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# A Forest Classification For Canada

*By*

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## *CORRIGENDA*

The form of poplar referred to in the text as Balm of Gilead (*Populus candicans*) has been identified, so far as the form prevalent in the Prairie Provinces (known locally as "black poplar") is concerned, as *Populus balsamifera* var. *Michauxii*.

References to this species in the accompanying monograph are as follows: Page 7, second paragraph, line 10; page 18, second paragraph, line 7; page 18, last paragraph, line 5; page 19, last paragraph, lines 12 and 14; page 20, last paragraph, line 2; page 21, third paragraph, line 4; page 21, fourth paragraph, line 15; page 22, third paragraph, line 3; page 22, fifth paragraph, line 5; page 23, second paragraph, line 1; page 48, eighth and ninth lines from foot of page.

Page 9, paragraph 6, line 2: *for* "these must be considered with" *read* "with these must be considered".

Page 46. According to the latest decision of the Committee on the Nomenclature of Economic Plants, appointed by the 1935 International Botanical Congress, the designation of the Douglas fir is *Pseudotsuga taxifolia* (Poiret) Britton.

# CONTENTS

CONTENTS—*Concluded*

# A Forest Classification for Canada

## INTRODUCTION

In the study of natural phenomena, it is necessary that some systematic arrangement of ideas and facts be adopted; that is, the phenomena must be classified. The most satisfactory method appears to be one that not only deals with groupings of similar things, but considers also their relationship and development. Compromise may be necessary for practical purposes, and generalization must appear in the broader categories. A test of the usefulness of any system lies in the opportunity it affords for its correction and modification with increasing knowledge, without disturbance of the framework.

Many schemes have been devised for dividing up the natural vegetation of the earth. These range from the purely arbitrary to those based on the more recent ecological ideas of the relation of the plant community to the habitat. This monograph deals with the application and modification of a scheme of the latter nature to Canadian conditions.

It is now well recognized that climate is the principal agent responsible for the presence and form of natural vegetation. Physical measurement of climate is yet far from satisfactory in its accuracy and usefulness, and, in so far as Canada is concerned, a further drawback is the comparative paucity of continued data and the general massing of stations in a rather narrow band along the southern boundary. The best means of recognition and valuation of climate appears to be its effect, that is, the vegetative community itself, of which the highest response to a particular climate is seen in the climax form. The climax not only stands to climate in the relation of effect to cause, but itself modifies climate.

The basic system of classification followed is that outlined by Weaver and Clements in their book, *Plant Ecology* (1929), in which the Climax Formations of North America are considered and described. In the present monograph only those forest formations or regions which occur in Canada are dealt with. The brief description of each is, in the main, a summary of the salient features as outlined by the above authors, with some modifications and amendments arising from Canadian conditions. It has been considered necessary to add two forest regions to their list. Each of these covers a portion of one of the above authors' regions, and the basis for separation has been, for the one, geographical location, for the other, a specialized character of the vegetation and climate, which appears to differ considerably from that of the Forest Region within which it was originally included.

The further subdivision of the Forest Regions into Forest Sections—a geographical distinction based on broad uniformity of association, which is the result of topography, soil, bed-rock, and local climate—has proved of considerable practical value. It was first started by the author to cover the three Prairie Provinces. Such good correlation was shown with the results of independent investigations, such as soil types, forest-inventory districts, and protein content of wheat, that an extension to the remainder of Canada is considered to be of value.

Naturally, the location and boundaries and the naming and recognition of the individual sections are not to be taken as definitive. It is to be hoped that this monograph will be productive of criticism and helpful information.

In separating the sections, the original work of Dr. Fernow on Forest and Land Classification of Canada, published in 1911 in the Proceedings of the



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Society of American Foresters, has been of great assistance (12). In a sense, much of the present monograph is an extension and modification of his findings in the light of later and more extensive information. The lecture notes of Dr. Howe, of the University of Toronto, dealing with a revision of Dr. Fernow's work, have been also most helpful (16). Amongst valuable works of reference must be mentioned Brodie and Sharpe's Forest Resources of Ontario (34), Whitford and Craig's Forests of British Columbia (38), and Ab-Yberg's Proposed System of Classification for the Province of Quebec (1). Information has also been obtained from many government publications—those of the Geological Survey of Canada being of especial value—and other articles of a forestry or ecological nature too numerous to mention here individually. In many cases the origin of such information is shown by the numbers in parentheses throughout the text, which refer to the bibliography; but this is by no means complete. The personal knowledge of the writer has necessarily been used wherever possible. Acknowledgments are gratefully made to members of the Quebec and Ontario forest services for their advice in revision of the parts dealing with these provinces, to the assistance and helpful criticism of many interested in the subject, and to the work of Clements and Weaver, who are responsible for the basic classification.

## FOREST REGIONS

The broad examination of the natural vegetation of any continental land mass shows that great groupings, of wide extent and relative permanence, can be distinguished. These are the product of climate, which is the controlling factor, and present a characteristic appearance which is due to the presence of dominants of the same life-form. Furthermore, within each grouping, this life-form is the ultimate expression of the normal course of succession. To such broad divisions the term Climax Formation is applied (37).

In Canada, three such climax formations occupy the bulk of the land area. They are the Tundra Formation (Arctic and Alpine), the Forest Formation, and the Grassland Formation.

The wide-spread nature of the Forest Climax Formation and the varying characteristics and responses to climate of the members of the dominant life-form therein, such as deciduous as against evergreen trees, render it necessary and advisable to recognize within such a formation further divisions termed Forest Formations or Forest Regions. The recognition of such subdivisions is governed by the principles outlining the Climax Formation, and takes into consideration evolution and the relationship of species and genera. It is necessarily objective, indicating climate through the nature of the climax and reflecting it through the geographical position. Each Forest Region thus becomes characterized by the presence of certain tree species. Primarily these are the climax dominants, one or more of which extend throughout the region and indicate the climatic controls.

The divisions here considered applicable to Canada are:

1. The Boreal Forest Region,
2. The Subalpine Forest Region,
3. The Montane Forest Region,
4. The Coast Forest Region,
5. The Columbia Forest Region,
6. The Great Lakes–St. Lawrence Forest Region,
7. The Acadian Forest Region,
8. The Deciduous Forest Region.

A brief description of these regions follows.

### The Boreal Forest Region

The bulk of the land mass of Canada is covered by this Forest Region, which is continuous from the Atlantic coast of Quebec to Alaska and northward to the Arctic ocean at the Mackenzie delta. It is also present on the higher elevations of the Gaspé peninsula.

Though this region is primarily coniferous, there is a general admixture of certain broad-leaved trees, which, particularly in the central and south-central parts, play an important part in its composition. The characteristic species is the white spruce, which ranges throughout the region, but other conifers extend widely and characterize certain portions. These are the black spruce, the balsam fir, the tamarack, and the jack pine. Along portions of the east slope of the Rockies, the Stikine-Dease plateau, and in Yukon Territory, this last species is replaced by lodgepole pine, an intrusive from the neighbouring Subalpine Forest Region, as is also the alpine fir present in the Yukon. The broad-leaved trees are principally the aspen, balsam poplar, balm of Gilead (black poplar; *Populus candicans*), paper birch, and Alaska white birch. In the transition area between this region and the Grassland Formation, the poplars become dominant.

Contact is made in the north with the Arctic division of the Tundra Formation, and again, with the Alpine division, at from 3,000 to 4,000 feet elevation, where this forest region is interrupted by the northern parts of the Cordilleran System. To the southwest occurs the Subalpine Forest Region, which is considered by Clements as a climatic modification, and to the central south the Grassland Formation. To the southeast there is a very irregular contact with the Great Lakes–St. Lawrence and the Acadian Forest Regions, with considerable intrusion of species from one to the other.

The climate is characterized in general by long winters, rather low precipitation of from 15 to 30 inches, increasing eastward, and a short frost-free period of less than 100 days. Sufficient differences exist in precipitation and related temperature to indicate a primary division of the forest into a moister eastern portion and a northwest and central drier portion. With this is correlated the more prominent part played by the broad-leaved species in the second and drier portion.

Historically, the region is considered as a differentiated part of an early circumpolar forest; it resembles the coniferous forests of Northern Europe and Asia.

During glacial times, the bulk of this Forest Region was of necessity obliterated or moved southward. Returned now to approximately its old position, it has had a marked effect on the character of other forest regions with which it came in contact

### The Subalpine Forest Region

This is essentially a coniferous forest, occupying the upper slopes of the Cordilleran System east of the Coast ranges, and lying between the Alpine Tundra Formation and the Montane Forest Region.

It is most closely related to the Boreal Forest, its differentiation being considered as due to the more pronounced relief of the western mountain system, one of the natural passageways for this forest during climatic migrations (37).

The dominant species, Engelmann spruce and alpine fir, are generically the same as in the Boreal, and the subclimax lodgepole pine and aspen are common both to it and to the Montane Forest. The presence of mountain hemlock on the western ranges connects it with the Coast Forest. In addition, alpine larch and the white-bark pine enter into Canada in the more southern portions of the eastern ranges.

In general, the forest extends down to the 3,000-foot level. Rainfall is relatively high, temperatures low, and the growing season short.

### The Montane Forest

Occupying the main body of the Cordilleran Mountain System of North America, and extending eastward to the foot-hills is an extensive forest which makes contact with all the other forest regions there, as well as with the Grassland, Woodland, and Scrub formations. It is most closely allied to the Coast Forest, in which one of its dominants, the Douglas fir, is well developed, and a transitional zone of considerable extent is formed between the two (37). Throughout the Forest Region constant and extensive contact is made with the Subalpine Forest at the upper levels.

The dominants are yellow pine and Douglas fir, but the subclimax aspen and lodgepole pine cover large areas, the former being most characteristic of the northern parts of the Central Plateau, where it gradually merges with the dominants of the Subalpine Region. Sugar pine, a characteristic co-dominant of the southern part of the Montane Forest, does not extend into Canada.

Although the Forest Region is principally confined to the Interior valleys and ranges, one of the associations, Douglas fir and lodgepole pine, intrudes northward into Alberta along the east side of the Rockies, mingling there with the Subalpine Forest. Furthermore, two subclimax species, madrona and Garry oak, both from the western associations of this Region, reach the coast in British Columbia and form an association with species from the Coast Forest.

Within Canada, the climate is relatively dry, with low summer rainfall and moderate to high temperatures, the most xeric conditions being found towards the lower river-valleys, where the forest merges into the Grassland Formation. This Region forms part of what is often termed the Interior Dry Belt (38).

### The Coast Forest

This characteristic forest of the major portion of the Pacific coast of North America has, because of oceanic compensation and high rainfall, an extreme north-south range. It has further been considered by Clements as extending eastward to the Columbia Basin, where the higher lands of the western slopes of the Rockies and associated ranges provide similar climatic conditions (37). In so far as Canada is concerned, the relatively wide geographical separation of these two areas has influenced, in this classification, the consideration of the latter extension as a separate forest, part of which is of a transitional nature to the Montane Forest.

The Coast Forest proper has a main relationship and contact with the Montane Forest but, towards the north in Canada, it meets, first with the Subalpine Forest and later, with part of the western division of the Boreal Forest.

The principal dominants in Canada are the western red cedar and the western hemlock. Associated with these are Douglas fir in the southern portion and Sitka spruce most frequently in the northern. The Douglas fir, responding to drier conditions, is a link with the Montane, of which it is one of the dominants. Amabilis fir and yellow cedar occur generally, their ability to stand drier conditions being shown in their common presence toward the upper limits of tree growth. Western white pine occurs in the southern portions, but has close affinities with the Montane Forest and forms one of the dominants of the Transition Zone referred to under the Columbia Forest.

Of the broad-leaved trees, several alders are widely dispersed but occupy a relatively secondary position in the associations, and the Garry oak and madrona, two entrants from the Montane Forest, serve to characterize a transitional area round the strait of Georgia in the southern part.

Tree growth in the Coast Forest is of great luxuriance as a result of the excessive rainfall and moderate to somewhat high temperatures.

### Columbia Forest Region

The main valleys in general of the Columbia River system in the Selkirk and Monashee mountains, the upper valleys of tributaries of the Thompson river in the Monashee and Cariboo mountains (including part of the Shuswap area), the Quesnel Lake area and the valley of the upper Fraser river between the Cariboo and Rocky mountains, all within British Columbia, support a forest that closely resembles floristically that of the Coast. It is considered by Clements as being one and the same.

The connection is made through a wide transition zone with the Montane Forest Region in Idaho and northwest Montana (37). In Canada there is, geographically, such a complete separation between the two that the use of the term Coast Forest for the area is most confusing. Furthermore, a large part is of the transitional nature indicated above, containing one of the dominant species of the Montane Forest and another dominant not found in the Coast Forest proper. For these reasons, it has been considered advisable to treat the whole as a separate forest region, corresponding closely to what has been termed the Interior Wet Belt of British Columbia (38). This forest in general makes contact at the lower levels with the Montane Forest and at higher levels grades into the Subalpine.

In the southern valleys and middle slopes, the dominants are western white pine and western larch, with a considerable admixture of Douglas fir and grand fir. Red cedar and western hemlock are present in small quantities, but increase towards the northern valleys, where they become dominant—mixing at the higher levels with Engelmann spruce—and the more southern species, with the exception of the Douglas fir, drop out.

The climate is intermediate to that of the Coast and Montane Forests.

### The Great Lakes—St. Lawrence Forest Region

This forest, centering on the Great Lakes system and continuing eastward down the St. Lawrence valley, is now of a most irregular character. It extends from the Lake of the Woods district eastward to New Brunswick, the northern boundary being broken by lake Superior. Phylogenetically it is related, in respect to its coniferous dominants, to the Coast and Montane Forests of the west, and its ultimate survival is often questioned (37). Compressed and fragmented against the mass of the Deciduous forest by Boreal invasion in glacial times, its return has been hampered by the nature of the terrain and conditioned by the general line of ice retreat. Since then, major climatic phases have favoured in turn further Boreal and Deciduous intrusions—a condition strengthened by logging and fire so that in parts of its western portion recent investigation has even indicated that the climax dominants are now invaders from adjoining regions (14).

The indicating species, according to Clements, are white pine and hemlock and possibly red pine, but it would appear that these must be considered with certain Deciduous Forest species, the so-called northern hardwoods. These are the sugar and red maples, the yellow birch, and, in part, the beech. The large-toothed aspen appears also to be a characteristic companion species with a wide range through the region. Secondary roles are played by the cedar and the jack pine, the latter an intrusive from the Boreal; further Boreal species, the balsam fir and black and white spruce, are of considerable importance in certain parts. The general northeastward strike of the three hardwood species reflects very clearly the influence of the land bridges across the Great Lakes system and the ice-sheet positions of the last glaciation.

Climatic conditions show a relatively wide range. The precipitation varies from 25 to 45 inches, west to east; the length of growing season ranges from

100 to 150 days, and the average temperature is higher than that in the Boreal forest.[1]

### The Deciduous Forest Region

This region occupies the greater part of the east half of the United States. Only a small portion enters Canada, and is in the southwesterly projection of Ontario. It is essentially a temperate forest, and resembles similar forests in Europe and Asia. It has had great influence on the Forest Regions that touch its northern border, its species intruding and mixing with their dominants in a very intricate manner. This is shown by the general presence of the dominants of one of the major associations of the Deciduous forest as companion species of the characteristic conifers of the Great Lakes–St. Lawrence Forest. These dominants are maple and beech. In many respects certain portions of the Great Lakes–St. Lawrence Forest might by now be considered part of the Deciduous Forest. I have considered it best, however, to retain them within the Great Lakes–St. Lawrence Forest and restrict the latter Forest Region to parts characterized by species such as tulip tree, chestnut, magnolia, mockernut hickory, chestnut oak, and black walnut.

Here the climatic conditions are most favourable with a growing season of over 150 days.

### The Acadian Forest Region

South of the gulf of St. Lawrence, Canada extends out into the Atlantic ocean in a series of irregular peninsulas and islands. Of these, Prince Edward Island and the greater part of New Brunswick and Nova Scotia are occupied by the Acadian Forest Region, which extends southwestward along the Appalachian System into the United States to occupy increasingly higher altitudes.

The Forest is related to the Great Lakes–St. Lawrence Forest, the dominant conifers of which —hemlock, white pine, and red pine—are well distributed; to the Deciduous Forest, in possessing the so-called northern hardwoods—sugar maple, yellow birch, and beech (which also occur within the former forest)—and to the Boreal Forest through the presence of white spruce and balsam fir. The characteristic dominent is, however, the red spruce, which is confined to this region and extends throughout it.

