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A FOREST CLASSIFICATION FOR THE MARITIME PROVINCES

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INTRODUCTION

The standard reference for regional forest descriptions in Canada for over twenty years has been *A Forest Classification of Canada*, prepared by W. E. D. Halliday (1937). The widespread use of this work as a reference and as a means of broad comparison reflects its importance and the need it filled. Recently, increased knowledge of the forests of Canada led to the revised classification by J. S. Rowe (1959), titled *Forest Regions of Canada*.

Forest descriptions covering large continental areas necessarily require a broad scale in both mapping and presentation of detail. In the maritime provinces of New Brunswick, Prince Edward Island, and Nova Scotia, however, coastal influences and abrupt changes in elevation result in marked differences in forest composition and succession within relatively short distances. Detailed descriptions and a large-scale map are therefore a necessary aid in evaluating the significance of these differences for forest management.

The classification put forward in this paper is intended to provide the detailed descriptions for local use. The underlying principles are specific to the objectives of classification discussed in another section. Suffice it to say that both the criteria used and the scale of mapping are patterned after Rubner and Reinhold (1953), whose forest classification for Europe is sub-titled *A Basis for a European Silviculture*. Similarly, the classification described here is intended to provide a basis for a "Maritime Silviculture". To do this, it should distinguish general levels of productivity and the kinds of silvicultural problems such as competition, wind, and fire that may be associated with a particular geographic area. These are a few of the attributes used in *A Forest Classification for the Maritime Provinces* to distinguish geographical units, each characterized by specific relationships between the vegetation, climate and soil. The classification is therefore a regional basis for site classification and forest management.

Although the method adopted here differs from that used in *Forest Regions of Canada*, the reservations noted by Rowe (1959) with respect to classification in general are valid. The maps and descriptions provided are only as good as the knowledge available at the time of writing. As more information accumulates, revision is to be expected. In addition, clearly distinguishable regions are not to be expected in all areas. The criteria used in the classification have been chosen to describe the gradations from one geographic area to another, providing at the same time the arbitrary scales along which regional boundaries can be located. The use and limitations of this approach are described in the following Section.

Most of the forest descriptions were made by Dr. I. C. M. Place and Prof. H. D. Long in field work from 1952 to 1954, and by Prof. Long and the writer after 1955. Published descriptions were used where available, as were observations by other foresters and ecologists. Mr. W. G. E. Brown contributed to the method followed in formulating the classification.

BASES OF FOREST CLASSIFICATION

A fundamental principle in geography is that there is no natural system of regions inherent in the nature of the world. This principle applies equally to forest classification. A system of regions, forest or otherwise, can be judged only in relation to the purpose for which it is required (Whittlesey, 1954), and the criteria used as the basis must be measured in terms of usefulness to man (Hartshorne, 1939). In forest classification, criteria are required that ensure the greatest advantages to the practice of forestry.

Classifications Reviewed

Early in the last century, plant geographers began developing methods for describing and classifying the vegetation of the world. Their objective was to outline the regions characterized by certain groups of plants. Plant distributions were the main criteria, and the resulting classification was intended to serve those interested in the vegetation. A recent trend in vegetation classification is that proposed by Braun-

Blanquet (1921, 1932) and by Passarge (1954). It is entirely phyto-sociological, and is determined according to the organization of the plant community.

Other attempts to account for the distribution of vegetation have been based on climatic data. The methods used by Köppen and Geiger (1936) and Thornthwaite (1931, 1948) are based on measured values of temperature and precipitation and represent a classification of climate only. Although there is a close relationship between climate and plant distribution, the species in widely separated areas of similar climate are never the same. Regardless of the similarity in climate, if different species are present, there is a difference in the relationship between the vegetation and climate. A classification of climates alone is therefore not satisfactory for forestry purposes.

Recent forest classifications: In preparing *A Forest Classification of Canada*, Halliday (1937) followed a third major system, that of Weaver and Clements (1929). The Forest Formation, a major unit of vegetation produced and controlled by climate, is the basis of the classification. Halliday treated as Forest Regions those portions of Canada dominated by one Forest Formation. In application, he used the "presence of certain tree species", the climax dominants, as the criteria for delineating his regions. The regions were then subdivided into Forest Sections on the basis of a broad uniformity of the forest associations, which he attributed to features of topography, soil, bedrock, and climate.

