley, Strawberry, and Cinnamon Fern were also common in the old-pasture cedar stands. Here too, Yarrow (*Achillea Millefolium* L.), *Carex pallescens* L., var. *neogaea* Fern., Mouse-ear Chickweed (*Cerastium vulgatum* L.), *Glyceria striata* (Lamb.) Hitchc., var. *stricta* (Scribn.) Fern., Common Woodrush (*Luzula multiflora* (Retz.) Lejeune), Heal-all (*Prunella vulgaris* L.), Tall Field Buttercup (*Ranunculus acris* L.), Rough Goldenrod (*Solidago rugosa* Ait.), and Common Speedwell (*Veronica officinalis* L.) were also commonly present (four out of five samples). This latter group of species includes a number which are weed survivals from the fields and pastures upon which the Cedar stands are developing.

Less commonly occurring species, seemingly restricted to one or the other of the two Cedar types, are listed below.

Lake-side Type	Old-Pasture Type
<i>Aster acuminatus</i> Michx.	<i>Aster lateriflorus</i> (L.) Britt.
<i>Aster macrophyllus</i> L.	<i>Carex debilis</i> Michx., var. <i>Rudgei</i> Bailey
<i>Carex disperma</i> Dewey	<i>Chrysanthemum Leucanthemum</i> L., var. <i>pinnatifidum</i> Lecoq. and Lamotte
<i>Carex Novae-angliae</i> Schwein.	<i>Hieracium Pilosella</i> L.
<i>Dalibarda repens</i> L.	<i>Oxalis europaea</i> Jord.
<i>Drosera rotundifolia</i> L.	<i>Potentilla simplex</i> Michx.
<i>Osmunda regalis</i> L., var. <i>spectabilis</i> (Willd.) Gray	<i>Taraxacum officinale</i> Weber
<i>Polypodium virginianum</i> L.	<i>Veronica serpyllifolia</i> L.
<i>Streptopus roseus</i> Michx., var. <i>perspectus</i> Fassett	

In all some two hundred and twenty-six species of vascular plants were found in association with Cedar in the two site types.

Mosses were of common occurrence on the sample areas. Thirty species, each occupying an area in excess of one percent of the sample area were found. Of these the most common at the lake-side were *Dicranum* spp., *Hylocomium splendens* Hedw., *Leucobryum glaucum* (Hedw.) Schimp., *Polytrichum juniperinum* Hedw., and *Sphagnum* spp. The most common on old-pasture sites were *Rhytidiadelphus triquetrus* (L.) Hedw. and *Thuidium delicatulum* (L.) Hedw. *Mnium hornum* L. was equally common on both site types.

The Cedar attained its best growth form in the pasture sites. Here the trees tended to be tall, straight, and limbed to the ground. The lake-side trees often possessed a poor growth form, being may stemmed and pistol-buttled. The occurrence of stagheads in this habitat and the tendency of the stems to fork were also noted. In general, the growth form was similar to that which had been described for Maine by Curtis (1946).

The diameters of the individual trees ranged up to a maximum of 29.5 inches at breast height in one individual at Cedarwood Lake, but the average diameter in the different stands ranged from 2.3 to 10.8 inches, with the lowest average diameters in the younger old-pasture stands. The maximum height reached in the sample areas was fifty feet, and the average height of the different stands ranged from twelve to thirty-three feet, with the old-pasture stands being the most uniform. The greatest age was found to be in excess of two hundred and fifty years but the decayed nature of the stems of the older trees did not permit an exact determination. In general, the lake-side stands contained the oldest trees with all ages present, while the pasture stands were usually even aged.