All the area in Canada considered under this Forest Region is included by Clements as part of the Boreal Forest. This does not seem in keeping with the distribution of vegetation and the climatic conditions. John Macoun, an outstanding Canadian botanist, after examination of Prince Edward Island and part of Cape Breton Island, states definitely that there is no boreal character to the vegetation (25). This is substantiated by the later work of Dr. Fernow in Nova Scotia (11). Furthermore, several more of the associated Deciduous Forest species of the Great Lakes–St. Lawrence Forest, such as elm, butternut, white ash, silver and red maples, and red oak, are found within the region, and wire birch is more or less confined to it and adjacent portions of the Forest.

It is evident that during glacial times the original forests suffered a fate similar to that of the forests of the Great Lakes–St. Lawrence Forest Region, being forced against the Deciduous Forest Region along the higher levels of the Appalachians and in large part destroyed by a following Boreal invasion. Clements points out that because of the lower altitude of these mountains when compared to the western ranges only one or two species were differentiated, one of these being presumably the red spruce (37). It is probable that in view of the Boreal antecedents of this species and the presence of such Boreal invaders as the white spruce, balsam fir, and the ubiquitous aspen and white birch, he has placed

[1] Note.—Since the above was written an article by G. E. Nichols has come to hand, entitled "The Hemlock, White Pine, Northern Hardwoods Region of Eastern North America" (Ecology, Vol. XVI, No. 3, 1935). The essential unity of the region is demonstrated, good agreement is shown with its amended range in this work, and the importance of the northern hardwoods is well brought out.

this area in question with the Boreal Forest and classes the Great Lakes-St. Lawrence Forest dominants as relict species.

In the matter of climate, there is a considerably higher precipitation—in general over 40 inches, the bulk of which falls during the winter months—and a higher temperature than that found within the Boreal Forest.

## FOREST SECTIONS

Briefly stated, the Forest Section is a geographical subdivision of the Region, based on floristic considerations and the result of physiographic, edaphic, and local climatic conditions.

The characterization of the Region by climax dominants and other tree species has already been outlined. These species are found within the Region grouped together in the form of associations where, combined with other forms of vegetation, they make well-defined communities, which can be considered as the result of the sum of the environmental conditions. These associations will naturally be found in all stages of successional development, and in addition there will be other aggregations of vegetation when the tree form is not, at any rate at the moment, a member.

More detailed study of the Forest Region shows, in many cases, the possibility and advisability of distinguishing within the whole very definite areas, often of considerable extent, which are marked by the consistent presence of certain associations, and which show, in the mass, a character differing from other parts of the Region (15).

Such differentiation can largely be traced to the effect of local climate, the underlying geologic structure, the character of the surface deposits, the topography, and the resulting drainage plan, or to combinations of all these (15). An excellent presentation of this view is given by Withrow (39), who says: "The influence of the climatic factors, temperature and rainfall, on plant formations, species distribution, and vegetative structures is pronounced. The effect of edaphic and physiographic features is just as striking on a somewhat lesser scale. Rainfall and temperature determine the major formations as desert, grassland, and forest. Edaphic and topographic characteristics produce local variations within these formations. Exposure, run-off, and soil type may be conducive to the persistence of associations within major plant communities which are totally unlike the climatic climax or its seres."

To such areas as above, the term Section has been applied, and each has been distinguished by a suitable prefix. It must, of course, be clearly recognized that the same type of plant community may be found in more than one Section. The most wide-spread and characteristic example would be an association of black spruce, tamarack, and sphagnum moss in a poorly drained depression. What is important is the general character of the Section, where the prevalence of specialized factors has resulted in certain groupings of vegetation being characteristic throughout the whole and giving to it a very marked appearance (15).

## DESCRIPTIONS OF FOREST SECTIONS

In dealing with the individual sections, the descriptions have been condensed so as to cover in general only the most salient features. These features are in effect the justification for the Section. Reference to the accompanying map will indicate their geographical position and relations.

## Boreal Forest Region

### A. EASTERN DIVISION

*B.1. Northeastern Coniferous Section*

Along the southward-facing slopes of the Laurentian peneplain, from the gulf of St. Lawrence to approximately latitude 52° north, and extending round the head of the Saguenay valley west to lake Mistassini and southeast to the higher parts of the Laurentide mountains extends a forest that is predominantly coniferous and very uniform in its nature.

Two species form the bulk of the tree cover, namely, balsam fir and black spruce, in varying degree of association in relation to topography and drainage. The Boreal dominant, white spruce, is generally distributed, but is numerically of little importance. White birch, aspen, and balsam poplar are secondary associates, somewhat restricted to river-banks and lake shores. Jack pine occurs on suitable sites, more particularly in the western half of the Section, and does not range throughout.

The topography generally is that of a rolling country with a series of roughly parallel and southward-flowing rivers in rather deep valleys. The underlying rocks are the characteristic granite-gneisses of the Precambrian Shield with large areas of intrusive diabase and anorthosite and some altered sedimentaries. On these rests glacial débris of varying depth and texture, alluvial material is found in the valleys, and, at the mouths of the rivers flowing into the gulf of St. Lawrence, occur some marine clays. The soil profile is a podsol.

With this Section have been included certain parts to the south and southwest of lake Mistassini. Here late Precambrian sedimentaries appear to have had a marked influence on the quality of growth; mixed associations of white spruce, aspen, and balsam poplar are more prevalent, and well-developed black spruce stands are typical (21).

The bulk of the pulpwood supply for the province of Quebec is found within the whole Section considered here.

*B.2. Gaspé Section*

The eastern extension of the Appalachian Mountain system into Quebec terminates in the Gaspé peninsula with the Notre Dame and Shickshock mountains. These are of the nature of high irregular plateaux, interrupted in places by mountain peaks rising to 3,600 feet. From these plateaux run irregular rivers, generally in rather deep valleys.

The Section, which is in two parts, takes in generally the higher lands of the peninsula, but the portion east of the Matapedia river valley extends down to the south shore of the gulf of St. Lawrence.

The whole has been placed with the Boreal Forest Region in view of the prevalence of certain of its dominants, and a further distinguishing character is the fact that certain portions have not been glaciated, and consequently possess relict flora. It is immediately in contact with one of the Sections of the Great Lakes–St. Lawrence Region and intrusion of species from here is common, especially up the river-valleys.

Black spruce and white spruce form the characteristic associations, being well developed on the deeper soils, but also occupying large areas of a swampy nature, where they are of stunted growth. Balsam fir is present, but in no great quantity, being most prevalent on the lower slopes of the Section. White birch is common throughout. Up the river-valleys and towards the edges of the Section such species as cedar, black ash, white pine, and some sugar maple and elm intrude from the adjoining Section and Forest Region.

The underlying rocks are mainly sedimentary; in the eastern part they are limestones and slates of the Devonian and Silurian periods, with areas of Devonian granitic-gneiss intrusives and Ordovician-Devonian extrusives. In the western portion, they are entirely of locally metamorphosed sedimentaries, mainly of the Silurian period. Soils are generally deep, resulting from glacial action, or, in many cases, are of a residual nature. On these a podsol-type profile is formed.

*B.3. Central Laurentian Section*

This Section covers a relatively flat plateau portion of the height of land in Quebec between the James bay and St. Lawrence watersheds, from which streams flow to all points of the compass. To the north are many of the headwaters of the Chibougamau river and streams flowing into lake St. John. In the eastern part is the large chain of lakes from which the St. Maurice flows; to the south lie part of the Lièvre, Gatineau, and Ottawa rivers, and to the west is situated the upper part of the Bell river.

The rocks are granites, gneisses, and schists of the Precambrian Shield, overlain for the most part with very light-textured deposits, a large part of which appears to be of a residual nature from weathered quartzose granular gneiss.

The large quantities of sand have favoured the dominance of jack pine associations of various character, and fires have further assisted this condition. Interspersed with the sand plains are water-catchment areas; black spruce and tamarack occur at the headwaters of the various streams. The more rocky parts have stands of black spruce and jack pine, and the heavier soil deposits, such as those on lake shores and river-banks, support some mixed associations of white spruce, aspen, balsam poplar, and white birch.

*B.4. Northern Clay Section*

Occupying the central portions of the northward-facing slopes of the Laurentian peneplain in Quebec and Ontario, this Section is conditioned by the extensive clay deposits available for soil formation. These clays and silts are modified morainic and till material and deposits from glacial Lake Ojibway. It is bounded to the north by the marine clays and sedimentary rocks of the Coastal Plain Section and underlain by Precambrian granites, gneisses, and schists. Absence of surface rock, extensive poorly drained depressions, relatively few lakes, and clay-banked, rather sluggish streams are characteristic. The soil type is a podsol, influenced in many instances by the high water-table.

The relatively poor drainage has favoured extensive coniferous associations, with black spruce the dominant species, mixed with tamarack and some eastern white cedar. Improvement in drainage, due to slight elevations, is reflected in mixed stands of white birch, balsam fir, white spruce, aspen, and balsam poplar.

*B.5. Coastal Plain Section*

An area of Palaeozoic sedimentary bed-rock with overlying marine clay deposits borders James bay on the south and southwest sides. It extends back to an elevation of about 750 feet above sea-level, and is characterized by a flat topography and poor drainage. The rivers flow through to James bay somewhat as converging radii, with the minimum of cross-drainage, their courses lying between low alluvial banks which permit narrow strips of good tree-growth reaching to their mouths. Back from the rivers lie immense areas of muskeg and bog. This Section has been separated from the Northern Transition Section to the northwest (part of which is on similar rock and soils) by virtue of the more favourable climatic conditions, which permit reasonable tree-growth on the river-banks and allow the intrusion of certain more southern species.

The soil profile, where the soils are not of organic nature, tends to be much modified by the high water-table, and mature podsols form only on the best-drained portions of the river-banks. The prevailing tree association is naturally black spruce and tamarack, greatly reduced in growth by the high water-table. However, white spruce, balsam fir, aspen, balsam poplar, white birch, and some Eastern white cedar, of similar quality to that within the Northern Clay Section, occur along the river strips. Evidence of edaphic, rather than climatic, conditioning is shown by the presence at several points of white elm and black ash on river-banks.

*B.6. East James Bay Section*

The Palaeozoic sedimentaries of the previous Section do not extend to the east side of James bay and Hudson bay; here are found the Precambrian granites of the Labrador peninsula, and the topography consists of a series of steps descending from east to west. Definite evidence of uplift—some of which, at least, occurred since the latest glaciation—is shown by well-marked terraces in the glacial till some 300 feet above sea-level, and by stratified marine clays and sands, exposed by river action, extending up the valleys to over 500 feet elevation (22).

In consequence of the above, the soil conditions that obtain are more favourable than are those found over the bulk of the Labrador peninsula, and these are reflected by the vegetation and character of the tree growth. In the sheltered valleys with clay and sand deposits, white and black spruce, balsam poplar, aspen, white birch, and balsam fir reach merchantable sizes; jack pine, black spruce, and tamarack are found on the higher lands between. Back from the shoreline extends an area of low-lying swamps (22). The limits of the Section to the east are indicated by the presence of white spruce and balsam poplar, which are not found beyond the range of the marine deposits. To the north, more rigorous climatic conditions affect the growth, character, and distribution of the species.

*B.7. Central Transition Section*

Along the height of land in central Ontario and Quebec is a Section of intermediate nature. It is basically of the Boreal Forest Region in so far as the bulk of the species and their distribution is concerned, but contains within it certain indicator and other species from the Great Lakes–St. Lawrence Forest Region, either as scattered specimens or in more or less isolated patches.

In position, it runs from the upper St. Maurice valley along the higher southward-facing slopes of the Laurentians in Quebec to lake Abitibi. From here to the western boundary, somewhat past lake Missinaibi, it occupies, in general, the height of land and the northward-facing slopes. Along its northern front it is in contact with the sands of the Central Laurentian Section and the lacustrine clays of the Northern Clay Section.

The topography is rolling, and the rivers are interrupted by many lake extensions. The bed-rock is of Precambrian granites and gneisses, with a coarse and somewhat thin overburden of glacial débris, modified in the north by glacial Lake Ojibway, the upper shorelines of which are found within the Section. The soil profile is typically a podsol.

The general character of the forest cover is a mixed one, consisting of an association of black spruce, balsam fir, and white birch, with scattered white spruce and aspen. This appears the dominant and mature type on the middle slopes. Here and there will be found, on heavier-textured ridges, patches and specimens of both sugar maple and yellow birch—more commonly in the Quebec portion. On rocky shores, and also on ridges, there is some presence of white and red pine. These pines are most abundant in the neighbourhood of

lake Abitibi, but are found fairly generally throughout the Section. The last four species are all from the Great Lakes–St. Lawrence Forest. A more widely distributed tree—also from this Region—the Eastern white cedar, is present throughout the Section in the prevailing swamp associations of black spruce and tamarack (which cover large areas), and also along stream banks. Balsam fir often forms pure stands on rather moist sites, and appears to be numerically more common in the Quebec portion. Jack pine occupies dry ridges and sandy flats, increasing with fires and often associated with black spruce on poor, rocky soils. Fires have also produced a considerable extent of secondary associations of white birch and aspen, with an understory of black spruce and balsam fir. This Section is comparable to the Central Divide Region of Brodie and Sharp and, in part, to the Transition Zone of the Quebec Forest Service.

*B.8. Central Plateau Section*

Along the height of land to the north of lake Superior is a relatively level plateau-like country which extends northeastward in a gentle slope to the lower lands around James bay. The whole is characterized by extensive sand and gravel deposits, by low rocky outcrops of the underlying Precambrian granites, and by shallow swampy depressions.

The above conditions have affected the distribution of the tree species. Jack pine associations are probably the most dominant and characteristic; this is in part the result of fire, but there is also the possibility that factors allowing for natural regeneration are present. Black spruce associations are well developed and prevalent, from those occupying the shallow swamps to those of maximum development on the better-drained level country. Admixture of the two species is common, and white birch and balsam poplar occur within the associations. On the more restricted and favourable sites, such as river-banks and lake shores, where better-drained and heavier soils are found, associations of white and black spruce, white birch, balsam fir, and some aspen occur, and in the eastern portions there is some presence of Eastern white cedar in low positions.

*B.9. Superior Section*

The forest conditions of the Great Lakes–St. Lawrence Region, which are found to the east of lake Superior, do not extend north of the lake. A climate of greater severity would appear responsible for the general Boreal nature of these parts. To the west of the lake, however, forests of the former Region occur once more, though of a distinctive character.

The above Section extends on the north shore-line, from near the Michipicoten river westward to the upper Kaministikwia river, and has a generally rough and irregular topography, hills rising somewhat rapidly from the lake, and wide river-valleys extending northward. Terraces and other lacustrine deposits from glacial Lake Algonquin and its predecessors are common in these valleys and on the southward-facing slopes, bordering the lake. Glacial deposits cover most of the ground, but much exposed rock is present—a condition greatly strengthened by the severe burning to which this Section has been subjected.

The geologic structure consists of Precambrian granites with areas of late Precambrian iron slates, sandstones, and conglomerates, with block-faulting and diabase intrusion.

The presence of white spruce associations with some balsam fir, balsam poplar, and white birch, especially on the river terraces, is possibly a characteristic feature of the Section. Such associations begin to show up in the neighbouring Section to the east of the lake. On slopes and lower hill-tops, where heavier glacial deposits can be found, mixed associations of black spruce, white birch, white spruce, and some aspen and balsam fir are common. These, together with black spruce of poor form, with some jack pine and white birch on the higher and more rocky elevations, make up the bulk of the forest cover. Lower

and poorly drained positions support black spruce and tamarack, with a scattering of Eastern white cedar. The whole cover is, however, much fragmented by repeated burns.

Very localized patches of red and white pine occur, possibly connected with sandstone and conglomerate areas. Other intruders from the Great Lakes–St. Lawrence Region are found in the eastern portions, where outliers of sugar maple and yellow birch occur on hilltops. In the river-valleys is also some black ash.

*B.10. Nipigon Section*

Within the Nipigon basin are deposits of horizontally bedded lacustrine sand and fine stratified clays of considerable extent. These sand-plains occupy large parts of the shore-line, and extend back up many of the river valleys draining into lake Nipigon, especially in the northern and northeastern parts. Formed under an arm or bay of glacial Lake Warren or Lake Algonquin, subsequent uplift probably has separated them from similar deposits along the shore of lake Superior.