In a classification of the deciduous forests of North America, Braun (1950) placed most of the Maritime Provinces in her New England Section of the Northern Appalachian Highland Division, Hemlock—White pine—Northern Hardwoods Region. She included the Acadian Forest Region described by Halliday, and excluded only the Boreal Forest in northwestern New Brunswick. She used the 'Forest Region' to denote a natural entity whose boundaries are determined in part by "the limits of the more or less continuous ranges of characteristic species". Physiographic boundaries were used where information on the vegetation was insufficient for locating a regional boundary.

A more detailed classification of the forests in New England was prepared by Westveld and a committee of the Society of American Foresters (1956). Five Vegetation Zones are distinguished within the New England Section recognized by Braun. The boundaries of the Zones were determined by mapping groups of forest types possessing similarities of site and several key species. Western New Brunswick is bordered by a single heterogeneous Zone, the Spruce — Fir — Northern Hardwoods, although Hawley and Hawes (1912) had distinguished a Northern Hardwood Region in the Aroostook Valley of northern Maine.

Methods based on site classification: Other approaches to forest classification have resulted from the use of forest regions as a basis for site classification. In describing a system of site classification for universal application, Hills (1950) established the Forest Site Region as a broad, integrated pattern of soil sites within which the potential forest production could be compared. He states that it is a climatic region, defined by the occurrence of certain cover types in particular successional sequences.

Earlier, Heimburger (1934) had divided the site types in the Adirondack region into three geographical series, corresponding to floristic provinces, but based on flora, the soils, and the forests. In effect, he established three site regions, but probably at a more detailed scale than that used by Hills. Both investigators have successfully linked site classification and broad forest classification by formulating regions on the same principles as those governing their site classification. In this way the site region is designed so that the relationship between the vegetation and the physiography tends to follow a definite pattern within the region (Hills, 1952). The range in vegetation and climate acceptable within a site region is governed by the scale of the site classification. Although Hills and Heimburger used different approaches, they adopted somewhat similar scales of classification and set off site regions with comparable ecological amplitudes. Various approaches to site classification can be applied within such a framework.

The Classification for the Maritime Provinces

Classification may be achieved by studies carried out on a broad scale, proceeding to subdivisions from the top down, or it may be obtained by working from a detailed level to larger units. Because intensive silviculture and management requires a detailed scale, the small unit is a logical building stone for a classification designed to provide a basis for silviculture and yield predictions. The site type has been adopted here as the small, basic unit.

Definition of concepts: To avoid misinterpretation of the concepts in this section, the intended meaning of each will be reviewed briefly. The first is the term 'site type'. The British Commonwealth Forest Terminology (1953) defines 'site' as "the complex of physical and biological factors for an area which determine what forest or other vegetation it may carry". This statement specifies that the forest is presumed to result from a complex of physical and biological factors. The 'complex' cannot include the forest as a biological factor if it is also the result. The Commonwealth definition is adopted therefore, with the restriction that 'biological factors' include only soil microbiology and such related aspects of plant life as provide physical requirements of the tree community. The 'site type' is the class of relatively similar sites that forms a mappable unit.

The term 'association' is not to be construed in a restricted or technical sense. The definition adopted is that of the Oxford Universal Dictionary in which 'association' is "the being associated", or "occurring in combination with". Applied to forest stands it describes a recurring community of one or more tree species (Rowe, 1959).

The Oxford definition of a 'classification' specifies a systematic arrangement into classes according to a method. Cover types and site types are examples of such classes as applied to forests, but they are necessarily arbitrary abstractions at a local level for a specific purpose. In a similar way, forests may be classified for other purposes at a regional level by applying criteria over larger areas.

Another concept is the use of 'region' in a general sense. Whittlesey (1954) and Hartshorne (1939) indicate that the term 'region' as widely understood in geography implies an area of any size "throughout which accordant areal relationship between phenomena exists" (Whittlesey, 1954). Specific regions are singled out only when specific criteria are applied and the area is found to be relatively homogeneous in terms the criteria. Regions such as the Districts and Ecoregions in the following text will be distinguished from the general expression by a specific designation. 'District' is the term commonly used to designate a subdivision of a region identified by secondary criteria.

Definition of the proposed units: The site type, as a recognizable, recurring unit of mainly physical factors, provides the unit within which to make comparisons of forest conditions. A zonal site type, identified broadly as a well-drained, sandy-loam on a mid-slope position, can be recognized whether the vegetaton is sugar maple, spruce and fir, or abandoned pasture. When the surrounding relief and soil minerology are also comparable, differences in the lesser vegetation and in the composition of the old-growth forests can be used to characterize regions.