Reproduction of Cedar in the lake-side sites was usually excellent (Table II). In the three such stands studied, seedlings occurred at the rate of 2,400, 15,971, and 20,348 per acre. A striking sparsity of young trees more than ten years of age and less than one inch in diameter at breast height existed in these stands, a condition similar to that reported by Curtis (1946) for Maine. This author suggested that the high seedling mortality might be due to a lack of light, or nutrients, and to variable moisture conditions. In the case of Cedar Lake, Annapolis County, the highest reproduction occurred in the moss mat at the lake edge, while in the stand at Cedarwood Lake, the young Cedar were largely confined to dry and exposed or only partly shaded hummocks.

TABLE II  
DENSITY AND ABUNDANCE PER CENTS OF THE SEEDLINGS OF THE PRINCIPAL  
TREE SPECIES OF CEDAR STANDS

Stand	Cedar Lake, Anna.		Cedar Lake, Digby		Cedarwood Lake		Hillsburn		Lawrencetown		Ledgell		Rockland		West Paradise		Total	
	D	A%	D	A%	D	A%	D	A%	D	A%	D	A%	D	A%	D	A%	D	A%
<i>Abies balsamea</i> .....	—	—	1.0	27.8	—	—	—	—	0.4	7.2	—	—	0.8	1.3	—	—	0.3	1.9
<i>Acer pensylvanicum</i> ...	0.2	1.9	—	—	1.0	5.5	—	—	—	—	—	—	—	—	—	—	0.2	1.0
<i>Acer rubrum</i> .....	0.4	3.8	—	—	2.6	14.3	—	—	0.4	7.2	—	—	—	—	8.4	97.7	1.5	10.3
<i>Acer spicatum</i> .....	—	—	—	—	—	—	—	—	0.2	3.6	—	—	—	—	—	—	0.1	0.2
<i>Amelanchier laevis</i> .....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.1	0.5
<i>Betula lutea</i> .....	—	—	0.6	16.7	—	—	—	—	—	—	—	—	—	—	—	—	0.2	1.6
<i>Betula papyrifera</i> .....	0.2	1.9	0.2	5.6	1.4	7.7	—	—	—	—	—	—	0.6	1.0	—	—	0.5	3.3
<i>Betula populifolia</i> .....	—	—	0.4	16.7	0.4	2.2	42.2	—	—	3.6	—	—	—	—	—	—	0.1	0.2
<i>Juniperus communis</i> ...	—	—	—	—	—	—	—	—	0.2	3.6	—	—	9.8	15.8	—	—	1.2	8.5
var. <i>depressa</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Picea glauca</i> .....	—	—	—	—	—	—	—	—	—	—	0.2	20.0	0.4	0.6	—	—	0.1	0.5
<i>Picea rubens</i> .....	—	—	—	—	—	—	—	—	0.4	7.2	—	—	0.6	1.0	0.2	—	0.2	1.0
<i>Prunus virginiana</i> .....	—	—	—	—	—	—	—	—	3.0	53.6	0.4	40.0	—	—	—	—	0.4	3.0
<i>Pyrus americana</i> .....	—	—	—	—	0.2	1.1	—	—	—	—	—	—	—	—	—	—	0.1	0.2
<i>Quercus rubra</i> .....	0.6	5.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.1	0.5
var. <i>borealis</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Thuja occidentalis</i> ....	9.2	86.8	1.2	33.3	10.2	55.0	3.0	57.8	1.0	17.9	0.4	40.0	50.0	80.4	—	—	9.4	65.2
<i>Tsuga canadensis</i> .....	—	—	—	—	2.4	13.2	—	—	—	—	—	—	—	—	—	—	0.3	2.1

In the well established old-pasture type of Cedar with a closed canopy, reproduction was sparse, but tended to be much better in the younger more open stands. For instance, in the stand at Hillsburn, reproduction occurred at the rate of 2,800 seedlings per acre, while at Rockland, a younger stand, the rate was 100,000 per acre. In the younger, open stands, trees of the intermediate size class (below one inch in diameter at breast height) were commonly present, but in the more mature stands these were rare or absent. In both types some vegetative reproduction was present, with a tendency for the trees to occur in clumps.