On these parts of the basin, covered by the above section, a rather uniform forest has resulted, with black spruce forming the dominant species in the associations. In the higher positions jack pine forms open stands, followed lower down by the main body of black spruce with a deep moss ground-cover, and at lower levels by swamp types with tamarack. Certain parts with more favourable soil conditions support stands of white birch, aspen, and some admixture of black spruce and balsam fir; in the immediate river-valleys white spruce occurs.

The topography is somewhat low and rolling, with a gentle rise on each side of the valleys to the higher portions of the divide. The underlying rocks are Precambrian granites and gneisses with some later conglomerates and sandstones, and, particularly on the west side, large areas of diabase trap rock.

*B.11. Western Transition Section*

North of that portion of the Great Lakes–St. Lawrence Forest centering on the Rainy River drainage lies a considerable extent of country in which the general forest cover belongs to the Boreal Region. Here, however, two species from the former Region have a consistent and wide range, though always as scattered individuals or isolated clumps. These species are the white and red pine, which here reach their most northerly distribution in Canada in the vicinity of latitude 51° N., and may be either intrusives from the south or, possibly, relicts of former more extensive stands fragmented by Boreal Forest invasion and later fire history. In addition, presence of yellow birch is reported, and there is some occurrence of the large-toothed aspen.

The main body of the forest cover, however, consists of associations of jack pine with black spruce and mixtures of white and black spruce, white birch, aspen, and some balsam fir, where deeper soil deposits are found. Swampy depressions contain black spruce, but tamarack is not very abundant. Extensive and repeated fires have influenced the character of the above associations and increased the extent of bared rock.

The Section includes the upper drainage basin of the English river and part of the headwaters of the Albany river. It has a rough and rolling topography with very numerous lakes. Having been strongly glaciated and also not influenced by glacial Lake Agassiz, the soils are generally thin, with occasional morainic ridges and much exposure of the underlying rocks of the Precambrian Shield.

*B.12. Hamilton-Ungava Valleys Section*

Certain of the river-valleys of the Labrador–Quebec peninsula show a marked contrast in tree-cover and growth-quality to the prevailing character as described under the Northeastern Transition Section. Protection is certainly one of the controlling factors, but the presence of heavier soil deposits and the

influence in places of the underlying rock has undoubtedly been another. The valley of the Hamilton river, 500 to 800 feet below the surrounding country, is the largest of these areas, and supports a forest of commercial size, the species being white and black spruce, balsam fir, white birch, aspen, and balsam poplar. Another area is part of the valley of the Koksoak around Cambrian lake and northward; here weathered deposits from the late Precambrian altered sedimentaries appear to have favoured tree distribution and growth, and there is an open forest cover of large-sized white spruce, balsam poplar, tamarack, white birch, and black spruce. This area is decidedly northerly, and the surrounding country has an arctic type of vegetation with an almost complete absence of white spruce and balsam poplar (22).

*B.13. Northeastern Transition Section*

The greater part of the peninsula of Labrador and Quebec, a high, well-worn, and flattened tableland rising somewhat to the east, is covered by a scant and poor forest growth. Climatic conditions are certainly more rigorous than in the southern parts, but another conditioning factor has been the denuding effect of glaciation, which has left large areas of bared Precambrian rocks, or very thin soils. There is a characteristic light cover of stunted black spruce and balsam fir, with scattered birch and jack pine. Shallow black spruce and tamarack swamps and treeless moors, where the vegetation takes on an alpine appearance, with abundance of white lichens, are common, the whole interspersed with many lakes. Where soil conditions are more favourable—as round some of the lakes—a much denser forest occurs, and a marked contrast is afforded by the deeper river-valleys of the previous section, where the soil deposit is deeper, and shelter is present.

## Boreal Forest Region

### B. Central and Northwestern Division

*B.14. English River Section*

Here is included that portion of the English River drainage area which, at one time, was under the influence of glacial Lake Agassiz. It is relatively low country, with an undulating surface, the Precambrian rocks being, for the most part, covered by stratified clays and sands; in the northern and eastern parts morainic ridges with lake beaches occur. To the southwest is the Rainy River Section of the Great Lakes–St. Lawrence Forest with similar deposits, and, to the west, the deeper lake deposits overlying the flat Palaeozoic rocks of the Manitoba Lowlands Section. Because of generally heavy soils, aspen and balsam poplar occur extensively, in pure associations or mixed with white spruce, balsam fir, and white birch. Black spruce and tamarack occupy shallow swamps, and jack pine associations the more sandy areas. White pine and red pine entrants from the Great Lakes–St. Lawrence Forest have a limited presence on the rocky parts of the river-banks and lake shores, and on sand-ridges. Green ash, white elm, and bur oak are found also on suitable sites, apparently intrusives from the neighbouring sections to the west and southwest.

*B.15. Manitoba Lowlands Section*

Between the higher lands of the Cretaceous Escarpment to the west and the Precambrian rocks to the east is a low-lying flat country, rising somewhat to the south and underlain by horizontally bedded Palaeozoic limestones. It contains numerous large lakes and swamps, relicts of glacial Lake Agassiz, which previously covered the whole area. The parent material for soil formation consists of lacustrine clays and sands of varying thickness, together with

modified glacial till and moraine. A characteristic feature of the topography is low narrow parallel ridges of gravel with swampy depressions between. There are many lake beaches, especially to the west, and the rivers in general flow through built-up banks of alluvial material.

Because of general lack of drainage and high water-table, organic soils and poorly developed and modified soil profiles are characteristic. The lime content of the bed-rock has further influenced the profile with the formation of rendzinas and high-lime peats. In the western portion, meadow, podsolic, and local soils are found (10). The prevailing forest cover is black spruce and tamarack, with jack pine ridges. In the southern part, and along alluvial river banks, associations of aspen and black and balsam poplar (*Populus candicans* and *Populus balsamifera*), in a pure state or mixed with white spruce, balsam fir, and white birch, are present. Bur oak intrusions are common on the drier sites in the southern parts; elm, green ash, and Manitoba maple are generally distributed along river-banks and lake shores, and Eastern white cedar has some local presence.

*B.16. Aspen-Oak Section*

In the centre of Canada, the southern edge of the Boreal Forest meets with the Grassland Formation through a wide transition zone that has characters of both formations. This zone runs in a rough half-circle from the International Boundary in Manitoba to the foot-hills of the Rocky mountains. It is climatically conditioned, the most important factor being probably an equal relationship between evaporation and precipitation during the growing months (36). In consequence, major climatic phases cause fluctuations in the boundaries of the zone. At present, the direction of movement appears to be into the Grassland, but elimination of prairie fires and grazing may have been a recent temporary factor. The southeastern portion of this transition zone has a distinctive character, and forms the section being considered.

Aspen is the most prevalent species, ranging from patches of small material invading the Grassland, through larger and irregular clumps to the continuous good-growth associations with black poplar approaching the Forest Formation proper. Characteristic of the Section, however, is the general distribution of bur oak. This species is found in associations of poor form on dry gravelly ridges, is scattered through aspen stands back from the river-courses, and occurs in some abundance on flood plains of the rivers. It is best developed on the slopes of the Cretaceous Escarpment, especially where contact is made with the Mixedwood Section. On alluvial soils along the rivers, white elm forms a well-developed association, growing to a large size and reaching the western limit of the Section with no marked falling off in growth. Some basswood is found in this association, together with green ash, Manitoba maple, and cottonwoods. Black ash has a limited presence on swampy grounds to the southeast, and the so-called prairie ash occurs on the drier upper parts of the river-valleys.

On certain higher grounds within the Section are stands which, from the species and growth character, appear related to the Mixedwood Section and can be considered as relict areas left during the northern movement of the Forest Formation following the retreat of the last ice-sheet. White birch, a well-distributed Boreal species, is common here, both aspen and Balm of Gilead (*Populus candicans*) are well developed, and, in a few cases, white spruce is present. On certain of these areas, there is considerable bur oak and some white elm and green ash along the streams. Among such relict areas can be classed the Pembina mountains, the Tiger, Brandon, and Arrow hills, Moose mountain, and Turtle mountain. One well-defined relict area, on low ground, namely, the Spruce Woods, in which white spruce and tamarack are well represented, has been included with the Mixedwood Section.

The presence of the various species enumerated above and the scattered grassland areas indicate the transitional nature of the Section. Some of the species, such as bur oak, white elm, and basswood can be linked with the Deciduous Forest Region to the southeast, their intrusion being probably related to one of the desiccation periods following the melting back of the last ice-sheet. Such invasion is marked in the Rainy River Section of the Great Lakes–St. Lawrence Forest and continues northward into two or more other Sections of the Boreal Forest. In part, it would appear to be correlated with the Lake Agassiz deposits, but this group of Sections in Manitoba and Ontario have certain similarities which may be due to climate.

The topography is varied. To the east is flat Palaeozoic limestone covered by deposits from glacial Lake Agassiz. Then come morainic deposits on the higher elevations of the Cretaceous Escarpment shales. Further lake sediments are found in the Souris valley, and to the west of this is a series of parallel morainic ridges. On the International Boundary is a Tertiary outlier, the Turtle mountains, with morainic deposits. The soil type is the very dark brown park or so-called northern chernozem, showing degradation to podsolic conditions with increasing tree cover (10).

*B.17. Aspen Grove Section*

The westerly portion of the transition zone is covered by this Section and has a somewhat simpler composition. Aspen is the dominant species, grading, as before, from patches to high-forest associations with black poplar. Along the rivers, and extending out into the grass land, especially in the extreme western parts, are lanceleaf, narrowleaf and Great Plains (Western) cottonwood (*P. acuminata, trichocarpa,* and *Sargentii*), Manitoba maple, and green and 'prairie' ash. Between the grass land proper and the Rocky mountains in the extreme south of Alberta, a very poorly marked transition zone is present, which has been included with the subalpine forest. The topography is generally rolling, the stands being developed on glacial deposits resting on Mesozoic and Tertiary shales and sandstones. The soil type is similar to that of the last Section. Patches of Aspen Grove occur under suitable conditions in the main body of the Grassland—on the elevations of the Cypress hills and the Great Sand Hills—and are also found intruding in the Mixedwood Section, in the Peace River district, and around Edmonton.

*B.18. Mixedwood Section*

This very extensive Section, roughly triangular in shape, with its base on the foot-hills of the Rocky Mountains and its apex in western Manitoba, has a generally marked unity throughout. The topography is that of a prominent series of rounded hills, cut by deep river-valleys, and having, in general, a steep north-to-northeast slope. This slope marks the northern and northeastern boundary, and corresponds with the edge of the eroded Cretaceous shales of the Mesozoic era, which were noticeably steepened by ice action on the eastern face of the Section. The soils, derived from morainic and till sheet deposits, are of a podsol to podsolic type, influenced markedly in places by the presence of a considerable quantity of limestone fragments from the Palaeozoic rocks to the northeast. As the name implies, the characteristic association is a mixture, in varying proportions, of aspen, balm of Gilead, white spruce, white birch, and balsam fir (7). The highest individual development of white spruce is probably reached in this Section. Large areas of well-developed aspen and balm of Gilead (*Populus candicans*) associations also occur, generally on the heavier-textured soils, and in particular towards the contact with the Aspen Grove and Aspen-Oak Sections (30). Jack pine associations tend to predominate on sandy areas, and a mixture of black spruce and jack pine is characteristic of the plateau-

like tops of the hills. The lower positions and the upper water-catchment areas develop black spruce and tamarack sphagnum bogs, which are not, however, of any great depth. There is a minor occurrence of white elm, green and 'prairie' ash, Manitoba maple, and bur oak intrusives at certain places along the edges of the Section, noticeably in the southeast

A portion of considerable extent lying immediately to the east of the Foot-hills Section is much fragmented. Throughout it occur areas of an Aspen Grove character, patches of Grassland conditions, and development of pure white spruce clumps. Associated with the above are soils of the very dark brown park type or of a specialized podsolic form. Outliers of the Foot-hills Section also occur on higher ground. Glacial history may be a possible explanation for such conditions. The above portion lies about the line of contact between the Cordilleran and Keewatin ice-sheets. The western edge of the latter, in the last Wisconsin advance, appears to have terminated in the vicinity of the Missouri Coteau, the northward extension of which, after cutting across the Athabaska river, runs parallel to it for some distance. The area in question may then have occupied a gap between two ice-sheets, and have been covered in part by glacial lakes, with consequent effect on the movement of vegetation, soil type, and presence of relict communities.

*B.19. Foot-hills Section*

In western Alberta, the foot-hills of the Rocky mountains, between 3,000 to 5,000 feet elevation, present a rough and broken topography and descend eastward to the plains region in a series of somewhat flat-topped plateaux, much dissected by sharply cut river-valleys.

The uplifted and folded Mesozoic and Tertiary sedimentaries forming the bed-rock are overlain with glacial deposits and colluvial material, and the mature soil type is a podsol. The Section covering this area is in the nature of an ecotone or mixing zone between the Boreal and Subalpine Forests influenced greatly by the factor of fire, which has favoured the spread of lodgepole pine, a subclimax dominant from the latter Forest. This species, together with white and black spruce, forms the main forest cover, which is predominantly coniferous. Aspen and white birch have a scattered representation in mixture with the above species, and there are some areas of black spruce and tamarack on the flat tops of the plateaux. Balsam fir is largely replaced by alpine fir from the Subalpine Forest, and jack pine is absent. Outliers from this Section, with an association of lodgepole pine and black spruce, occur to the east on plateau tops such as the Cariboo mountains.

*B.20. Hyper-Churchill Section*

The upper course of the Churchill river follows the contact between the Precambrian and sedimentary rocks in northern Saskatchewan. Between this contact and the main heights of the Cretaceous Escarpment to the south is an irregular flattish area underlain by Palaeszoic limestones and some Cretaceous shales. This was occupied by glacial Lake Hyper-Churchill, relicts of which persist in the numerous lakes and swamps. Modified drift and lacustrine deposits form the soil-cover, and extend southward up the valleys into the Escarpment proper, where beach lines are in evidence. The soil types are podsolic (modified in part by high water-table) and organic soils, all being probably influenced by the lime content of the bed-rock.

The topography and drainage have favoured extensive associations of balsam poplar, balm of Gilead, and aspen. The numerous swamps are characterized by reed grass or black spruce and tamarack. White spruce, though present, has only a limited distribution.

*B.21. Nelson River Section*

Parts of the Precambrian Shield extending north and east of the Manitoba Lowlands Section were covered by glacial Lake Agassiz, principally in its later stages, and the consequent deposition of lacustrine clays and sands has had the effect of producing a more or less level topography on a once irregular and rolling surface.

The above Section takes in the main body of such deposits on the Precambrian rocks and includes the Burntwood and Grass river valleys, and the Nelson river north to around Sipiwesk lake, and extends up the rivers on the east side of lake Winnipeg for ten to fifty miles. The clays are generally free from gravel or boulders, and with adequate drainage a podsol soil-type is formed. Their distribution and depth is irregular, and areas of bared rock occur throughout.

Black spruce associations form a large part of the cover, but, owing to the extensive and numerous swamps lying back from the rivers, are mostly of restricted growth. Along the rivers, on islands and in well-drained localities, well-developed stands of white spruce, with some balsam poplar, balm of Gilead, white birch, aspen, and balsam fir, are customary, with possibly more aspen and balsam poplar under such conditions on the east side of lake Winnipeg. Extensive and repeated fires, however, have fragmented all the forest cover, and large areas, especially round the Burntwood river, now support a small growth of aspen, white birch, and scattered white and black spruce, or jack pine and aspen, or are grassy scrub. Tamarack is present with black spruce in the swamps, isolated occurrences of green ash and Manitoba maple are reported on some of the river-banks, and there is a little bur oak on the east side of lake Winnipeg.

*B.22. Northern Coniferous Section*

On the southern half of the Precambrian Shield, extending from western Ontario to northeastern Alberta, is a forest where climatic conditions are favourable for reasonable tree growth but where, because of intensity of glaciation, the soil-cover is thin, and considerable bed-rock is exposed. The relief is irregular, with rocky parallel ridges separating poorly drained depressions and innumerable narrow lakes. Towards the centre of this part of the Shield, the northward extension of Lake Agassiz, with consequent heavier soil deposits, has been included as a separate Section. Local residual soils of light texture occur on the plains south of lake Athabaska, developed from sandstones of the Keweenawan series. Thin soil-cover and drainage conditions have resulted in a predominance of poor-growth black spruce, mixed with jack pine on the drier and tamarack on the wetter sites. Extensive fires have also further reduced the available soil and favoured the spread of jack pine. In the river-valleys and round some of the lakes, where more favourable soil conditions obtain, white spruce, balsam fir, aspen, and balsam poplar and balm of Gilead form mixed stands of good growth. White birch has a general and scattered representation over the majority of sites. To the west, on the residual soils, park-like stands of pure jack pine are reported. The northern edge of the Section is climatically determined, and corresponds more or less with the limit of merchantable size (15).