A descriptive term to denote regions recognized by vegetation in relation to these environmental criteria may be obtained by applying the prefix 'eco-'* to the term 'region'. 'Encoregion' is proposed therefore as the geographic unit within which ecological relationships between species and sites are essentially similar, and within which silvicultural treatments may be expected to obtain comparable results. Procedures for delineation of the Ecoregions follow.

The large size of the Ecoregion necessitates geographically limited subdivisions, both as a convenience in applying the classification, and as a means of reducing the range of internal ecological variation. The subdivisions may be distinguished on the basis of physical patterns of relief, texture of the predominating soil, type of bedrock, or a drainage pattern. Each of these criteria relate to the preponderance of a particular site type or group of site types. The subdivision so recognized is called a 'Site District'.

For broad comparison of the predominating tree species, a larger unit than Ecoregion is useful. The Forest Zone has been adopted for this purpose. It groups together Ecoregions showing affinities of dominant species composition. Ecoregions grouped in this way, and extended to other parts of Canada form broad belts, or zones, at a scale similar to that of the regions used by Halliday (1937).

Methods and criteria: The field records for most of the forest descriptions consisted of species lists with observations

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*From the Greek *oikos*, house, understood in the sense of 'mutual interrelations between organism and environment'.

on abundance and quality. Trees, young growth, shrubs and herbaceous vegetation were observed as a unit. Observation points were located throughout the Maritime Provinces in the course of a detailed canvass along county roads. Most of the observations were on well-drained sites, but cross-sections of the vegetation from ridgetops to valley bottoms and swamps were studied. Soil texture, presence of bedrock near the soil surface, drainage conditions and local relief were noted. Records were kept on the distribution limits of the tree species as well as for many shrubs and herbs. Distribution data from the observation points were supplemented by forest inventory records, low-level flying, and continuous notes of roadside species distribution.

In the course of the work, the more outstanding differences in species—site relationships and broad species distribution patterns became evident. Particular attention was then directed to observation of the gradation between areas of widely different stable forest. Except along the occasional abrupt topographic boundary, no sharp break in vegetation pattern could be observed. Owing to the magnitude of the gross differences in forest conditions, the gradation between sugar maple — beech forest, and spruce — fir must be broken into several arbitrary steps. Characteristics of the tree, shrub, and herb species on the zonal site are a means of observing this gradation. The variation that is tolerated within the zonal site type in any one area may be used to break the gradient on the zonal sites into segments. Each segment constitutes an Ecoregion.

The Site District and Forest Zone are secondary units derived from the Ecoregion. The criteria for their determination have been indicated in the definition of these units. The Site Districts, although identified by geographic location and the distribution pattern of site types, remove some of the variation within the Ecoregion, but they too grade from one into the other. Criteria for the identification of the site type, on which the Ecoregion is based, are discussed elsewhere.*

Discussion; Ultimately, the most critical test of a forest classification will be the success of the silviculturist in obtain-

*Loucks, O. L. 1956. Progress Report: Site classification, Acadia Forest Experiment Station. Forestry Branch, For. Res. Div., Ottawa. Unpublished.

————————. 1957. Site classification during 1957 at Acadia and Green River Forestry Branch, For. Res. Div., Ottawa. Unpublished.

ing relatively uniform responses from a species, or a mixture of species, following a particular treatment anywhere in one region. If the regions are established with attention to this objective, they will provide a natural basis for silviculture. If, however, differences in silvicultural response are encountered, as may be anticipated in areas where information on the vegetation and forest succession is lacking, corrections must be made in the delineation of the regions. Usefulness for silviculture, manament, and site classification is proposed as the primary objective of a classification for forestry purposes.

The importance of an ecological basis for silviculture has been stressed by Toumey and Korstian (1947) and by Lutz (1957). If ecological relationships and responses are to be understood in the silviculture of individual stands, it follows that the same relationships must be used in arranging large areas of forest land into regions for forestry purposes. Differences in the composition and vigour of competing vegetation impose major differences in the silviculture of two otherwise similar stands. Similar differences on zonal site types in widely separated parts of the Maritime Provinces are equally important for silviculture and should be distinguished in establishing the Ecoregions.

A special effort has been made to describe the undisturbed forests, in a belief that they best express the long-term influences characterizing each Ecoregion. These influences also control the growth and development of stands under intensive management, where, because of the disturbance, some characteristics of the vegetation are less well expressed. Other features, such as the abundance and vigour of competing shrubs and ground vegetation can be observed only in disturbed stands.