The lake-side stands showed more variability in drainage than did the old-pasture stands. In each case the lake-side sites varied from good to poor drainage, while in the old-pasture stands four out of five were well drained, the exception being Rockland which occupied a rather swampy area.

The soils upon which the Cedar grew were variable in nature. The lake-side sites were most often heavy and wet, this latter condition showing a seasonal variation. The profile development was also variable, but tended to be distinct except in the wetter locations. The old-pasture stands were on better drained soils but these also tended to be somewhat wet and heavy although only one of these, Rockland, was located in a swamp. Soil profiles in these stands were indistinct and poorly developed.

Hydrogen ion concentration (Table V) of the A2 soil layer varied from 4.1 to 5.7 with an average pH value of approximately 5.0. In the B layer the value varied from 4.5 to 5.8, with an average of 5.1. In general the pH of the old-pasture soils was slightly higher than that of the lake-side sites. The soils may be classified as strongly acid with only two determinations of the B layer being in the moderately acid group (Wilde, 1946).

The amount of exchangeable calcium (Table V), in terms of milli equivalents per 100 grams of soil, in the soil samples ranged from 0.12 to 7.26 in the A2 layer, with an average of 1.71; and from 0.30 to 6.03 with an average of 1.45 in the B layer. The values obtained for the old-pasture sites tended to be higher than those of the lake-side sites. In the case of exchangeable magnesium (Table V) expressed in milli equivalents per 100 grams of soil, the range in the A2 layer was

from 0.10 to 4.00 with an average of 0.86; in the B layer from 0.13 to 1.73 with an average of 0.49. As was the case with exchangeable calcium, the higher values were obtained from the old-pasture samples.

### Jack Pine.

Jack Pine was found to occur in a greater variety of habitats than did Cedar. Four of the eight stands sampled, Dover, Gibraltar Rock, New Haven, and Rocky Lake all occurred on barrens with rock outcrops and shallow gravelly soils. The remaining four stands included one at Cambridge on a sand plain, (Plate II, Fig. 1) one at Martinique on a wet clay soil, and two, Bay Head and Thompson Station, on drier well-drained clay soils.

In seven out of eight of the samples, fire scars on the older trees, charcoal in the upper layers of the soil, and in some cases charred stumps, indicated that fires had occurred in the stands. The one exception was Bay Head. Cutting had also occurred to a limited extent in four of the stands of better growth trees, but no clear-cut had occurred. As a rule the stands were more extensive than were those of Cedar, ranging in extent from two acres at Gibraltar Rock to approximately six square miles at Thompson Station. The smaller stands were those on rocky barrens.

Jack Pine was the dominant species in all the sample areas, forming a closed canopy in all except the rock barren sites (Table III). In these latter the commonly associated tree species were Red Spruce and sometimes White Pine (*Pinus Strobus* L.). White Birch was a common species in the New Haven stand. The "Fire-trees"; Wire Birch and Large-toothed Aspen (*Populus grandidentata* Michx.), were abundant in the Cambridge site, and here, along with Red Pine (*Pinus resinosa* Ait.) and Red Maple in small numbers, comprised the tree species present. Thompson Station was essentially similar in tree species to Cambridge, with the omission of Balsam Fir and Large-toothed Aspen. Martinique showed a relatively large proportion of Larch (*Larix laricina* (DuRoi) K. Koch) and Black Spruce (*Picea mariana* (Mill.) BSP). The species most uniformly present with Jack Pine, although never very abundant, were Balsam Fir and Red Maple.