*B.23. Mackenzie Lowlands Section*

The Mackenzie river flows to the north in a broad valley, through a wide and relatively level plain. This plain takes in also the lower portions of the main tributaries, the Athabaska, Peace, Liard, and Peel rivers, and is underlain mainly by horizontally bedded Palaeozoic limestones, concealed in places by Mesozoic and Tertiary sedimentaries. To the west, the Mackenzie mountains rise sharply, and to the south lies the rather abrupt face of the Cretaceous Escarpment. Eastward, there is no marked difference in elevation, the boundary

being determined in part by the rougher country of the Precambrian Shield, and, towards the north, by the climatically determined Northern Transition Section.

It is a country of numerous lakes and swamps, with most of the shore-line of Great Bear lake included, and the general flatness is interrupted by a few isolated, low ranges of undulating hills. A considerable depth of soil, of a generally heavy texture, covers the area, and is derived from glacial, lacustrine, and alluvial deposits. The mature soil profile is probably podsolic or a podsol, influenced, no doubt, by the water-table and nature of the underlying rock.

The prevailing forest cover appears to be coniferous (33), with white spruce the major dominant, forming pure associations. Extensive fires have, however, favoured the admixture of aspen, balsam poplar, balm of Gilead, and Alaska white birch with this species, and the occurrence of jack pine associations on the lighter soils. On the better-drained alluvial soils such as old river-banks, well-developed stands of balsam poplar are very characteristic, and the poorer-drained sites support numerous shallow black spruce and tamarack swamps and large areas of wild hay meadows and willow scrub. The tamarack also predominates at the tree limit to the west on the Mackenzie mountains, at about the 1,500-foot elevation, but does not extend into the northern part of the Section. Records would indicate exceptionally good growth for the majority of the species, where the drainage is good, and this condition continues even down to the Arctic Circle (28).

*B.24. Upper Liard Section*

This Section takes in the upper portions of the Liard river west from where it breaks through the Rocky mountains and their northward extension, the Mackenzie mountains. This river and its tributaries occupy a series of irregular valleys arranged in a somewhat star-shaped manner and rising from the ranges of the Cassiar, Yukon, and west slopes of the Rocky Mountain system. The climate is more humid than that of the plateaux to the west, and the region is heavily forested (9). The soil material is derived from glacial, colluvial, and alluvial deposits, with probably some local residual soils from the underlying, uplifted, and contorted Palaeozoic and Tertiary sedimentaries.

The dominant and most abundant species is white spruce, with admixture of alpine fir as the tree line is approached, and aspen and white birch on the most favourable sites. Fire has favoured the extension of lodgepole pine over large areas. Black spruce and tamarack occur in low positions, and considerable quantities of balm of Gilead and possibly some black cottonwood are found along the river-banks.

*B.25. Stikine Plateau Section*

Between the Cassiar and Coast ranges is a high plateau, dissected by river-valleys and characterized by a dry climate. That portion drained by the Stikine and Taku river-systems forms the above Section, together with part of the upper Dease river. This river, cutting eastward through the Stikine mountains, enters a similar dry region caused by these hills (9). The forest cover is scanty, and largely confined to the valleys. The upper slopes of these valleys and the plateaux show grassy alpine conditions.

The prevailing stands are an open mixture of aspen, white spruce, and lodgepole pine, interspersed with grassy areas. Alaska white birch has a scattered representation, black cottonwood appears on the river-banks, and there is some alpine fir towards the tree line.

Glacial débris, alluvial and colluvial deposits, and some residuals form the soil material.

*B.26. Yukon Section*

The Yukon river and its tributaries and the upper courses of the Peel river are included within this Section. It is a large area and necessarily somewhat composite in character; when better known, it may require division. The whole country is mountainous, with the ranges and plateaux largely isolated by wide valleys and depressions, in which the forest stands occur. Over the eastern portion, glacial débris has been deposited, but to the west there has been little or no glacial action, and local residual soils are present, developed from the Palaeozoic sedimentaries and Precambrian intrusives which form the underlying rock structure. The forest has a general open character, and tree height is somewhat restricted. Considerable difference in character exists between opposite sides of the valleys, as the general northwest direction of the rivers permits almost continuous sunshine on the north and northeasterly slopes, which are grass-covered and relatively bare of trees, whereas the opposite slopes are relatively well-wooded (27). The best tree growth appears to be on the middle slopes, the growth being much smaller on the lower slopes and in the valley proper.

White spruce forms the bulk of the stands, mixed with aspen, balm of Gilead, and Alaska white birch. Black cottonwood is found in the river-valleys in the southern parts. Lodgepole pine occurs in small groves with a local distribution. In swamps and low positions, black spruce of a stunted nature grows, with a scattered representation of tamarack. Towards the tree line, which reaches the 4,000-foot elevation, but varies greatly according to slope and aspect, alpine fir becomes dominant.

*B.27. Northern Transition Section*

In the centre of Canada, the Boreal Forest grades into the Tundra Formation through a transition zone in which increasingly unfavourable climatic conditions reduce the number, distribution, and size of the tree species. Areas of open swamps and tundra associations are intermixed with the stunted forest cover, and the trees become confined to narrow fringes on the river-banks, and finally disappear. Precipitation is reduced, the growing season is restricted, and the ground is free of frost for only a limited period. Furthermore, the gentle slope to the north provides no protection from the cold dry northerly winds.

The characteristic species are black and white spruce—the latter reaching fair diameters in sheltered spots and in favourable soil conditions—white birch, and tamarack. This last species tends to dominate large areas in the more northerly parts. Jack pine occurs along the southern edge, and stunted aspen and balsam poplar extend some distance into the Section. The bed-rock is, for the most part, the granites of the Precambrian Shield with, towards the east, the flat Palaeozoic sedimentaries surrounding Hudson bay. Marine clays overlie the latter, and glacial deposits the main portion; on these, organic and immature soil types are principally developed.

## Subalpine Forest Region

*SA.1. East Slope Rockies Section*

A characteristically coniferous forest covers the east slopes of the Rockies from around the 4,000-foot elevation to the tree line. The subalpine dominant, Engelmann spruce, forms the bulk of the forest cover, the subclimax lodgepole pine being mixed with this species following fires and often forming large areas of stands of varying degrees of purity. Alpine fir enters towards the tree line, together with white-bark pine and, in the south, alpine (Lyall's) larch. Along the lower slopes, in the southern parts, there is some intrusion of Douglas fir

from the Montane Forest Region, and a fringe of aspen occurs where the Section comes in contact with the Grassland Formation.

The topography is mountainous, with steep-sided valleys, and the soils are mostly colluvial, derived from glacial and residual material. The much-contorted and uplifted underlying rocks are mainly Mesozoic shales and sandstones of the Triassic, Jurassic, and Cretaceous periods, with some local Cambrian limestones. Where mature soil profiles have formed, they will be podsols.

*S.A.2. Interior Subalpine Section*

This section is not continuous, but consists of a series of separate areas determined both by altitude and longitude. It has a composite nature, and, when further information is available, will, no doubt, require subdivision. The altitudinal position varies, from the tree-line to 3,500-foot elevation in the southern areas, and to 1,000 feet, or the lowest altitude, in the northern or Cassiar-system position. The section is characterized by associations of Engelmann spruce appearing throughout. In these associations is found alpine fir, which increases in dominance toward the tree-line, and a scattered representation of white-bark pine. Subclimax areas of lodgepole pine are common, and both black and white spruce intrusives from the Boreal forest occur in the northern parts.

To the northwest, in the valleys of the Nass and Skeena rivers, and in part on the eastward-facing foot-hills of the Coast Range, an association of Engelmann spruce and Western hemlock seems characteristic. Scattered mountain hemlock and Western birch occur. There is some intrusion of Western red cedar and amabilis fir on the coastal side, and at higher altitudes alpine fir enters.

The bed-rock is largely of Palaeozoic sedimentaries with Tertiary and granitic intrusions. Soil conditions are much as in the previous Section.

## Montane Forest Region

*M.1. Yellow Pine & Douglas Fir Section*

The southern portion of the Interior Plateau of British Columbia is occupied by this V-shaped Section, with its apex to the south. This eroded plateau of Palaeozoic and Mesozoic sedimentaries and granitic intrusives, with later Tertiary effusives, is covered with glacial deposits through which the rivers flow in wide, terraced valleys in which they have laid down considerable later alluvial material. The forested parts have probably a podsolic soil-type.

Climatically, it forms part of the so-called Interior Dry Belt (38). The conditioning factor in the area is lack of precipitation during the summer months. Topography further strengthens the trend to more arid conditions, and the bottoms of the river-valleys are occupied by bunch-grass and sage-brush communities of the Grassland Formation.

Two well-defined associations form the bulk of the forest cover. On the lower slopes and adjacent to the Grassland conditions are open yellow pine stands, with grassy openings. Further up and on the plateaux Douglas fir is the dominant, interspersed with aspen and with areas of lodgepole pine. On favourable situations, patches of yellow pine persist with this association, and the whole is of an open nature with grassy intervals. The Douglas fir differs in character from that growing in the Coast Forest, being reduced in size and having rapid taper. This habit, together with differences in the cone, has led to its being classed as a variety (20).

Included with the above Section is the relatively narrow and steeper valley of the Kootenay river and part of the upper Columbia trench, where similar

conditions and tree distribution are found. Here the Section occupies the bottoms and lower slopes of the valley, being bounded higher up on the sides by the Columbia Forest and Subalpine Forest.

*M.2. Central Douglas Fir Section*

This includes the lower central parts of the Interior Plateau, embracing the Fraser, Chilcotin, Buonaparte, and middle North Thompson valleys and the plateaux west and east of the Fraser.

Yellow pine does not extend into this Section, but Douglas fir—of the Interior type, however—remains as the chief dominant, with considerable replacement by lodgepole pine after fire. Aspen is well distributed, and at higher altitudes Engelmann spruce enters from the Subalpine Forest. As in the former Section, the Grassland Formation occupies the bottom-lands and commonly extends up the lower slopes, especially in the Chilcotin valley. Similar soils are found underlain largely by Tertiary lavas.

*M.3. Northern Aspen Section*

To the north, the major portion of the plateau in which the Blackwater and Dean rivers rise (the northeastern part of which is known as the Telegraph range) and the lower part of the Quesnel River valley are covered with a forest in which aspen plays a very important part (23). With the well-distributed aspen is mixed lodgepole pine, Engelmann spruce, and scattered Douglas fir. The stands are inclined to be open, and on the river-banks black cottonwood appears; irregular grassy areas occur, particularly on the Blackwater. The higher parts of the plateau to the west are occupied by the Subalpine Forest. Detailed information of the area is unfortunately scanty.

The probably podsolic soils have been derived from glacial deposits which rest mainly on Tertiary lavas and Cretaceous sedimentaries.

*M.4. Montane Transition Section*

The Nechako and Upper Bulkeley rivers, together with part of the Fraser and Stuart rivers, flow through the northern part of the Interior Plateau. This portion somewhat resembles an undulating and high plain, broadening to the west and interrupted with groups of low hills and numerous lakes. The higher ranges of the Cassiar system form the northern boundary, the Cariboo the eastern, and the Coast ranges the western. Rather flat-lying Palaeozoic and Mesozoic sedimentaries, with Tertiary lavas and some local Tertiary sedimentaries, form the bed-rock, which is covered by deposits of river and glacial drift.

The characteristic and most widely distributed association consists of Engelmann spruce and alpine fir, often in rather open stands. Scattered through this is Douglas fir, which would appear to have had formerly a greater representation. Its presence has largely led to the inclusion of the Section in the Montane Forest Region. The action of fires has caused a considerable extent of aspen and Western birch association, with or without Engelmann spruce, and led to stands of lodgepole pine (13). To the east, the Engelmann spruce & Alpine fir stands grade into the Engelmann spruce & Western red cedar & Western hemlock and Engelmann spruce & Douglas fir associations of the northern Section of the Columbia Forest, and Western hemlock appears again in the foothills of the Coast range. Along river-banks, black cottonwood is common, and numerous grassy openings are found.

*M.5. Douglas Fir & Lodgepole Pine Section*

An association of the above character is described by Larsen (18) as typical for most of the forest cover on the east slope of the Rocky mountains in central Montana. At higher elevations these are replaced by typical stands of the Subalpine Forest, and at lower by the Grassland Formation.

Such a condition appears to extend northward into Canada in the Waterton Lakes district. The Douglas fir found on the Bow and Kananaskis rivers is evidently an intrusion from this Section and Forest Region.

The association consists of lodgepole pine and Douglas fir, the latter generally on the southern and western aspects, and Engelmann spruce in canyon bottoms and seepage spots. Some limber pine is present on the foot-hills, and clumps of aspen at the contact with the Grassland Formation.

The underlying rock is much contorted Mesozoic strata with some late Precambrian altered sedimentaries. Soils will be largely colluvial in origin, and probably podsolic in type.

## Coast Forest

### *C.1. Madrona-Oak Transition Section*

On the islands of the strait of Georgia, the adjacent east coast and southeast part of Vancouver island, and at scattered points along the mainland shores occurs the only distribution in Canada of two tree species, namely, the madrona and the Garry oak. Of these two, the latter is almost entirely confined to the southeast part of Vancouver island, although extensive stands are present on the mainland south of the International Boundary. Isolated patches, such as those reported some distance up the Fraser river, are evidently due to the agency of birds.

The above localities are related, physiographically and climatically, to the broad depression south of the International Boundary, between the Olympic mountains of the Coast ranges and the Cascade ranges, and represent a northern extension of this depression, which, because of the lowering of the coast, has been largely covered by the sea.

The two species belong to the Sierran Montane Forest (37). The madrona occurs as a characteristic subclimax tree with associations of Western red cedar, Western hemlock, and a much more widely distributed Montane dominant, the Douglas fir. Garry oak tends to form pure associations or groves, but is also found scattered in the above associations. On alluvial soils red alder is common, and broad-leaved and vine maples have a general distribution.

### *C.2. Southern Coast Section*

The southern part of the Coast Forest, extending over most of Vancouver island and the British Columbia mainland north to Knight inlet, is included in this Section. The eastern boundary is, for the most part, the higher elevations of the Coast range, at around 4,500 feet elevation, where alpine tundra, bare rock, or permanent snow and ice conditions are encountered. Up the Fraser valley at some distance west of Lytton, contact is made with the Montane Forest of the Interior Plateau in a relatively narrow transition area, and on the Coast range south of this valley stands of the Subalpine Forest are met with. The main association comprises the two Coast Forest dominants, namely, Western red cedar and Western hemlock, in combination with Douglas fir and scattered Western white pine (4). The Douglas fir, a dominant in common with the Montane Forest, is here of the coast form, tall and with little taper. Its distribution within the Coast Forest in Canada is practically confined to this Section, as is that of the Western white pine. At higher elevations, amabilis fir and mountain hemlock are present, with alpine fir increasing towards the tree line. Black cottonwood, red alder, broad-leaved maple, and grand fir occupy alluvial bottom land, the last species being also restricted to this Section. There is a small scattered representation of Sitka spruce at low coastal points. The underlying rocks are mainly late granitic intrusives on the mainland, and Palaeozoic and Mesozoic sedimentaries on Vancouver island. The largely colluvial and alluvial soil material is derived from glacial deposits, and the soil type is a podsol.

*C.3. Central Coast Section*

This covers that portion of the Coast Forest on the mainland between Knight inlet and Douglas channel. The greater part has not the protection of Vancouver island, and growth conditions, except in sheltered and usually inland valleys, are considerably poorer than they are toward the south. It also experiences the highest precipitation of the whole Coast Region, annual figures of 210 inches being reached on Princess Royal island.

The principal association is Western red cedar, Western hemlock, and amabilis fir (4). On exposed situations, the trees are reduced to a scrubby form and mixed with yellow cedar and mountain hemlock, the former being found down to the shoreline. At higher altitudes, alpine fir is present. Sitka spruce has a limited distribution, and Douglas fir is present locally in sheltered valleys. On alluvial soil and in protected situations there is some broad-leaved maple. The topography is rough and mountainous, with much bare and moss-covered granitic rock, especially on exposed shores, and with innumerable inlets and steep valleys. The soil is largely colluvial, derived from glacial deposits, and of a podsol type.