The resulting classification differs from that in *Forest Regions of Canada* (Rowe 1959) primarily in the application of criteria to the site type and synthesis of the regions from a local scale. The groups of Ecoregions, the Forest Zones, are comparable to the Forest Regions described by Rowe, but the method used in the Maritime Provinces is not designed for continent-wide comparisons. The objective of this classification differs little from that of Hills (1950, 1952), but there are distinctions in the means by which the objective is attained, and in the size of the region adopted. The 'Site District' is the same in both classifications.

Because the Ecoregion is not intended as a discrete or natural entity, the boundaries are not always sharp. A need remains for factorial studies of the ecological variations involved. Detailed analysis of data will be required to prove or disprove the existence of natural units or distinct boundaries except along a break in the physiography. So many facets of the vegetation are considered in different places that individual Ecoregions will not necessarily be different in all aspects of the vegetation. Special groupings of Ecoregions will therefore be useful for particular applications such as yield prediction and cull studies. Most important, however, is the recognition of forest classification as a multiple-level phenomenon, requiring the cover type and site type to be an integral part of larger units. The present treatment is limited to description of the larger, regional units, but should be viewed as the basis for pratical site classification at a local level.

PHYSICAL FEATURES AND CLIMATE

No forest classification would be complete without some attempt at an accounting for the geographic distribution of tree and shrub species in terms of environmental influences. The description of physical features and climate that follows is intended to provide background information for the discussion that appears with the forest descriptions.

Relief

The Maritime Provinces have a total land area of 51,237 square miles, of which about 90 per cent is either forested or is potential forest land. Most of this area is in the form of a barrier between the Atlantic Ocean and the Gulf of St. Lawrence, and a maritime climate characterizes all of Nova Scotia, Prince Edward Island, and the southern part of New Brunswick. Central and northern New Brunswick tend to a continental climate.

The climate, and consequently the distribution of forest species in the Maritime Provinces, is strongly influenced by the relief illustrated in Figure 1. Few of the uplands are high, but they rise and fall quickly, exerting a profound influence on the marine air masses. The major physiographic features have been named and described by Putnam (1952). Four prominent physiographic units may be recognized in New Brunswick: the Northwestern Plateau, the Central Highlands, the Southern Uplands, and the Eastern and Central Lowlands. The Northwestern Plateau is a strongly dissected peneplain of folded and metamorphosed sedimentary rocks. An immense granite intrusive with a skyline above 2,000 feet in elevation forms the Central Highlands. The Southern Uplands consist of the low mountains along the Bay of Fundy rising to 1,400 feet, the Kingston and Belle Isle Ridges to the north, and the broken uplands west of the Saint John River. The Eastern and Central Lowlands are a plain of horizontally stratified sedimentary beds, almost entirely below 500 feet in elevation. Prince Edward Island is a continuation of these lowlands, with no part more than 500 feet above sea level.

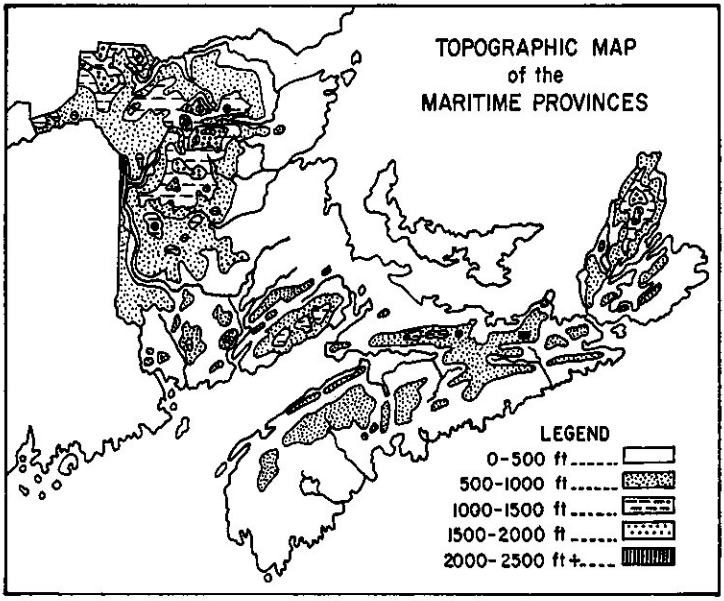

Fig. 1. Outline map of the Maritime Provinces illustrating the irregular configuration of uplands.