TABLE III  
DENSITY AND ABUNDANCE PER CENTS OF THE PRINCIPAL TREE SPECIES  
OF JACK PINE STANDS

Stand	Bayhead		Cambridge		Martinique		Thompson Station		Dover		Gibraltar Rock		New Haven		Rocky Lake		Total	
	D	A %	D	A %	D	A %	D	A %	D	A %	D	A %	D	A %	D	A %	D	A %
<i>Abies balsamea</i> .....	14.6	9.0	0.2	0.5	0.8	1.7	—	—	1.6	3.9	0.8	2.1	0.4	1.2	0.2	0.7	2.3	4.2
<i>Acer rubrum</i> .....	4.0	2.5	2.2	5.1	0.4	0.9	2.0	4.0	3.6	8.8	5.4	13.9	0.4	1.2	1.8	5.9	2.5	4.5
<i>Betula papyrifera</i> .....	—	—	—	—	—	—	—	—	—	—	—	—	5.6	17.0	—	—	0.7	1.3
<i>Betula populifolia</i> .....	25.8	16.0	13.0	30.0	—	—	2.6	5.2	—	—	—	—	—	—	—	—	5.1	9.3
<i>Larix laricina</i> .....	1.4	0.9	—	—	19.4	41.8	—	—	1.0	2.5	—	—	1.0	3.0	0.4	1.3	2.9	5.2
<i>Picea mariana</i> .....	—	—	—	—	13.0	28.0	—	—	—	—	—	—	1.6	4.8	—	—	1.8	3.3
<i>Picea rubens</i> .....	100.8	62.4	3.2	7.4	—	—	26.2	52.2	4.4	10.8	5.8	14.9	—	—	6.2	20.4	18.3	32.9
<i>Pinus Banksiana</i> .....	14.8	9.2	17.8	41.0	12.8	27.6	19.2	38.2	30.2	74.0	25.8	66.5	24.0	72.7	19.6	64.5	20.5	36.8
<i>Pinus resinosa</i> .....	—	—	0.6	1.4	—	—	0.2	0.4	—	—	—	—	—	—	—	—	0.1	0.2
<i>Pinus Strobus</i> .....	—	—	—	—	—	—	—	—	—	—	0.6	1.5	—	—	2.2	7.2	0.4	0.6
<i>Populus grandidentata</i> .....	—	—	6.4	14.7	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Populus tremuloides</i> .....	0.2	0.1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.1	0.1
<i>Quercus rubra</i> <i>var. borealis</i> .....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.2	0.5
<i>Tsuga canadensis</i> .....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.2	0.5

A shrub layer was heavy and well developed in all but the rock barren sites. This was heath-like, and characteristic of a general acid habitat. Lambkill, Labrador Tea (*Ledum groenlandicum* Oeder), Rhodora (*Rhododendron canadense* (L.) Torr.), Blueberry, and Witherod (*Viburnum cassinoides* L.) were commonly present in all sites but in varying abundance. Downy Alder, Huckleberry, Common Juniper, and False Holly (*Nemopanthus mucronata* (L.) Trel.) were found in three of the four rock barren sites but were absent or rare in the remaining stands. Sweet Fern (*Comptonia peregrina* (L.) Coulter) and Hardhack (*Spiraea latifolia* (Ait.) Borkh.) were commonly present in all but the rock barrens.

The herbaceous ground cover was never absent, and like the shrubs was characteristic of the general habitat. Bunchberry, Teaberry (*Gaultheria procumbens* L.), and Bracken (*Pteridium aquilinum* (L.) Kuhn, var. *latiusculum* (Desv.) Underw.) were present in all sites and varied in abundance. Also commonly present in all stands but not as plentiful as the above species were the Common Lady's Slipper (*Cypripedium acaule* Ait.), Wild Lily-of-the-valley, Cow-wheat (*Melampyrum lineare* Desr.), and Star Flower. Clintonia, Broom Crowberry (*Corema conradii* Torr.) and Three-toothed Cinquefoil (*Potentilla tridentata* Ait.) were characteristic and abundant in the rock barrens.

One hundred and seven species of vascular plants were identified in the sample areas, about one half the number found at the Cedar sites.