*C.4. Northern Coast Section*

The Coast Forest north of Douglas channel and within Canadian territory forms the above Section, which includes also the Queen Charlotte islands. The country of the mainland is very mountainous and rocky, with steep-sided inlets, the sides of which are forested for no great distance up. The Queen Charlotte islands, of sedimentary rock formation with Tertiary effusives, have a more regular topography and contain large areas of muskeg.

Sitka spruce reaches its best development here, especially on the islands, and the characteristic forest is an association of this species with Western hemlock and Western red cedar (4). On the mainland, amabilis fir is also a constituent, but is not found on the Queen Charlotte islands. The exposed sites and muskegs support a stunted growth of Western red cedar, yellow cedar, Western and mountain hemlock, and some Sitka spruce. Lodgepole pine also occurs in these positions and is found extensively after fire, though of small size, in the eastern parts of the Section. On alluvial soils, there is considerable black cottonwood, and towards the tree line, alpine fir and mountain hemlock increase in abundance.

## Columbia Forest Region

*CL.1. Southern Section*

Within this Section, the distribution of certain tree species and the general growth-character indicate a broad transitional zone with the Montane Forest. The characteristic dominants of the Coast Forest—Western red cedar and Western hemlock, both somewhat reduced in size—form what is probably the climax association, in company with grand fir and varying amounts of Western white pine. In this association, Douglas fir and Western larch have a subclimax position, following disturbances. The Douglas fir is of a type that more closely resembles that found in the Montane Forests of the Interior Plateau than in the Coast Forest (20). As the drier conditions of the former Forest Region are approached, these last two species form more definite associations, and the other species tend to drop out. Disturbances, such as fire, also favour the distribution of lodgepole pine, particularly in the latter associations. On alluvial soils, black cottonwood is found. The area covered is that of the southern half of the Selkirk-Monashee mountains and the upper slopes of the Kootenay river and its tributaries. At around the 4,000-foot elevation, the Subalpine Forest is encountered, and in the lower valleys at about 2,500 feet, to the west and south, the Montane Forest. The topography is mountainous, with eroded

plateau-like areas and stream-valley plains in which are several large lakes. The rock formation is complex, the tilted and faulted Late Precambrian altered sedimentaries showing considerable later igneous intrusions, and there are areas of Palaeozoic limestones and Precambrian granite-gneisses. Soils are derived from glacial and colluvial deposits, and the soil type is podsol to podsolic.

*CL.2. Northern Section*

The northern half of the Selkirk and Monashee mountains, part of the Cariboo mountains, and the valley of the upper Fraser are included in this Section. As before, on the higher slopes, the Subalpine Forest Region is met with, and mixing of the dominants takes place. Contact with the Montane Forest occurs at places on the west slope of the Cariboo and Monashee mountains.

Western larch and grand fir are absent, the main associations being Western red cedar and Western hemlock with admixture, at higher elevations, of Engelmann spruce and alpine fir, from the Subalpine Region. Western white pine occurs in these associations in the southern portion, but is not present in the northwestern and northern parts. Douglas fir has some distribution throughout, and in the bottom-lands black cottonwood is common. Associations in which Engelmann spruce plays a more dominant part appear to be characteristic of the upper Fraser valley, where this species mixes with Western red cedar, some Western hemlock, and a scattering of Douglas fir, on the bench-lands. On the slopes, the above association grades to one of Engelmann spruce and Douglas fir, particularly on the eastern side, and this in turn is replaced higher up by Engelmann spruce and alpine fir stands of the Subalpine Forest.

The topography and rock formations are much as in the last Section, the igneous intrusives being, however, absent. Similar glacial deposits form the colluvial and alluvial soils, and the soil type is a podsol.

## Deciduous Forest Region

*D.1. Niagara Section*

The rather low-lying portion of the Ontario peninsula, enclosed by lakes Ontario, Erie, and Huron, reaches the most southerly latitudes in Canada. This area enjoys very favourable climatic and soil conditions, which allow for the sole distribution in Canada of many Deciduous Forest species.

The associations are predominantly composed of broad-leaved trees. A large number of these species, many of small size, find their northern limit here. Amongst these are chestnut, tulip tree, mockernut and pignut hickories, chinquapin, chestnut, scarlet, black, and pin oaks, black gum, blue ash, magnolia, papaw, Kentucky coffee tree, redbud, red mulberry, and sassafras. In addition, within this Section is the main distribution for Canada of black walnut, sycamore, swamp white oak, and shagbark hickory, together with the more widely distributed butternut, bitternut hickory, rock elm, silver maple, and blue beech. All these species occur as scattered individuals or groups, either on specialized sites or within the characteristic association for the Section. This association, made up of widely distributed broad-leaved trees common in part to both the Great Lakes–St. Lawrence and the Deciduous Forest Regions, consists primarily of beech and sugar maple, together with basswood, red maple, and (Northern) red, white, and bur oak. The presence of the species listed above, and the predominance of beech within the characteristic association, indicate a definite relationship to an Ohio centre of distribution. Coniferous species are poorly represented; very scattered hemlock occurs within the characteristic association, on the lighter soils are small local areas of white pine, often with an understory of black and scarlet oak, and there is some presence of red juniper, generally on poor gravelly sites.

The rock formation is mostly flat-lying Devonian limestones and shales, covered by glacial material of considerable depth, with some deposits from glacial Lake Iroquois on the northeast and possibly some from Lake Algonquin on the northwest. Owing to the influence of climate, vegetation, and the underlying rock, very fertile soils of the Brown Forest Type have been developed.

As the area is now closely settled, the forest cover has been reduced to farm woodlots, hedgerows, and woods on the lighter soils.

### Great Lakes–St. Lawrence Forest Region

*L.1. Huron-Ontario Section*

This takes in the main body of the Ontario peninsula, extending from lake Huron and the southern portion of Georgian bay to lake Ontario. With it is also included Manitoulin island.

The topography is somewhat irregular, with a marked rise in altitude to the west culminating in the highlands south of Georgian bay. The bed-rock of this portion is Silurian limestone. To the north there is a general rise, and the boundary is here practically determined by the contact between the Ordovician limestones of the eastern portion and the Precambian granites and sedimentaries of the Algonquin Highlands, and their connection to the Adirondacks. This line of contact is irregular, and is for the most part made with the altered limestones and granitic intrusives of the Grenville-Hastings series.

The underlying rock is overlain by glacial material, and the west and east boundaries are, in part, modified by the wave action and lacustrine deposits from glacial Lakes Algonquin and Iroquois and some marine deposits from the Champlain Sea. Gray-brown and brown forest soils generally have been developed, with the possibility of podsolic types being found on the highlands and in the coniferous stands.

The prevailing association is broad-leaved, but there is a reduction in the number of species. Sugar maple and beech are dominant, comprising about three-quarters of the forest. With them are basswood, white elm, yellow birch, white ash, and some red maple, and (Northern) red, white, and bur oak. Small groups of hemlock and balsam fir and an occasional white pine occur within the association, as well as a scattered distribution of large-toothed aspen, bitternut hickory, butternut, ironwood, and black cherry; and blue beech, silver maple, slippery and rock elm, and black ash are found locally on specialized sites such as river-bottoms and swamps. In the southern parts, there is some intrusion of black walnut, sycamore, and black oak. White and red pine stands are found on lighter soils and were formerly more common; red juniper is present on gravelly sites, and Eastern white cedar in swampy depressions. After fires, aspen, principally large-toothed, and white birch often form secondary associations.

The northern boundary or line of contact with the altered limestones of the Precambrian Shield is of importance ecologically as determining to a greater or less extent the northern or southern limits of many species. Jack pine, for instance, does not come south of this line, and sycamore, butternut, and bitternut hickory do not go north of it.

On Manitoulin island, sugar maple forms the dominant association, with a varying admixture of red maple, elm, basswood, yellow birch, (Northern) red and white oak, ironwood, beech, white and black ash, large-toothed aspen, and white birch. Conifers are scattered generally but in no great quantity, and consist of white and red pine, white spruce, balsam fir, hemlock, and red juniper (3).

The Section is well settled, and considerable clearing has taken place. In spite of this, there are still extensive areas of forest in the form of copses, woodlots, and swampy or waste lands.

*L.2. Upper St. Lawrence Section*

Between the Laurentian Plateau to the north and its outlier the Adirondacks, and the Alleghenies to the south, is a well-marked valley or lowland through which the waters of the Great Lakes system drain. This valley, of flat-lying Ordovician and local Cambrian limestones, is covered with glacial material, over which lie extensive deposits of marine clays and sands, dating from the period of inundation in Pleistocene times by the Champlain Sea.

The upper part of these lowlands, extending from east of Montreal to reach some distance up the Ottawa River valley to the west, comes under this Section, which also continues south into the United States by the Champlain valley.

Though the general character of the tree cover is broad-leaved, there is a fair representation of coniferous growth, which, previous to settlement, was probably more extensive. The dominant association is made up of much the same species as are found in the preceding Section, that is, of sugar maple and beech, together with small quantities of yellow birch, white elm, red maple, basswood, white ash, (Northern) red, white, and bur oak and large-toothed aspen, with local occurrence of rock elm and blue beech. In the immediate river-valleys there is some local distribution of butternut, cottonwood, and slippery elm, with intrusion, up the Champlain valley, of shellbark hickory. With the general association are patches of hemlock, white spruce, balsam fir, and some white pine; and on light soils an association of white and red pine, now as second-growth stands, is relatively common. In poorly drained depressions small areas of either tamarack, Eastern white cedar, and black spruce, or black ash are found, and clumps of cedar are often characteristic of poor stony sites. After fires, second-growth stands of aspen, mainly large-toothed, and white birch with balsam fir and white spruce are often found. Both this and the preceding Section are noteworthy for the very rich vegetation, particularly of spring-flowering herbs, to be found on the forest floor.

Although extensive settlement and clearing has taken place, there is some extent of forest-cover as woodlots or on poorer sites. Over most of the Section, brown forest soils are present and furnish land of high agricultural value; soils of a podsolized nature also occur, generally in company with coniferous stands.

There is a small area, on the south side of the Section, where a portion of the highlands of the Adirondacks extends north of the International Boundary. Here is a forest that must be considered as part of the Acadian Forest Region; red spruce is probably present. Because of the small area, a separate description or Section has not been made.

*L.3. Lower St. Lawrence Section*

The eastern part of the valley described above comes under this heading. The lowlands narrow down to the east, and the boundary on the north side of the river is only a short distance below Quebec city. On the south side, however, it continues for some distance along the river flats.

Characteristically, a mixed forest prevails, showing influence from the Boreal Forest Region to the north in its species. The principal association is made up of sugar maple, hemlock, white pine, and yellow birch, with considerable balsam fir and white birch and scattered white spruce—the last three all Boreal species. In the above are distributed some silver maple, (Northern) red oak, beech, white ash, butternut, red pine, and white elm. Aspen and white birch are relatively common after disturbances; cottonwood and red maple are found on river-banks, and swamps are composed of both black ash and black spruce with cedar.

Geological structure and soil-parent material are as for the previous Section, but the soil type is probably predominantly podsolic. Large parts have been cleared for agricultural purposes, but extensive forest areas still remain.

*L.4. Algonquin-Laurentides Section*

This quite extensive Section takes in the Georgian Bay district, the Algonquin highlands, upper Trent valley, the upper course of the Ottawa river, and the lower slopes of the Laurentide mountains, including the valleys of the St. Maurice and Gatineau rivers.

It is probable that more information may lead to subdivision of the area. The whole Section, however, differs fundamentally from the preceding ones in the Great Lakes–St. Lawrence Forest Region in that the bed-rock is part of the great Precambrian Shield of Canada, and consists largely of crystalline limestones (Grenville series), schists, and gneisses of the altered sedimentaries and granite intrusives. The topography is rough and irregular, and glacial deposits of varied character, chiefly of a somewhat light texture, cover the greater part. In addition there are some lacustrine deposits from the Nipissing–Great Lakes and Algonquin periods. A podsol type of soil is to be expected, but areas of gray-brown and brown forest soils may be present, particularly in the southern parts.

In this Section, white pine probably reached its maximum development in Canada (1), but extensive lumbering and fire have removed the greater part. Red pine has also been a prominent species, especially on the Algonquin Highlands (31). In spite of the previous dominance of these species and the presence of intrusive conifers from the Boreal Forest Region, the general character is that of a mixed forest (26), and the dominant or competitive association is one of sugar maple, yellow birch, hemlock, and white pine. In addition are varying amounts of basswood, white spruce, balsam fir, beech, (Northern) red oak, elm, white ash, red maple, ironwood, white birch, and large-toothed aspen. The composition of this association changes somewhat to the north, as hemlock, (Northern) red oak, and beech decrease numerically and finally drop out before the limits of the Section are reached and the proportion of yellow birch, white spruce, balsam fir, and white birch increases. White pine was originally of much greater representation in this association, and found its optimum growth here. Extensive areas within the section originally supported fine stands of white and red pine with a scattering of other species. Because of cutting and fire, these "pineries" have now a general secondary association of aspen, large-toothed aspen, white birch, balsam fir, white spruce, white and red pine, and scattered soft maple, red oak, and ironwood; on the lighter soils, jack pine, red pine, white pine, and white birch are also found. Such "pineries" are common on the Algonquin Highlands and on the areas of altered limestones of the Grenville series along the line of contact with the Huron-Ontario Section, such as in the Trent Valley district. Here, in addition to the above, a characteristic feature appears to be areas of pure hardwood, with a dominance of sugar maple; common occurrence of white and bur oak and ironwood, often as scrub growth; and extensive red maple and black ash, or Eastern white cedar swamps (17). Throughout the Section, other areas of hardwood occur on ridge tops and on heavier soil deposits, and black spruce, tamarack, and some cedar are found in swampy depressions.

In the eastern parts, the general mixed association grades northward to the Boreal Forest stands of the Central Transition and Northeastern Coniferous Sections, with yellow birch the surviving hardwood, which becomes more scattered and stunted in its growth.

To the west, along the shores of Georgian bay, is a specialized area or "shore type," developed on the rather rocky, thin-soiled, and low plateau found here. Jack pine is dominant, of an open, clumpy nature, together with aspen, white birch, red oak, red maple, white and black spruce, and white and red pine, all showing poor form and size.

*L.5. Eastern Townships Section*

To the east of the St. Lawrence valley in Quebec is an area of upland with parallel ranges and valleys running in a northeast-southwest direction. This is the northern termination of the Green mountains of the Appalachian system.

The base rocks are mainly deformed Cambrian and Ordovician sedimentaries, with considerable quantities of limestone, Precambrian intrusives, and altered sedimentaries. They are covered with glacial deposits, and, in addition, along the northwest face are beaches and shorelines of the glacial Champlain Sea. The soil type is podsolic to podsol.

It is a well-forested region. The prevailing associations appear to be white spruce and balsam fir on the higher grounds and thinner soils; sugar maple, yellow birch, white spruce, balsam fir, white pine, and hemlock on better sites, and some cedar and black spruce in swamps. Following fire, aspen and white birch become prominent.

In connection with this Section, there is considerable disagreement amongst observers with regard to the presence or absence of red spruce, and its substitution for white spruce as a dominant. In accordance with Marie-Victorin (29), red spruce has been considered as absent, and the Section consequently has been placed within the Great Lakes–St. Lawrence Forest Region and not the Acadian Forest Region. It is possible that more detailed investigation will alter this concept, or show the Acadian Forest to extend just over the International Boundary.

*L.6. Temiscouata-Restigouche Section*

This Section extends northeast from the previous one to the lower elevations of the Gaspé peninsula and into New Brunswick around the upper valley of the St. John, the Baie de Chaleur, and the Restigouche river drainage.

It is a portion of the Great Lakes–St. Lawrence Region in which relicts of the Boreal Forest have been, as it were, trapped by the St. Lawrence estuary and exert a strong influence.

It is marked by the absence of hemlock, although other dominants of the Region are present. According to Marie-Victorin (29), the Acadian dominant red spruce does not appear to be present in the Quebec portion, and from reports of the area in New Brunswick, this species, if present, has only a very limited range. In consequence, this Section has not been considered as part of the Acadian Forest.

Cedar is a most characteristic species, reaching its best growth here, and its presence is reflected in the number of shingle mills throughout the area. It is found principally as a bottom type with black spruce and tamarack, but is also found scattered through mixed associations. The Boreal Forest species, white spruce and balsam fir, are of considerable importance, especially in the New Brunswick parts (32). The former species forms pure or mixed associations, generally in the valleys, with some balsam fir and yellow, white, and wire birch. On the slopes and rocky knolls, balsam fir predominates, in mixture with yellow birch, white birch, and, originally, white and red pine. The tops of ridges and hills are very noticeably capped with stands of sugar maple and some yellow birch. Both red and white pine, formerly of much greater abundance throughout the area, are still present, the latter showing up more prominently in second-growth stands following fire. Alluvial flats support balsam poplar, black ash, white elm, and white spruce. Jack pine appears within the Section only as isolated clumps.