Nova Scotia is dominated by three systems of uplands: the Atlantic Uplands, the Cobequid Mountains and Pictou — Antigonish Highlands, and hills and mountains on Cape Breton Island rising from the south to the Northern Plateau. The broad, low tableland of the Atlantic Uplands consists of an inclined surface with a granite core, increasing in elevation toward the north at about 15 feet per mile to the brow of South Mountain. The Cobequid Mountains and the Pictou—Antigonish Highlands rise above 1,000 feet in a few places to form a range of low mountains nearly 160 miles long. On Cape Breton Island, the Southeastern Upland, numerous hills and mountains, and the Northern Plateau form a series of landforms increasing in elevation to the north and culminating at 1,500 to 1,700 feet. The lower elevations in Nova Scotia are occupied by the Northumberland Coastal Lowlands (an extension of the Eastern Lowland of New Brunswick) and a system of valleys and lowlands extending from Annapolis to Sydney.

Geology and Soils

Most of the relief can be related to the bedrock geology of the region. A simplified geological map, modified from recent maps of the Geological Survey of Canada (1949, 1955) is illustrated in Figure 2. Granites and ferromagnesian intrusives comprise most of the uplands. A large part of the Paleozoic slate and argillite bedrock in northwestern New Brunswick forms a strongly dissected plateau which, in the vicinity of the granitic intrusives, rises above 2,000 feet. Precambrian quartzites often form the approaches to upland areas. The more recent horizontally stratified sandstones, shales and conglomerates (mostly Triasaic and Permo-Carboniferous) are limited to the lowlands.

The granitic uplands have tended to weather slowly and recent glaciation has produced shallow, stony soils. The ice advance left much of the bedrock bare in these areas, and lithosolic soils are common. Although the ferromagnesian intrusive and volcanic rocks are almost as hard as the granites, they have weathered to fine-textured materials and the soils are richer. The argillite and slate beds of the Precambrian quartzite and slate group have weathered more quickly to produce a thick mantle that was moulded into hundreds of drumlins during glaciation. The quartzites weathered slowly, and although frequently covered by a soil mantle from the adjacent slates and argillites, bare bedrock and shallow, coarse soils are common.

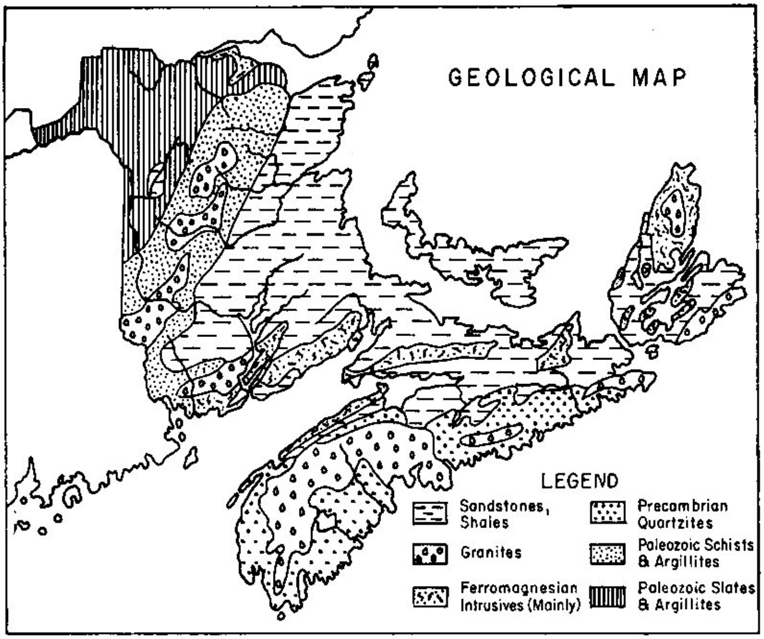

Fig. 2. A simplified outline of the geology of the Maritime Provinces.

The older Paleozoic rocks in central and northwestern New Brunswick are Ordovician, Silurian, and Lower Devonian in origin. Many of those in the northwest contain lime in the form of calcite streaks. Metamorphosis of these beds has resulted in a strong vertical cleavage. This and the soft nature of the rock has allowed even small streams to cut deep, V-shaped valleys, and extremely rugged topography has resulted. For the same reasons, the advance of ice over the area did not leave a scoured bedrock, but rather a rubbly, shallow till, formed from crushed slate and argillite. The schists and argillites in central New Brunswick are less prone to vertical cleavage and the soils are often shallow.