Some eighteen species of mosses were found to be present in the Jack Pine stands in excess of one per cent coverage of the sample areas. The most common of these were *Dicranum* spp., *Leucobryum glaucum*, *Pleurozium Schreberi* (Brid.) Mitt., and *Sphagnum capillaceum* (Weiss.) Schrank.

The growth form of the Jack Pine was correlated with the habitat, those trees on the well-drained, deep soils were tall and straight (Plate II, Fig. 1), while those on the shallow humus and gravelly soils of the rock barrens, or in the poorly-drained sites were short and stunted in appearance (Plate II, Fig. 2). The rate of growth was less rapid in these latter sites. These observations agree with those of Sterrett (1920).

**PLATE II.**



**Figure 1. Cambridge. Jack Pine.**



**Figure 2. Dover. Jack Pine of poor growth form with young pine. Red maple and dense shrub layer in foreground. Black spruce forest in background.**



The diameters of the individual Jack Pine trees ranged up to a maximum of 23.8 inches at breast height in one tree at Thompson Station, while the average diameter for the eight stands ranged from 3.4 to 6.4 inches, the lowest average diameter being on trees of the rock barrens. The tallest trees were in the Cambridge and Thompson Station stands, approximately fifty-five feet high; much taller than the tallest trees of the rock barren sites, the average height of which was from fourteen to nineteen feet. The average height of trees other than the rock barren sites was from thirty to thirty-five feet. The maximum age recorded was 103 years in one tree at Gibraltar Rock, although the average age in this stand was of the order of 40 to 45 years. The Jack Pine stands were not old, for most of the stands originated following a fairly recent fire which only a few scattered older trees survived.

Reproduction in the Jack Pine stands was sparse (Table IV). Seedlings of this and associated tree species were seen in all the stands studied, but were so scarce that few or none were included in the smaller quadrats used in sampling. Three of the sites showed no Jack Pine seedlings, while two of these showed no seedlings of any tree species. The largest number of Jack Pine seedlings, 1600 per acre, was found in the Dover sample, a rock barren site. Seedlings were more abundant under open stands of the rock barrens where the shrub layer was sparse and low, than they were in the other stands which possessed a more mature forest with a well developed shrub layer. Jack Pine appears to be a shade intolerant species, unable to reproduce itself beneath a mature stand (Sterrett, 1920; Hutchinson, 1918).

With one exception, that of Martinique with only fair drainage, the Jack Pine sites were well drained, although small local wet pockets were found in all. Soils on the sites varied in nature and in depth, from shallow humus and gravel on the rock barrens to deep sandy or clay soils, to wet clay. In all stands the soil profile of the podzol type was well developed when the depth of soil permitted.

Hydrogen ion concentration (Table V) of the A2 layer varied from 3.5 (Gibraltar Rock) to 4.4 at Bay Head with an average pH value of 4.0. The B layer varied from 4.2 at Gibraltar Rock to 5.2 at Cambridge with an average value of 4.7. A comparison of rock barren sites with other sites shows a slight difference in pH values, the former being more acid in both the A2 and B layers.

TABLE IV  
 DENSITY AND ABUNDANCE PER CENTS FOR THE SEEDLINGS OF THE PRINCIPAL TREE SPECIES  
 OF JACK PINE STANDS

Species	Bayhead		Cambridge		Martinique		Thompson Station		Dover		Gibraltar Rock		New Haven		Rocky Lake		Total	
	D	A%	D	A%	D	A%	D	A%	D	A%	D	A%	D	A%	D	A%	D	A%
<i>Acer rubrum</i> .....	—	—	—	—	—	—	0.4	66.7	—	—	—	—	—	—	—	—	0.1	5.7
<i>Betula populifolia</i> .....	0.8	80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.1	11.4
<i>Picea mariana</i> .....	—	—	—	—	1.2	35.3	—	—	—	—	—	—	—	—	—	—	0.8	17.2
<i>Picea rubens</i> .....	—	—	—	—	—	—	0.2	33.3	—	—	—	—	—	—	—	—	0.1	3.0
<i>Pinus Banksiana</i> .....	0.2	20	—	—	2.2	64.7	—	—	0.8	100	—	—	1.2	100	1.0	100	0.6	62.7