Following fire, both white and wire birch and aspen gain numerically. The presence of the wire birch is interesting, as this species appears to be closely connected in its range with the Acadian Forest Region.

The bed-rock is of Cambrian, Devonian, and Silurian sedimentaries, locally metamorphosed. Soils are derived from glacial material, residuals, and some

marine clays on the northern parts. In New Brunswick in particular, the soft nature of the Silurian limestones has produced a rich and deep material which forms part of the so-called Fertile Belt of this province. The soils are distinctly calcareous and of a loamy nature in general, coarser towards the northeastern parts, and a podsolic to podsol type has been developed.

The topography is rolling, with relatively flat-topped hills and plateaux and streams cut into rather deep and narrow valleys.

*L.7. Saguenay Section*

West of the estuary of the St. Lawrence river is a basin-like area centring round lake St. John and connected by the fault line and deep valley of the Saguenay to a low-lying coastal strip on the west shores of the above estuary. The underlying bed-rock is of the customary Precambrian granite of the Canadian Shield, with intrusives of diabase and anorthosite round lake St. John. The surface deposits are largely marine clays, of considerable depth round the lake, and of Pleistocene time.

Here is a forest that is in marked contrast as to species with the surrounding lands. Sugar maple, yellow birch, white pine, and scattered red pine are present, together with cedar, basswood, white elm, black ash, and balsam poplar in local patches and on river-banks. The majority of these are Great Lakes–St. Lawrence Forest species. Other Boreal Forest intrusives are also found, especially after fire, when stands of aspen, white birch, white spruce, balsam fir, and white pine are common.

The occurrence of white pine and red pine so far north has led to some misconception at times in drawing lines of northern limits of the species by joining up parts of known presence. In consequence, large areas of land in Quebec have been included as supporting these species, although this does not appear to be the case.

On the generally heavy surface deposits, soils of a podsolic type can be expected, and organic soils will be common. It is possible that brown forest soils are present, reflecting local underlying rock conditions and tree species. Because of the favourable soils, much of the Section has been cleared for agriculture.

*L.8. Haileybury Section*

From the northern portion of lake Timiskaming, extending towards the height of land, the fault valley in which this lake lies opens up to an undulating and gently inclined plain. Here the altered sedimentaries and volcanics of early Precambrian age and the granitic intrusives are covered by lacustrine clay deposits from glacial Lake Barlow.

On these clays, black spruce associations appear to be characteristic and well distributed; they contain some balsam fir, white birch, and aspen. As the result of fires, the extent of the last two is greatly increased, and mixed stands of aspen, white birch, black spruce, and balsam fir are common. On moister flats and river-banks, associations of balsam poplar of large size are reported, with Eastern white cedar, of good growth, by the rivers and in the more swampy depressions.

In spite of the prevalence of many boreal species, the whole section shows the strong influence of more southern species and, consequently, has been placed within the Great Lakes–St. Lawrence Forest Region. Basswood is scattered along the rivers throughout, together with some white elm and black ash. At the head of Lake Timiskaming, well-developed yellow birch, together with sugar maple, red oak, and red maple are found, the last two species occurring in large quantities on low lands near the mouth of the river Blanche (2). Further scattered presence of the above species takes place within the Section. White pine is not common, probably because of unfavourable soil conditions, but occurs on the lighter soils and shorelines and more commonly to the north. Hemlock is not present, and white spruce is not abundant.

A large part of the Section is now cleared and partially cultivated, and fires have been extensive in the past.

*L.9. Timagami Section*

A large area north of lake Huron, extending up to the height of land but not including the immediate coastal region, provides habitats where white and red pine have played and still play an important part. This is due largely to the presence of sandy and gravelly soils laid down in the upper levels of glacial Lake Algonquin. These are more common in the northern parts of the Section; to the south the deposits are of finer texture.

The typical association for the Section may be considered as one of white pine with scattered white birch and white spruce, the latter often of equal development with the pine. In certain localities, red pine is present, and it also occurs as bluffs on high rocky shores. After fires, the proportion of white spruce and white birch increases, and black spruce often enters.

Over much of the area, mixed stands of white birch, white and black spruce, aspen (mainly large-toothed), white pine, and scattered yellow birch are common, with intrusion of sugar maple on the southern flanks. These stands are related in part to the effect of fires, which increase the representation of white birch and aspen. Under certain conditions, however, white and red pine reproduce themselves adequately following fire. In swamps and low depressions, black spruce and tamarack form an association, together with some Eastern white cedar. Jack pine occurs within the Section, but is generally restricted to dry, rocky, and poor sites, though sometimes replacing white pine after fires. Balsam fir is by no means common, and usually is found with white and black spruce and white birch in stands of poor quality.

The topography is somewhat irregular, but there is a well-marked slope to the south, facilitating drainage. The bed-rock is of Precambrian granite and gneiss, with local conglomerates, tillites, and sandstones of the Huronian series. The forest soils are podsolic to podsol in type. The Section agrees closely with the Sudbury Region of Brodie and Sharpe (34).

*L.10. Algoma Section*

This area has a well-marked topography which is reflected in the character of the associations. In general, it consists of a series of high ridges and valleys, running from east to west, having the southern side steep and the northern gently sloping. Drainage is mostly to the west and southwest.

The characteristic association is a mixture of yellow birch, balsam fir, white spruce, white pine, sugar maple, and scattered cedar and ironwood; it is found principally on the gentle northern slopes. Tops of ridges are covered with pure hardwood stands of sugar maple and yellow birch. The steep southern slopes allow white pine, cedar, and scattered red pine to dominate, with white birch prominent after fire. A characteristic feature of a large part of the Section is the marked development of white spruce flats along the river terraces. In this association is black spruce, white birch, and balsam fir. The more southern parts of the Section do not appear to contain such stands, but their representation increases to the north and is extended into the adjoining Superior Section. Fire is to some extent a factor in this condition, as is the case with areas of jack pine sand-plains. Along the shores of lake Superior are lowlands with much stunted Eastern white cedar, black spruce, and tamarack, together with alder thickets, and scrubby red maple and white elm on the higher parts back from the lake. Red oak (Northern) has some distribution on the southwest side of the Section in the neighbourhood of Batchawana bay, and a scattering of hemlock is found almost as far north as this. The well-marked distribution of sugar maple and yellow birch—the so-called northern hardwoods—within this section and the comparative absence of these species in the Section immediately to the northeast can, no doubt, be explained through the land bridge afforded by the Mackinac

peninsula at Sault Ste. Marie. This may have allowed invasion by the Deciduous Forest element of the Great Lakes–St. Lawrence Forest following the breaking up of Lake Algonquin into the present Great Lakes system. Further evidence of this invasion is afforded by the isolated presence of white oak at Sault Ste. Marie.

Precambrian granites, gneisses, and schists with some local basalts and conglomerates of the Huronian series are the base rocks, which are covered with glacial deposits, later alluvials, and some lacustrine deposits from Lake Algonquin to the west. Podsols and podsolic types have been developed. This Section is the equivalent of the Algoma Extension of Brodie and Sharpe (34).

*L.11. Quetico Section*

After the retreat of the last ice-sheet, part of the returning much-fragmented Great Lakes–St. Lawrence Forest would seem to have pushed north through what is now Minnesota, probably from the direction of Minneapolis (8), into the country between the lake of the Woods and lake Superior.

Over the greater part of this area, the underlying granites, schists, and dolomites of the Precambrian Shield have been strongly glaciated, and the resulting soil deposits are thin and of a light texture.

The irregular nature of the terrain has led to the formation of a large number of rocky-shored lakes of various sizes. Certain parts with lacustrine deposits from glacial Lake Agassiz are included in the next Section.

The general character of the country appears to have favoured the development of red and white pine associations, of which large areas still remain. Here, the red pine is the more common, forming almost half the stand, and white birch is a constant member. The effect of fire has been to replace these stands to a large extent by jack pine, balsam fir, white and black spruce, white birch, some aspen (mostly large-toothed), and a varying quantity of red and white pine. Balsam fir seems to be well represented everywhere, occurring as seedlings in the red and white pine associations, and is considered as taking a co-dominant role with basswood south of the Section in the United States. This last species also appears relatively common over much of the Section, and in the southern parts there is scattered representation of yellow birch, sugar maple, red maple, Manitoba maple, and some white elm; large-toothed aspen and ironwood have a general distribution throughout.

Climatic conditioning of the area may be inferred from the fact that the red and white pine is, on the average, considerably shorter than the same species in the Great Lakes–St. Lawrence Region east of lake Superior.

*L.12. Rainy River Section*

During its early stages glacial Lake Agassiz extended to the east in a wide lobe, reaching Rainy lake and passing to the south of Red lake in Minnesota. Over this country lacustrine and modified glacial deposits are found. Two islands of higher land, however, with morainic material and outwash sands, were not covered by the lake; these are the Beltrami uplands in Minnesota and a smaller area, the Sandilands, in Manitoba.

In the above Section, the lake deposits in the eastern part overlie rocks of the Precambrian Shield, from Rainy lake to the lake of the Woods; west of this, they occur on flat-lying Palaeozoic sedimentaries. The untouched area of the Sandilands is also included within the Section.

In general, the topography is flat to undulating, and swamps are numerous.

The forest cover shows the influence of the northward movement of the Great Lakes–St. Lawrence Forest, mentioned in the previous Section, and also of the tension zone between the Forest and Grassland Formations and its Deciduous-Forest element. The nature of the ground and drainage has favoured the development of large black spruce, tamarack, and Eastern white cedar swamps and willow and alder scrub, particularly in the western portions on the

sedimentary rocks and south of the International Boundary. The northwestern limits of the Section are principally determined by the range of this association and the presence of cedar. Inland from the rivers are large areas of balsam poplar of fair size, white spruce, balsam fir, and scattered tamarack. On the river-banks are white elm, basswood, Manitoba maple, and bur oak, with the latter often forming open, grassy groves; large-toothed aspen occurs throughout. (19). Red and white pine have a scattered representation on suitable sites, particularly in the western parts; red pine apparently in the past occurred in some quantity on the light soils of the Sandilands, but is now replaced largely by jack pine after fires, and the white pine has been removed by lumbering. Soils are of the podsolic to podsol type, and certain agricultural settlement, with consequent clearing, has taken place, particularly in the eastern parts along the Rainy river.

*L.13. Lake Superior West Section*

A further extension into Canada of the characteristic Deciduous Forest element within the Great Lakes–St. Lawrence Forest takes place along the lower lands sloping to the west side of lake Superior, extending north to Port Arthur, and taking in the lower course of the Kaministikwia and Pigeon rivers.

Here white pine, sugar maple, white spruce, balsam fir, yellow birch, and scattered basswood form characteristic associations on the higher lands, with red maple and cedar on wetter sites. The effect of fire is reflected in stands of aspen, mostly large-toothed, white birch, white spruce, balsam fir, and some white pine.

Precambrian altered sedimentaries (conglomerates, slates, and iron-bearing rocks of the Animikie series) form the base rocks, and they are largely covered with clays and sands deposited by glacial Lake Algonquin.

## Acadian Forest Region

*A.1. New Brunswick Uplands Section*

In the northwest part of New Brunswick is a large area of rough uplands where the highest parts of the province are found, with elevations up to 2,700 feet. It was formed by uplift and folding during Devonian times, and a large portion consists of granitic intrusives through disturbed Cambro-Silurian slates. Subsequent heavy glaciation has left much bare rock, with thin, stony soils and many boulders. On these soils a podsol type has been developed.

The forest cover is essentially coniferous, with balsam fir association predominant (32). Black spruce associations are common, especially on stony slopes, and red spruce is generally distributed, falling off, however, towards the northwest. This species is found on the more favourable sites in admixture with white pine, cedar, sugar maple, yellow and wire birch, and scattered hemlock, and as the lower slopes and soils derived from sedimentary rocks are reached the proportion of hardwoods increases. Patches of red pine are present, and fire brings in white birch, increases the proportion of wire birch, and forms local stands of jack pine. On low swampy spots, black ash and tamarack are present.

The frequent occurrence of exposed rock surfaces and repeated fires have favoured in many places the development of extensive barrens (5).

*A.2. Miramichi Section*

The northeast quarter of New Brunswick consists of a gently undulating plain, sloping to the gulf of St. Lawrence and underlain principally by sandstones, shales, and conglomerates of the Pennsylvanian period of the Carboniferous system. The above section covers the western portions of this plain, with a relatively level and undulating topography which becomes more rolling towards the more elevated western and northwestern parts, where disturbed Palaeozoic sedimentaries are encountered. It includes the main drainage of the Miramichi and a large part of the Nipisiguit river.

The soils are light and sandy; they are deficient in lime, being derived partly from disintegration of the sandstone rocks, and, over certain areas of red sandstone, are composed of heavier-textured reddish shale loams. Marked leaching is found, with a podsol formation, and, in common with those of the following section, the term "hungry" is often applied to them. The best soils are the alluvials in the river valleys (5).

The forest cover is almost entirely of a mixed or softwood character. The extensive Miramichi fire of 1825 and subsequent fires appear to have favoured associations of red spruce, black spruce, balsam fir, aspen, white birch, wire birch, and white pine. In the older stands, hemlock is present to a limited extent; it was formerly well represented over the whole plain, and, it is thought, reached its best growth here (6). Lumbering and fire, however, have largely climinated this species. Black spruce associations, with cedar and tamarack, are common, especially to the southwest, but white spruce is somewhat restricted to drier spots in river-valleys and abandoned pastures. Lumbering has also influenced the originally wide-spread stands of white and red pine, which were a dominant feature of the Section; the former species, however, is still found to some extent in the younger stands, especially after fire. Jack pine is present, though not so well represented as in the section following.

On the better soils, particularly on the higher grounds to the west, yellow birch, white birch, white pine, balsam fir, red spruce, beech, and some maple and hemlock form mixed associations. Hardwood associations are poorly represented, small stands of beech of poor form being found on ridges and knolls. Of other species, mention may be made of scattered elm, a certain amount of black ash in the river-flats, and occasional red maple.

*A.3. Northeast Coastal Section*

This comprises, in general, the coastal portion of New Brunswick bordering on the gulf of St. Lawrence from the baie de Chaleur to Northumberland strait, and extending back to the headwaters of the smaller rivers draining into the gulf both north and south of the valley of the Miramichi.

It forms part of the well-marked triangular lowland of northeast New Brunswick, consisting of sediments of the Carboniferous system—here mainly of grey sandstones of the Pennsylvanian Period. The topography is uniform, having a level to gently rolling nature and rising from a low flat plain to about 300 feet elevation in the west, where the rivers have their source in level catchment areas. In the southern parts, these areas also form part of the St. John River drainage system.

The soil is decidedly sandy, being derived in part from disintegration of the sandstones and from glacial deposits, rougher débris from which is noticeable adjacent to the coast. The soil type is a podsol. Poor drainage is characteristic, and peat bogs, swamps, and barrens are well developed (6).

The prevailing character of the forest is softwood, and the trees are often reduced in size in the immediate vicinity of the coast. Black spruce associations, with cedar and tamarack and white and wire birch, are dominant, especially on the swampy lands, and extensive areas of jack pine are found on sand flats. Red spruce is well distributed, usually in admixture with such hardwood species as yellow birch, beech, and some sugar maple. Hemlock was formerly of considerable importance as pure stands or in admixture with the above. Balsam fir is possibly not so general as in other parts of the region; white spruce is present to a limited extent. Hardwood associations are restricted to small areas on ridges, and are often of a poor-quality beech.

Climatically, the influence of sea fogs would appear to be marked.

*A.4. Central Section*

This somewhat comprehensive section takes in the main St. John valley, the southern parts of New Brunswick, Prince Edward Island, and the central

and northwest-facing parts of Nova Scotia. It is probable that more detailed information will necessitate subdivision.

Not only is the land area diversified, but also the underlying rocks, soils, and topography. In general, the character is rolling, with highlands and peaks up to 1,000 feet. Prince Edward Island, however, is of low relief, and the St. John river valley is a prominent feature in New Brunswick.