The horizontally bedded sandstones and shales are more recent, mostly Mississippian and Pennsylvanian in origin. Conglomerates, coal neds, and occasional limestones may be found with them. Most of the beds are not dissected greatly by stream action and the soil mantle tends to be shallow. A compact, basal till was smeared over the bedrock during the last glaciation, but a sandy drift, probably of ponded origin, now covers large parts of the area.

Climate

Because of the distribution of land and water masses, climate in the Maritime Provinces is unusually variable. Putnam (1940) states that in winter, cyclonic storms pass along the southern border inducing invasion by cold air from the interior of Canada. In summer, the storms commonly pass to the north, drawing with them the warm, humid air from the south and southwest.

The climate of northern New Brunswick may be described as continental, with great fluctuations in daily and seasonal temperatures, but with a relatively uniform precipitation. Southern Nova Scotia, being under a marine influence, has a smaller range of temperature and more rainfall. The continental portions of the Maritime Provinces usually have an earlier spring than the marine locations, because of the long period required for appreciable warming of the ocean; but the marine areas have a longer autumn. Despite the absence of climatic records, Putnam (1952) lists two areas, the Central Highlands of New Brunswick, and the Northern Plateau of Cape Breton Island, as being sufficiently elevated to warrant separation as distinct climatic regions. There are several other uplands with less extreme elevations in which the climate is also much modified from that of the surrounding lowlands.

Although Putnam describes eleven climatic regions in the Maritime Provinces, they are mapped without detailed attention to the effects of local relief and distance from the ocean on both temperature and precipitation. The fact that residents in the southcoast community of Yarmouth, Nova Scotia, maintain cottages and gardens fifteen to twenty miles inland from the coast to benefit from the warmer temperatures is as significant as meteorological records. Repeated observation of showers over moderately low uplands such as Kierstead Mountain in central New Brunswick are also relevant. With due reservation, such observations have been used as a guide in the interpolation of the temperature, precipitation, potential-evapotranspiration, and water deficiency data plotted in Fig. 3. These charts are intended only to supplement those