TABLE V

pH, Ca and Mg Determinations for Cedar and Jack Pine Stands

	Stand	pH		Ca		Mg	
		A <sub>2</sub>	B	A <sub>2</sub>	B	A <sub>2</sub>	B
Cedar	Cedar Lake, Anna.	4.3	4.7	0.12	0.30	0.13	0.17
	Cedar Lake, Digby	5.3	5.0	1.83	0.48	0.73	0.13
	Cedarwood Lake	4.1	4.6	0.87	0.40	0.38	0.18
	Hillsburn	5.5	5.8	7.26	6.03	4.00	1.73
	Lawrencetown	4.8*	4.5*	0.18	0.40	0.20	0.17
	Ledgehill	5.3*	5.3*	1.33	1.35	0.50	0.38
	Rockland	5.7*	5.6*	1.75	1.47	0.76	0.62
	West Paradise	4.8*	5.4	0.30	1.17	0.10	0.52
Jack Pine	Bayhead	4.4	4.5	0.37	0.32	0.13	0.23
	Cambridge	4.0	5.2	0.12	0.12	0.15	0.08
	Martinique	4.3	4.8	0.73	1.71	0.52	1.16
	Thompson Station	3.7	4.9	0.18	0.50	0.13	0.17
	Dover	4.1	4.5	0.10	0.12	0.10	0.10
	Gibraltar Rock	3.5	4.2	0.08	0.12	0.13	0.10
	New Haven	4.1	4.5	0.12	0.12	0.10	0.07
	Rocky Lake	3.7	4.6	0.16	0.08	0.13	0.13

\*Where soil profiles were not clear soil samples were taken at depths of 6" and 12".

Exchangeable calcium in terms of milli equivalents per 100 grams of soil ranged from 0.08 to 0.73 in the A<sub>2</sub> layers, with an average value of 0.23; and from 0.08 to 1.71 in the B layer with an average of 0.39. The amount of exchangeable magnesium in the A<sub>2</sub> layer varied from 0.10 to 0.52 with an average of 0.17, while in the B layer the variation was from 0.07 to 1.16 with an average value of 0.25. A comparison of the rock barren sites with the soil of the other sites shows a slightly lower concentration of exchangeable calcium and magnesium in the former.

### Discussion.

Northern White Cedar occurs locally in Nova Scotia, mainly in Annapolis and Digby Counties (Map 1), with one substantiated record in Kings County, and one reported station in Cumberland County. The older, well established stands were all located on lake edges, but younger old-pasture stands were more frequent and were mainly located on the north facing slopes of the Annapolis Valley. The lake-side Cedar, because of its age and the development of the stands,

is undoubtedly native. The origin of the old-pasture stands is in doubt. Roland (1947), notes that, "In places in the Annapolis Valley it has escaped and spread extensively along the rocky pastures." That Cedar may seed into fields and pastures from planted trees has been established at Zwicker Lake, where a small area had been seeded in to the east of a few planted trees about an old homestead. No other case of a proven planted seed source was found, but in Rockland and Hillsburn the seed source for the old-pasture stands were native occurring Cedars. In general the Cedar stands have proven to be so localized and small that the species may occur, but has escaped notice on many of the inland lakes and streams in the western part of the province.

Jack Pine is more widespread in its distribution, but appears to occur mainly in the central portion of the province in Cumberland, Colchester and Halifax Counties, but also occurs in rather small stands east to northern Victoria County and Richmond County, and west to Shelburne County. In general Jack Pine occupied larger areas than did Cedar. In seven out of eight cases fire had occurred within the area occupied by the stands. Like Cedar, Jack Pine showed a tendency to spread in to nearby abandoned fields and pastures as a pioneer tree.