The bed-rock is extremely varied, ranging from Palaeozoic sedimentaries, in part locally metamorphosed, in the northwest, through granitic intrusives of Devonian times, lower Carboniferous sandstones, and Palaeozoic and Precambrian intrusives, to the Permian sandstones, disturbed Palaeozoic sedimentaries, Carboniferous sandstones, Triassic extrusives, and intrusive granites of Nova Scotia. Glacial deposits form a large portion of the soils, but transported and residual materials are common. The most fertile soils are probably those of the upper St. John valley, derived from limestone, and the red soils of the Permo-Carboniferous and Carboniferous systems in Prince Edward Island and Nova Scotia. In the main, the parent material is rich in lime, and podsols, and podsolic and, possibly, brown forest soil-types have been developed.

With such a diversity of topography and soils, it is hard to assign any specific character to the forests of the whole section. The presence of certain species, however, would seem to indicate more favourable climatic conditions than obtain in other parts of the Forest Region. This may probably be correlated with length of growing season. The species in question are butternut and basswood in the St. John valley and round Grand lake—with the first apparently of much greater extent in the past—red oak, extending from the upper waters of the Miramichi to Nova Scotia but now largely cut out, and bur oak. Both sweet birch and pitch pine have been also recorded in this Section.

In general, it can be said that the forest cover shows a definitely broad-leaved nature. In certain portions, hardwood stands are prominent, especially on the higher lands at the headwaters of the Miramichi, in the valleys of the upper St. John and the Tetagouche, where yellow birch, sugar maple, and beech associations are found. On the Kennebecasis river, yellow birch and sugar maple stands are common on ridges, and on the intrusive granites pure stands of beech occur. In the parts of Nova Scotia falling within this Section, Fernow (11) states that a better-developed hardwood growth and more luxuriant forest is found than that in the remainder of the province. In Prince Edward Island, in spite of the flat topography and low elevation, maple occurs generally throughout, although in other parts of the Section it is more confined to the higher and better-drained positions (24). Mixedwood associations probably make up the largest portion of the forest cover, and are mainly composed of yellow birch, red spruce, sugar maple, beech, hemlock, white pine, wire birch, red maple, and some balsam fir. Red pine is found on gravelly soils, but jack pine does not appear to be present to any extent. Black spruce is found both in the general mixture and also growing with cedar, tamarack, and white birch on swampy portions. White spruce is generally scattered, of greater representation probably towards the upper portion of the St. John River valley, with a tendency to come in on abandoned fields and in river-valleys. Fires increase the proportion of white birch, aspen, large-toothed aspen, and wire birch. Good development of white elm is found in the river-valleys, especially that of the middle part of the St. John, and black and white ash are present on rich bottomlands.

*A.5. Atlantic Slope Section*

The above Section covers the east side of Nova Scotia and part of Cape Breton island, where the forest cover of the relatively steep and irregular slopes to the Atlantic is under the influence of the moisture-laden winds from the ocean.

A coniferous forest has been developed here, with an association of red spruce and balsam fir dominant. To the north the balsam fir increases in importance,

especially in Cape Breton island. In general, the tendency is for the balsam fir to become dominant on the upper elevations and thinner soils, and for the red spruce to occupy the lower slopes, with some admixture, in the southern parts, of hemlock and white pine. On the better soils is found a mixture of red spruce, sugar maple, beech, yellow birch, wire birch, and, outside of Cape Breton Island, hemlock and white pine. Extensive areas of glacially deposited sands are found on which white pine forms almost pure stands; and gravelly ridges often support wire birch, red maple, and red oak.

A further characteristic feature of the Section is the large extent of barrens, open bogs, and brushland.

Both the soils derived from glacial deposition and, in part, those of residual nature are generally thin, stony, and gravelly, and of the podsol type. They rest on the late Precambrian and Cambrian quartzites and slates, and, more especially toward the higher and western portions of the Sections, on granitic intrusives.

Because of exposure and thin soil character, tree growth is somewhat reduced, the better stands being found on the deeper glacial deposits and on those developed from slates.

*A.6. Cape Breton Plateau Section*

The interior of the northern part of Cape Breton island is a high plateau, underlain by Precambrian granite-gneisses on which thin rocky soils are common.

Here is found an almost pure forest of balsam fir, with the addition of some red spruce and white birch (11). The more northern parts of this plateau are somewhat hilly, and both here and up the river-valleys is some intrusion of yellow birch, sugar maple, and beech from the surrounding Section. In the centre are extensive barrens and swamps.

The abundance of balsam fir in this Section and the adjoining ones may possibly be explained in the light of movements of vegetation following glaciation, in which parts of an earlier forest have been isolated by the barrier of the gulf of St. Lawrence. Although balsam fir is distributed throughout the Acadian Forest Region, its centre of abundance would seem to be within this Section. The lack of white spruce (the characteristic Boreal species) is, however, noteworthy, and, furthermore, Macoun (25) was unable to find a relation in the vegetation of the barrens to those of Labrador and considered the whole island as similar to the Acadian and Great Lakes–St. Lawrence Forest Regions.

*A.7. Cape Breton Plains Section*

With the exception of the southeast portion facing the Atlantic, and the previous Section, the remainder of Cape Breton island is included here; it consists of an undulating plain in the southern parts, and the rather steep slopes leading up to the plateau previously mentioned, in the north.

It differs from the main portion of Nova Scotia covered by the Central Section in the absence of hemlock, the very limited distribution of white pine, and the abundance of balsam fir, which species appears characteristic for the whole island (11). The prevailing association is of a mixed character, composed of balsam fir, white and yellow birch, beech, sugar maple, and red spruce. White spruce is present in limited quantities, red oak has a local distribution, and some white elm is found in the valleys. Considerable clearing and cutting has taken place in the forest cover, and fires have favoured the extension of white and wire birch and aspen.

The rocks are of lower Carboniferous sedimentaries interrupted by Precambrian granite-gneisses. The soils are generally of a light texture, and podsolic to podsol types have developed.

## APPENDIX

### Climate

Through the kindness of Professor J. H. Ellis, of the Soils Division of the University of Manitoba, I am able to give in this appendix certain climatic figures which are of great interest and bear out in a remarkable manner the general unity and validity of the Regional and Sectional concept. This concept, as outlined in the preceding pages, makes use of the character of the dominant vegetation of the formation, in this case the tree form, as the distinguishing criterion.

The climatic figures have been obtained by the formulae proposed by Thornthwaite (35) in his paper on the Climates of North America.

His method is, in brief, a computation of the precipitation-evaporation quotient by the use of mean monthly temperature and precipitation figures. Two basic factors for a given station are obtained, the Precipitation Effectiveness (P-E) and the Temperature Efficiency (T-E), and these are further conditioned by indicators of the Rainfall and Temperature Periodicity.

The formulae referred to are the following:

$$P\text{-}E = \sum_{n=1}^{12} 115 \cdot \left[\frac{P}{T-10}\right]_n^{\frac{10}{9}}$$

$$T\text{-}E = \sum_{n=1}^{12} \left(\frac{T-32}{4}\right)_n.$$

A striking general relationship is shown by Thornthwaite between his figures grouped under climatic regions, the broad physical soil types, the type of natural cover, and the climax formations outlined by Clements.

As a means of correlating and indicating the physical soil types for Canada in a more detailed manner, Professor Ellis, assisted by Mr. Wm. H. Schafer, has worked out, at considerable trouble, the factors and indicators as above for all Canadian stations with year-round records of temperature and precipitation for ten years and over.

On examining the data, it was found difficult to make a satisfactory separation of climatic regions or divisions. This was in part due to the relatively small number of stations available, particularly those with any duration of recording, and their general massing along the southern portion of the Dominion.

It occurred to Professor Ellis, who knew of preliminary work done by the writer on Forest Sections and Regions in the three Prairie Provinces (15), that if this work was extended to cover the whole of Canada, examination of the data for stations falling within the boundaries of a given Section or Region might then tend to show up significant differences. This method has apparently been used to some extent by Thornthwaite. Such an extension of the sectional and regional classification had already been commenced and a large portion of Canada covered. The present paper is the completed work.

Examination of the grouped climatic data shown in the following tables indicates that such differences do exist and several striking points are brought out. Good correlation is shown generally with the relationships obtained by Thornthwaite, although some important differences exist.

It must be remembered that the boundaries of the Sections and Regions are relatively tentative, so that such groupings of stations are subject to emendation, and the resulting averages are dependent also in part on the dispersion plan of the stations.

The symbols given hereunder are used to classify the data into Climatic Provinces. They are those employed by Thornthwaite, but a finer degree of division has been adopted by Ellis. Futher, the descriptive terms appropriate to these have been placed by him entirely on a climatic basis rather than on

the mixture of climatic and vegetational forms used in places by Thornthwaite. The symbols are as follows:—

| *Humidity Province* | *Precipitation-Effectiveness P-E Index* | *Descriptive Term* |
|---|---|---|
| A+ | 192 up | Wet |
| A | 128 to 191 | Wet |
| B+ | 96 to 127 | Humid plus |
| B | 64 to 95 | Humid |
| C+ | 48 to 63 | Sub-humid plus |
| C | 32 to 47 | Sub-humid |
| D+ | 24 to 31 | Semi-arid plus |
| D | 16 to 23 | Semi-arid |
| E+ | 8 to 15 | Arid |
| E | 0 to 7 | Arid |

| *Temperature Province* | *Temperature-Efficiency T-E Index* | *Descriptive Term* |
|---|---|---|
| A′+ | 192 up | Tropical |
| A′ | 128 to 191 | Subtropical |
| B′+ | 96 to 127 | Warm Temperate plus |
| B′ | 64 to 95 | Warm Temperate |
| C′+ | 48 to 63 | Temperate plus |
| C′ | 32 to 47 | Temperate |
| D′+ | 24 to 31 | Cool Temperate plus |
| D′ | 16 to 23 | Cool Temperate |
| E′+ | 1 to 15 | Subarctic |
| E′ | 0 | Arctic |

(N.B. In the above provinces, the descriptive terms have been very slightly altered from those used by Professor Ellis.)

*RAINFALL PERIODICITY*

| *Subtypes* | *Criteria* | *Descriptive Term* |
|---|---|---|
| r. | P-E Index more than 48 and highest index of seasonal effectiveness less than half the total unless total exceeds 128. | Moisture abundant at all seasons. |
| s. | Winter effectiveness index more than 16 and more than half P-E index, which must be less than 128. | Moisture deficient in summer. |
| w. | Summer effectiveness index more than 16 and more than half the P-E index, which is less than 128. | Moisture deficient in winter. |
| d. | P-E index less than 48 and highest index of seasonal effectiveness less than 16 or less than half the total. | Moisture deficient at all seasons. |

*TEMPERATURE PERIODICITY*

| *Subprovince* | *Per Cent Summer Concentration* |
|---|---|
| a. | 25 to 34 |
| b. | 35 to 49 |
| c. | 50 to 69 |
| d. | 70 to 99 |
| e. | 100 up |

In addition to the above, Thornthwaite considers that if the temperature-efficiency index is less than 32, it controls the climate; if the index is more than 32, the climate is controlled by the precipitation effectiveness.

## SUMMARY OF CLIMATIC DATA

| Forest Region | Section | Number of Stations | P-E Index | T-E Index | P-E Index | | T-E % Summer Conc. | Climatic Province |
|---|---|---|---|---|---|---|---|---|
| | | | | | Summer | Winter | | |
| BOREAL | | | | | | | | |
| a. Eastern Division | B. 1. Northeastern Coniferous | 9 | 109·7 | 26·4 | 20·3 | 39·5 | 67·7 | B+rD′+c |
| | B. 2. Gaspé | 1 | 88·3 | 29·4 | 22·3 | 27·0 | 64·6 | B rD′+c |
| | B. 3. Central Laurentian | None | — | — | — | — | — | — |
| | B. 4. Northern Clay | 5 | 91·7 | 30·6 | 19·4 | 31·7 | 67·9 | B rD′+c |
| | B. 5. Coastal Plain | 1 | 66·8 | 28·6 | 16·5 | 21·4 | 68·9 | B rD′+c |
| | B. 6. East James Bay | None | — | — | — | — | — | — |
| | B. 7. Central Transition | 8 | 100·8 | 30·5 | 17·9 | 38·5 | 66·2 | B+rD′+c |
| | B. 8. Central Plateau | 4 | 76·3 | 31·4 | 14·4 | 24·2 | 65·8 | B rD′+c |
| | B. 9. Superior | 3 | 81·3 | 30·3 | 17·8 | 25·3 | 65·1 | B rD′+c |
| | B. 10. Nipigon | None | — | — | — | — | — | — |
| | B. 11. Western Transition | 3 | 72·6 | 34·1 | 17·7 | 22·4 | 65·1 | B rC′ c |
| | B. 12. Hamilton-Ungava Valleys | None | — | — | — | — | — | — |
| | B. 13. Northeastern Transition | None | — | — | — | — | — | — |
| b. Central and Northwestern Division. | B. 14. English River | 1 | 44·8 | 34·5 | 10·8 | 13·8 | 64·9 | C dC′ c |
| | B. 15. Manitoba Lowlands | 4 | 43·4 | 32·6 | 11·9 | 11·5 | 67·1 | C dC′ c |
| | B. 16. Aspen-Oak | 22 | 43·5 | 36·0 | 13·0 | 10·7 | 63·4 | C dC′ c |
| | B. 17. Aspen Grove | 25 | 37·5 | 31·0 | 13·2 | 8·8 | 64·1 | C dD′+c |
| | B. 18. Mixedwood | 13 | 41·9 | 30·4 | 14·3 | 10·9 | 63·8 | C dD′+c |
| | B. 19. Foot-hills | 7 | 46·8 | 28·0 | 15·1 | 12·2 | 62·7 | C dD′+c |
| | B. 20. Hyper-Churchill | None | — | — | — | — | — | — |
| | B. 21. Nelson | 2 | 50·7 | 29·3 | 12·9 | 14·6 | 70·5 | C+rD′+d |
| | B. 22. Northern Coniferous | None | — | — | — | — | — | — |
| | B. 23. Mackenzie Lowlands | 6 | 33·6 | 24·3 | 9·1 | 8·7 | 75·7 | C dD′+d |
| | B. 24. Upper Liard | None | — | — | — | — | — | — |
| | B. 25. Stikine Plateau | None | — | — | — | — | — | — |
| | B. 26. Yukon | 2 | 38·2 | 23·2 | 8·0 | 14·4 | 72·1 | C dD′ d |
| | B. 27. Northern Transition | 1 | 54·1 | 18·8 | 18·3 | 10·9 | 81·9 | C+rD′ d |
| SUBALPINE | SA. 1. East Slope Rockies | 4 | 75·4 | 23·6 | 20·6 | 22·3 | 66·2 | B rD′+c |
| | SA. 2. Interior Subalpine | 4 | 131·8* | 27·1 | 9·7 | 63·0 | 64·1 | A rD′+c |
| MONTANE | M. 1. Yellow Pine & Douglas Fir | 9 | 57·3 | 39·9 | 8·2 | 29·1 | 57·0 | C+sC′ c |
| | M. 2. Central Douglas Fir | 3 | 37·1 | 34·8 | 7·6 | 15·6 | 59·8 | C dC′ c |
| | M. 3. Northern Aspen | None | — | — | — | — | — | — |
| | M. 4. Montane Transition | 5 | 51·8 | 29·3 | 8·0 | 22·9 | 61·3 | C+rD′+c |
| | M. 5. Douglas Fir & Lodgepole Pine | None | — | — | — | — | — | — |
| COAST | C. 1. Madrona-Oak Transition | 12 | 93·3 | 50·2 | 5·9 | 53·0 | 42·9 | B sC′+b |
| | C. 2. Southern Coast | 16 | 198·7 | 48·5 | 13·6 | 107·9 | 44·9 | A+rC′+b |
| | C. 3. Central Coast | 3 | 280·4 | 43·4 | 21·4 | 143·9 | 45·3 | A+rC′ b |
| | C. 4. Northern Coast | 6 | 252·4 | 37·3 | 26·3 | 129·2 | 51·2 | A+rC′ c |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| COLUMBIA | CL. 1. | Southern | 9 | 87·4 | 40·3 | 10·0 | 45·0 | 56·5 | B sC′ c |
| | CL. 2. | Northern | 2 | 125·3 | 34·3 | 14·1 | 62·5 | 60·1 | B+rC′ c |
| DECIDUOUS | D. 1. | Niagara | 12 | 87·2 | 48·8 | 13·5 | 35·5 | 54·8 | B rC′+c |
| GREAT LAKES-ST. LAWRENCE | L. 1. | Huron-Ontario | 31 | 99·0 | 43·5 | 13·9 | 42·5 | 57·0 | B+rC′ c |
| | L. 2. | Upper St. Lawrence | 12 | 101·1 | 43·0 | 15·3 | 39·0 | 59·1 | B+rC′ c |
| | L. 3. | Lower St. Lawrence | 6 | 129·0 | 40·1 | 19·5 | 49·0 | 60·8 | A rC′ c |
| | L. 4. | Algonquin-Laurentides | 23 | 109·2 | 38·2 | 16·8 | 41·5 | 60·8 | B+rC′ c |
| | L. 5. | Eastern Townships | 9 | 115·3 | 37·3 | 19·9 | 43·1 | 61·8 | B+rC′ c |
| | L. 6. | Temiscouata-Restigouche | 7 | 106·5 | 32·6 | 17·1 | 41·1 | 64·4 | B+rC′ c |
| | L. 7. | Saguenay | 4 | 80·3 | 34·8 | 19·2 | 27·3 | 64·0 | B rC′ c |
| | L. 8. | Haileybury | 3 | 98·4 | 35·5 | 14·9 | 33·7 | 64·9 | B+rC′ c |
| | L. 9. | Timagami | 4 | 80·2 | 36·0 | 14·7 | 30·8 | 62·5 | B rC′ c |
| | L. 10. | Algoma | None | — | — | — | — | — | — |
| | L. 11. | Quetico | 4 | 61·1 | 35·6 | 16·2 | 17·3 | 64·2 | C+rC′ c |
| | L. 12. | Rainy River | 4 | 54·9 | 35·2 | 14·8 | 13·4 | 64·5 | C+rC′ c |
| | L. 13. | Lake Superior West | 1 | 55·5 | 32·7 | 15·3 | 12·9 | 63·1 | C+rC′ c |
| ACADIAN | A. 1. | New Brunswick Uplands | None | — | — | — | — | — | — |
| | A. 2. | Miramichi | 2 | 131·8 | 36·8 | 18·2 | 48·9 | 62·7 | A rC′ c |
| | A. 3. | Northeast Coastal | None | — | — | — | — | — | — |
| | A. 4. | Central | 27 | 132·4 | 37·6 | 17·3 | 54·9 | 58·4 | A rC′ c |
| | A. 5. | Atlantic Slope | 7 | 165·0 | 37·3 | 21·6 | 71·8 | 56·7 | A rC′ c |
| | A. 6. | Cape Breton Uplands | None | — | — | — | — | — | — |
| | A. 7. | Cape Breton Plains | 1 | 172·1 | 37·9 | 18·9 | 75·9 | 57·4 | A rC′ c |

*Wide variation in P-E Index.