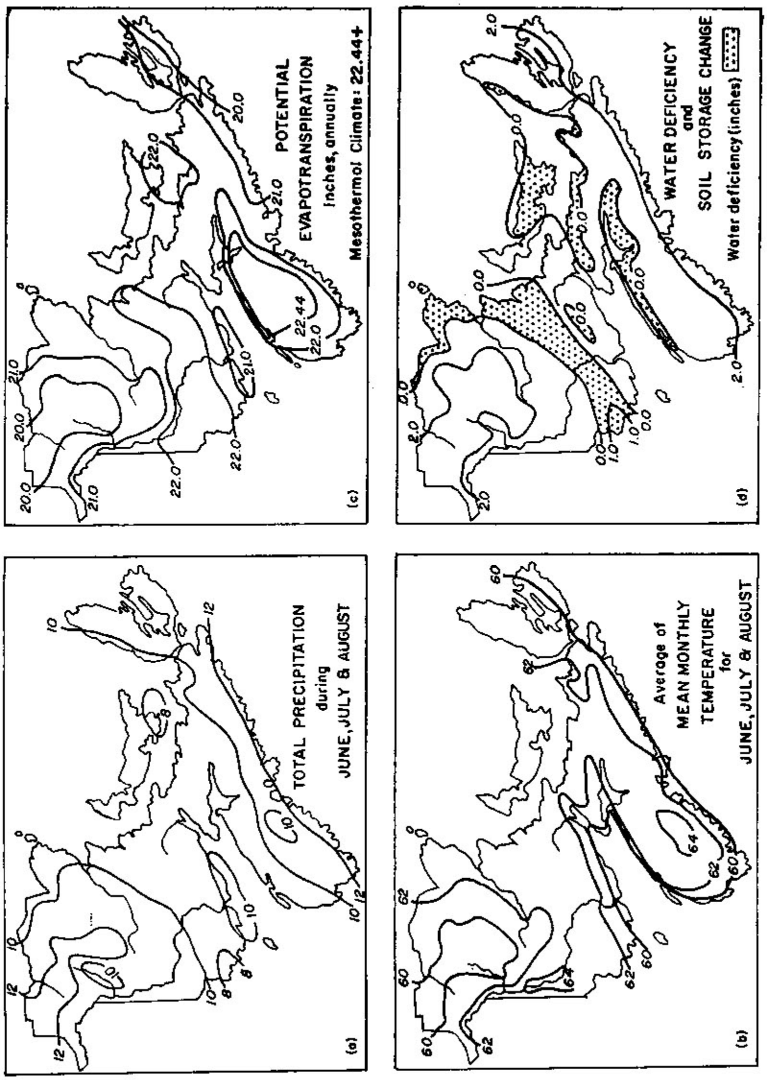

Fig. 3. Charts of climatic variables in the Maritime Provinces plotted from records of over 60 stations. (a) summer precipitation; (b) average summer temperature; (c) the potential annual water loss in inches through evaporation and plant transpiration, based on the latitude and mean temperature of the reporting station; (d) soil storage change, the withdrawal of moisture from the theoretical four inches stored in the soil when current precipitation fails to equal potential evapotranspiration. Water deficiency occurs after the four inches has been withdrawn.

published by Putnam (1940, 1952), and are based on published records of the Meteorological Division, Department of Transport (1940, 1954).

Comparison of the summer precipitation chart Fig. 3(a), with Putnam's chart of mean annual precipitation shows a strong contrast between summer and annual precipitation: the coastal influence on precipitation is much less apparent during the summer. The average of the mean monthly temperatures for June, July and August plotted in Fig. 3(b) shows correspondence with the abundance of tolerant hardwoods. Beech and sugar maple predominate where the mean summer temperature exceeds 64 degrees, but are more restricted to well-drained soils where the temperature is between 62 and 64 degrees.

Potential evapotranspiration (Thornthwaite 1931, 1948) obtains somewhat similar isopleths, but in a more refined way. In it, both temperature and latitude are taken into consideration to obtain a figure representing the annual pressure on the water supply. The central part of western Nova Scotia is distinguished by a Mesothermal Climate*, which according to Thornthwaite's classification is comparable to New England and Southern Ontario (Thornthwaite, 1948; Sanderson, 1948). A hardwood forest with oak is characteristic of this climate in areas with less precipitation than in western Nova Scotia. The complex of red spruce, hemlock, white pine and red oak in western Nova Scotia is thus a natural result of the Mesothermal Climate in an area of high precipitation.

Where summer precipitation is not sufficient to meet the monthly demand of evapotranspiration, the vegetation first borrows on moisture stored in the soil. This is indicated in Fig. 3(d) where the amount of water withdrawn from the theoretical supply stored in the soil (4 inches) is shown as Storage Change. In the areas of water deficiency, the soil storage has been depleted and rainfall is insufficient to provide for both evaporation and the transpiration of plants. The four inches of moisture estimated to be stored in the soil is an arbitrary figure applied to agricultural soils of moderately heavy texture. Coarse soils such as sands and sandy loams would not

*A thermal province recognized by Thornthwaite and defined as having from 22.44 to 44.88 inches of potential evapotranspiration annually. Most of the Maritime Provinces are a Microthermal Climate with a P.E. between 11.22 and 22.44 inches annually.

hold this much, and a greater deficiency results. Although a water deficiency of two inches is not thought serious for agriculture (Sanderson, 1948), there are differences in the forest vegetation in the Maritime Provinces which appear to be related to it.

ECOREGIONS IN THE MARITIME PROVINCES

In accordance with the principles of forest classification already outlined, Forest Zones, Ecoregions and Site Districts have been established throughout the three Maritime Provinces, New Brunswick, Prince Edward Island and Nova Scotia. The accompanying map shows the delineation of these units. The distinctive tree associations and climate of the Zones and Ecoregions are summarized in Table I. The descriptions which follow are primarily of the Ecoregions, although the latter are grouped by Forest Zones. Local variations within the Ecoregion are described under the District heading.

Sugar Maple — Ash Zone

Tolerant hardwoods distinguish the Zone, with sugar maple and beech predominating. Small representations of white ash, butternut, ironwood and basswood are characteristic. The Zone differs from the Sugar Maple — Hemlock Pine Zone in the presence of butternut and white ash as well as in such characteristic lesser plants as wild ginger, bloodroot, black raspberry, and maidenhair fern. In some aspects, the Zone is closely related to a similar forest in portions of Southern Ontario.

1. **Saint John River Ecoregion** (Carleton District)

A small area of forest, unique in the Maritime Provinces, is centered on the slopes to the Saint John River in western New Brunswick. In spite of considerable variation, only one District has been recognized; its description is included with that of the Ecoregion.