Cedar occurred in two different types of habitat, lake-side and old-pasture. The former were occupied by the older, better established stands; the latter by more extensive but younger stands. Jack Pine was found more commonly on rock barren sites, but also occurred on sand plains and both well drained and wet clay soils. The first type of site was usually more localized.

Many of the associated trees were common to both Cedar and Jack Pine, as for instance, Balsam Fir, Red Maple, Larch and Red Spruce. Others such as Wire Birch were found only with the old-pasture Cedar, and in the sand plain with Jack Pine; White Pine was commonly associated with both types of Cedar, and with the rock barren Jack Pine. No single species or group of species was found to be particularly associated with either Jack Pine or Cedar, but rather, these associated trees, shrubs, and herbs were characteristic of the habitat in which the Cedar or Jack Pine occurred. For instance, Broom Crowberry, Lambkill, Labrador Tea, and Rhodora were common on the rock barrens; Leather Leaf and Royal Fern at the

lake-sites; and persistent weeds such as Yarrow, Heal-all and Common Speedwell on old-pasture sites.

Reproduction of Cedar at the sample areas, with one exception, appeared to be ample at both lake-side and old-pasture sites to secure the continuity of the stands. However, very few of these seedlings appeared to survive, since there were few young trees present in any of the stands. Jack Pine, on the other hand, showed a rather poor reproduction, particularly in the more mature stands, a situation which has been described as typical for this species (Sterrett, 1920; Hutchinson, 1918) On the more open sites, such as the rock barrens, reproduction was somewhat better.

In general, drainage on both the Jack Pine sites and Cedar sites varied from good to poor, but the Cedar tended to occur on the poorer drained and the Jack Pine on the better drained locations. Four out of eight (all the "naturally occurring" stands) of Cedar were on the poorer drained sites, whereas in the case of Jack Pine, seven out of eight of the sites were well drained and dry.

The soils supporting the Cedar and Jack Pine stands were both highly acid, but those of the Cedar being less acid than those of the Jack Pine (Table V). A comparison of the range in average pH values shows 4.4 - 5.7 for Cedar, and 3.9 - 4.6 for Jack Pine.

The amount of exchangeable calcium in the soils, when compared, show the average amount in milli equivalents per 100 grams of soil to be 1.41 for Cedar, and 0.31 for Jack Pine, a significant difference. Fernald (1919), in referring to the factors which influence the distribution of Jack Pine and Cedar, states that, "*Pinus Banksiana* is confined to acid soils; *Thuja occidentalis* chiefly to basic soils and it reaches its maximum development in all its outlying stations only in particularly calcareous areas." Apparently in the case of these Nova Scotian stations, located at the eastern extremity of the range of the species, Cedar occurs not on basic soils but on highly acid soils, and while the calcium content of the soils is significantly higher than that found for Jack Pine, they are not positively calcareous. However Jack Pine does occur consistently on highly acid soils with a lower calcium content. No significant difference was found in the amount of magnesium present in the soils of the Cedar and Jack Pine stands.

On the basis of the present work it would appear that drainage, rather than pH or calcium content of the soils, may be the limiting factor in the distribution of Cedar in Nova Scotia. Cedar, in the old lake-side sites, maintains its position locally at the very water edge where little competition is offered by other tree species. It does not spread out into the surrounding forest. When opportunity offers it may spread into adjoining fields and pastures as a pioneer tree species, again under conditions which offer little competition.

It would appear that Cedar as it now occurs in Nova Scotia, is a post climax community about lake shores, and rarely, a pioneer forest stage in succession on old pastures. Jack Pine is found to be a pioneer tree on burned areas, particularly on rock barrens where it may be able to persist for some time, and is also possibly part of a physiographic climax on poorly drained sites.

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