Examination of the climates shown by the forest regions as a whole indicates certain well-marked distinctions. The climates have been briefly summarized below.

| Forest Region | Description of Climate |
|---|---|
| *Boreal* | |
| a. Eastern Division | *Humid plus to Humid.* Moisture abundant at all seasons. |
| | *Cool Temperate plus.* Climate controlled by *temperature* except for one transitional section, which has Temperate T-E index. |
| b. Central and Northwestern Division | *Sub-humid to Sub-humid plus.* Moisture deficient at all seasons except in two Sections, which have Sub-humid plus P-E index (one of transitional nature). |
| | *Cool Temperate plus to Cool Temperate.* Climate controlled by *temperature* except in three Sections which have Temperate T-E index. These Sections are grouped together and show special vegetational influences. |
| *Subalpine* | *Humid to wet.* Moisture abundant at all seasons. |
| | *Cool Temperate plus.* Climate controlled by *temperature.* |
| *Montane* | *Sub-humid plus to Sub-humid.* Moisture deficient in summer or deficient at all seasons or, in a Transitional Section, abundant at all seasons. |
| | *Temperate.* Climate controlled by *precipitation* except for Transitional Section above, which has Cool-Temperate plus T-E index. |
| *Coast* | *Wet* (Transition Section *humid*). Moisture abundant at all seasons except with Transition Section where it is deficient in summer. |
| | *Temperate plus to Temperate.* Climate controlled by *precipitation.* |
| *Columbia* | *Humid.* Moisture deficient in summer or abundant at all seasons (northern). |
| | *Temperate plus to temperate.* Climate controlled by *precipitation.* |
| *Great Lakes–St. Lawrence* | *Humid plus,* with two Sections *Humid;* three western Sections, *Sub-humid plus* and one eastern Section *Wet.* Moisture abundant at all seasons. |
| | *Temperate.* Climate controlled by *precipitation.* |
| *Deciduous* | *Humid.* Moisture abundant at all seasons. |
| | *Temperate plus.* Climate controlled by *precipitation.* |
| *Acadian* | *Wet.* Moisture abundant at all seasons. |
| | *Temperate.* Climate controlled by *precipitation.* |

It will be noticed from the above that the two divisions of the Boreal Forest appear to have some justification. The varying factor is one of precipitation. Thornthwaite has not worked out any precipitation figures for this part of North America, his contention being that " although there are variations of precipitation effectiveness in the regions where temperature efficiency is inade-

quate [i.e. controlled by temperature and with T-E less than 32], these variations appear not to be significant and are therefore not considered. Thus, if the T-E index is less than 32, no further climatic analysis need be made; the climate is either D′, E′, or F′ " (35). For these climates he uses the terms Taiga (Muskeg), Tundra, and Perpetual Snow and Frost.

Examination of the Section descriptions in this Region would appear to show significant differences in the vegetation which would at least have a bearing on forestry matters. Of particular importance here would be the co-dominant role which seems to be played by various species of poplar and birch. Such a division has, of course, been recognized by the Dominion Forest Service already in their inventory studies.

The Great Lakes–St. Lawrence Forest shows some irregularities. The western portions, which in Canada are geographically separated, have a much drier climate. With these might be related three Sections of the Boreal Forest which appear as exceptions on account of their temperature province. The climate of the former is sub-humid plus, rainfall abundant throughout the year, and Temperate; of the latter, Sub-humid, rainfall deficient throughout the year, and Temperate. The sections in question are L. 11, 12 and 13, and B. 14, 15 and 16. The distribution of bur oak may be here of indicative value. The paucity of stations, however, in at least two of the Sections does not permit of more than generalization at present. It must be noted, however, that Thornthwaite recognizes within his " C " climates that the rainy phase (CrC′c) " includes a narrow strip of Manitoba and a small corner of western Ontario but the dry phase (Cd C′c) extends in a wide belt from southwest Manitoba across Saskatchewan and Alberta " (35). With this last phase he is presumably referring to the wide extent of the Grassland Formation, most of which has a climate of this nature.

The separation of the Columbia Forest would appear to have some justification. Here, again, much more detailed work is necessary. Many of the meteorological stations seem to be in areas where Western larch, Douglas fir, and Western white pine are the characteristic associations, and which are considered by Weaver and Clements as an association that is typical of the transitional forest between the Coast and the Montane climaxes (37).

In the Coast Forest, the specialized nature of the Madrona-Oak Transition Section is well indicated by the figures.

The separation of the Acadian Forest Region from Clements' Boreal Forest would seem to have considerable validity. Not only do the Precipitation-Effectiveness figures place it in a separate Humidity Province but the Temperature-Efficiency figures cause it to be placed within an entirely different group of climates, those which are controlled by the Precipitation Effectiveness.

Allowing for inadequate measurements and somewhat arbitrary grouping, the climatic data that have been established as shown in this appendix would appear to be a most valuable check on the purely vegetational methods of classification. More than that, careful study of the figures should enable the classification to be materially improved and would also appear to justify, to a large extent, the use of the natural type of cover for such a classification. With the establishment of more extensive and well-distributed meteorological stations throughout Canada, the strength and accuracy of such a classification will be immeasurably improved.

## CHECKLIST OF TREE SPECIES

### *CONIFEROUS SPECIES*

Cedar
- Eastern White .. *Thuja occidentalis* L.
- Western Red .... *Thuja plicta* D. Don (Syn.: *Thuja gigantea* Nuttall)

Douglas Fir ..... *Pseudotsuga mucronata* (Raf.) Sudw. [Synonyms: *Pseudotsuga taxifolia* (Lam.) Britt.; *Pseudotsuga Douglasii* Carr., coast type; *Pseudotsuga glauca* Mayr, Interior type; *Pseudotsuga Douglasii* var. *caesia* Schw., Columbia and Rocky Mountain type].

Fir
- Alpine ..... *Abies lasiocarpa* (Hook.) Nutt.
- Amabilis ..... *Abies amabilis* (Loud.) Forbes.
- Balsam ..... *Abies balsamea* (L.) Mill.
- Grand (Lowland) *Abies grandis* Lindl.

Hemlock
- Eastern ..... *Tsuga canadensis* (L.) Carr.
- Mountain ..... *Tsuga Mertensiana* (Bong.) Carr.
- Western ..... *Tsuga heterophylla* (Raf.) Sarg.

Juniper
- Red ..... *Juniperus virginiana* L. [Syn.: *Sabina virginiana* (L.) Antoine].

Larch
- Alpine (Lyall's) . *Larix Lyallii* Parl.
- Western ..... *Larix occidentalis* Nutt.

Pine
- Jack ..... *Pinus Banksiana* Lamb. [Syn: *Pinus divaricata* (Ait.) DuMont de Cours].
- Limber ..... *Pinus flexilis* James [Syn.: *Apinus flexilis* (James) Rydberg].
- Lodgepole ..... *Pinus contorta* var. *latifolia* (Loud.) Engel. (Syn.: *Pinus Murrayana* Balf)
- Pitch ..... *Pinus rigida* Mill.
- Ponderosa ..... *Pinus ponderosa* Dougl. ex Laws.
- Red ..... *Pinus resinosa* Soland. in Ait.
- Sugar ..... *Pinus Lambertiana* Dougl.
- Shore ..... *Pinus contorta* Loud.
- Western White .. *Pinus monticola* Dougl. ex Lamb.
- White ..... *Pinus Strobus* L. (Syn.: *Strobus Weymouthiana* Opiz).
- Yellow=Ponderosa
- White-bark ..... *Pinus albicaulis* Engelm.

Spruce
- Black ..... *Picea mariana* (Mill.) B.S.P. [Syn.: *Picea nigra* (Ait.) Link].
- Engelmann ..... *Picea Engelmanni* Engelm.
- Red ..... *Picea rubra* Link. (Syn.: *Picea rubens* Sarg.)
- Sitka ..... *Picea sitchensis* (Bong.) Carr.
- White ..... *Picea glauca* Voss [Syn.: *Picea alba* Link; *Picea canadensis* (Mill.) B.S.P.]

Tamarack ..... *Larix laricina* (DuRoi) Koch (*Syn. Larix americana* Michx.)

Yellow Cedar ..... *Chamaecyparis nootkatensis* (Lamb.) Sudw. (Syn.: *Cupressus nootkatensis* (Lamb.)

*BROAD-LEAVED SPECIES*

Alder ..... *Alnus* (spp.)
- Red ..... *Alnus rubra* Bong. (Syn.: *Alnus oregona* Nutt.)

Ash
- Black ..... *Fraxinus nigra* Marsh. (Syn.: *Fraxinus sambucifolia* Lamb.)
- Blue ..... *Fraxinus quadrangulata* Michx.
- Green ..... *Fraxinus pennsylvanica* Marsh. var. *lanceolata* (Borkh.) Sarg. (Syn.: *Fraxinus lanceolata* Borkh.; *Fraxinus viridis* Michx.).
- [Prairie..... *Fraxinus campestris* Britt.]
- Red ..... *Fraxinus pennsylvanica* Marsh. (Syn.: *Fraxinus pubescens* Lamb.).
- White ..... *Fraxinus americana* L.

Aspen ..... *Populus tremuloides* Michx.
- Large-toothed .. *Populus grandidentata* Michx.

Beech ..... *Fagus grandifolia* Ehrh. (Syn.: *F. ferruginea* Ait.; *F. atropunicea* Sudw.; *F. americana* Sweet).

Basswood ..... *Tilia glabra* Vent. (Syn.: *Tilia americana* L.).

Birch
- Alaska White ... *Betula alaskana* Sarg. (Syn.: *Betula neoalaskana* Sarg.).
- White (or Paper) . *Betula papyrifera* Marsh.
- Sweet ..... *Betula lenta* L.
- Western White .. *Betula papyrifera* Marsh. var. *occidentalis* (Hooker) Sarg.
- Wire ..... *Betula populifolia* Marsh.
- Yellow ..... *Betula lutea* Michx.

Blue Beech ..... *Carpinus caroliniana* Walt. (Syn.: *Carpinus americana* Michx.).

Butternut ..... *Juglans cinerea* L.

Cottonwood ..... *Populus deltoides* Marsh. (Syn.: *Populus virginiana* Foug.; *Populus monilifera* Ait.).
- Black ..... *Populus trichocarpa* Torr. and Gray
- Lance-leaf ..... *Populus acuminata* Rydb.
- Narrow-leaf..... *Populus angustifolia* James
- Great Plains .... *Populus Sargentii* Dode

Cherry
- Black ..... *Prunus serotina* Ehrh.
- Choke ..... *Prunus virginiana* L.

Chestnut ..... *Castanea dentata* (Marsh.) Borkh. (Syn.: *C. americana* Raf.).

Cucumber Tree ..... *Magnolia acuminata* L.

Elm
- White ..... *Ulmus americana* L.
- Slippery (Red) .. *Ulmus fulva* Michx.
- Rock ..... *Ulmus racemosa* Thomas. (Syn.: *Ulmus Thomasii* Sarg.).

Gum, Black ..... *Nyssa sylvatica* Marsh. (Syn.: *Nyssa multiflora* Wang.).

Hickory
- Bitternut ..... *Carya cordiformis* (Wang.) K. Koch. [Syn.: *Hicoria cordiformis* (Wang.) Britt.; *Carya amara* Nutt.].
- Mockernut ..... *Carya alba* (L.) K. Koch. [Syn.: *Hicoria alba* (L.) Britt.; *Carya tomentosa* Nutt.].

Hickory—*Concluded*
- Pignut ..... *Carya glabra* (Mill.) Sweet. [Syn.: *Hicoria glabra* (Mill.) Sweet; *Carya porcina* Nutt.].
- Shagbark ..... *Carya ovata* (Mill.) K. Koch. [Syn.: *Hicoria ovata* (Mill.) Britt.; *Carya alba* Nutt.].

Ironwood ..... *Ostrya virginiana* (Mill.) K. Koch

Kentucky Coffee Tree. *Gymnocladus dioica* (L.) K. Koch. (Syn.: *Gymnocladus canadensis* Lam.).

Madrona ..... *Arbutus Menziesii* Pursh

Maple
- Broad-leaved .... *Acer macrophyllum* Pursh
- Manitoba ..... *Acer Negundo* L. [Synonyms: *Negundo aceroides* Moench; *Acer interior* Britt.; *Negundo interius* (Britt.) Rydb.]
- Red ..... *Acer rubrum* L.
- Silver ..... *Acer saccharinum* Wang. (Syn.: *Acer dasycarpum* Ehrh.).
- Sugar ..... *Acer saccharum* Marsh.
- Vine ..... *Acer circinnatum* Pursh

Mulberry ..... *Morus rubra* L.

Oak
- Bur ..... *Quercus macrocarpa* Michx.
- Black ..... *Quercus velutina* Lam. (Syn.: *Quercus tinctoria* Bartr.).
- Chestnut ..... *Quercus montana* Willd. (Syn.: *Quercus Prinus* Engelm.).
- Chinquapin ..... *Quercus Muehlenbergii* Engelm. [Syn.: *Quercus acuminata* (Michx.) Houba].
- Garry ..... *Quercus Garryana* Douglas.
- Pin ..... *Quercus palustris* (L.) Muench.
- Red (Northern Red) ..... *Quercus borealis* Michx. [Synonyms: *Quercus rubra* Duroi; *Quercus maxima* (Marsh.) Ashe; *Quercus borealis maxima* (Marsh.) Ashe].
- Scarlet ..... *Quercus coccinea* Muench.
- Swamp White ... *Quercus bicolor* Willd. (Syn.: *Quercus platanoides* Sudw.).
- White ..... *Quercus alba* L.

Papaw ..... *Asimina triloba* Dunal

Poplar
- Balsam ..... *Populus balsamifera* DuRoi. (Syn.: *Populus tacamahacca* Mill.)
- Balm of Gilead (Black P.).... *Populus candicans* Ait.

Redbud ..... *Cercis canadensis* L.

Sassafras ..... *Sassafras variifolium* (Salisb.) Ktze. (Syn.: *Sassafras officinale* Nees and Eberm.).

Sycamore ..... *Platanus occidentalis* L.

Tulip Tree..... *Liriodendron Tulipifera* L.

Walnut, Black..... *Juglans nigra* L.

Willow ..... *Salix* spp.

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