The occurrence of butternut, white ash, ironwood and basswood in an association dominated by sugar maple and beech distinguishes the Ecoregion. Red spruce and eastern hemlock are sparse, confined mainly to moist sites and steep slopes. Ill-drained lands with white cedar, black ash, red maple and white elm are common, as are spruce — fir — cedar

TABLE I. DISTINCTIVE FEATURES OF THE ZONES AND ECOREGIONS

Zone	Ecoregion	Characteristic species	Associated climate
Sugar maple—Ash		sM, Be, wAs*	Warm, dry
	(1) St. John River	sM, Be, I, wAs, Bu, Ba	,, ,,
Sugar maple—Hemlock—Pine		sM, Be, wP, eH, yB	mod. warm, mod. dry
	(2) Restigouche—Bras d'Or	SM, Be, bF, yB, wP, wS	Mod. cool, mod. dry
	(3) Magaguadavic—Hillsborough	sM, Be, wP, eH, bF, rS	Mod. warm, mod. dry
Sugar maple—Yellow birch—Fir		sM, yB, bF, Be	Cool, moist
	(4) Maritime Uplands	sM, yB, bF. Be, wS, rS, rM	,, ,,
Red spruce—Hemlock—Pine		rS, bF, eH, wP, rM	Mod. warm, mod. dry
	(5) Clyde River—Halifax	rS, wP, eH, rO, rM, bS, Be	Warm, dry
	(6) Maritime Lowlands	bF, rS, bS, eH, wP, rM, jP, wS, Be	Mod. cool, mod. dry
Spruce—Fir Coast		wS, bF, wB	Cool, wet
	(7) Fundy Bay	rS, bF, wB, wS, bS, yB, Mo	,, ,,
	(8) Atlantic Shore	wS, bF, bS, wB	,, ,,
Fir—Pine—Birch		bF, wB, wS, wP	Cold, moist
	(9) New Brunswick Highlands	bF, wB, wP, tA, wS, bS, jP, rS	Cold, mod. dry
	(10) Gaspé—Cape Breton	bF, wB, wS, bS	Cold, wet
Spruce Taiga		bS, bF, wS	Cold wet
	(11) Cape Breton Plateau	bS, bF, wS, wB, Mo	,, ,,

*Abbreviations of tree names are those adopted by the C.I.F., For. Chron., 1952.

swamps. The coniferous swamps and the stands of white spruce and cedar that reclaim much of the abandoned farmland contribute to the high proportion of softwood forest reported for this area by the Forest Inventory (1958).

The ground vegetation is distinguished by many species not found elsewhere in the Maritime Provinces; these include bloodroot, Goldie fern, four-furrowed Enchanter's-Nightshade and black raspberry. Sweet-cicely, spikenard, and a number of buttercups and violets are common. Competition is intense following a disturbance such as clear-felling, but sugar maple advance growth is usually abundant and gradually suppresses the herbaceous species.

Owing to the depth and quality of the well-drained soils, most of the hardwood lands have been cleared for agriculture, Fig. 4. The remaining forest is limited mostly to steep or stony lands and serves for farm woodlots. Quality sugar maple can be grown in two-log trees on fresh and moist sites, but white ash should be preferred for stony ridges. The excessive number of sugar maple saplings that become established following a disturbance is one of the silvicultural problems.

The combination of rich soils and a warm climate without excessive precipitation accounts for most of the distinctive features of forest and lesser vegetation. Sanderson (1948) shows a small part of western New Brunswick with a Moisture Index* below 80, the lowest in any part of the Maritime Provinces. Fig. 3(b) indicates the warm summer temperatures that are restricted to the core of this District. Thornthwaite (1948) shows parts of central Maine, 70 miles to the southwest, as a warm Mesothermal Climate (potential evapotranspiration above 22.44 inches). Fig. 3(c) shows southwestern New Brunswick to be similar. The warm temperature and relatively low moisture index combine to give the District a distinctive climate.

Well-drained heavy loams with shale fragments, and loams with sandstone fragments, are the most common soils (Stobbe and Aalund, 1944). Both are derived from the underlying shales and slates, broken locally by micaceous sandstones. Calcite veins contribute calcareous fragments in the parent material. Poorly drained soils are common. The well-

*A term used by Thornthwaite (1931, 1948) to express moisture supply or deficiency in relation to water need.

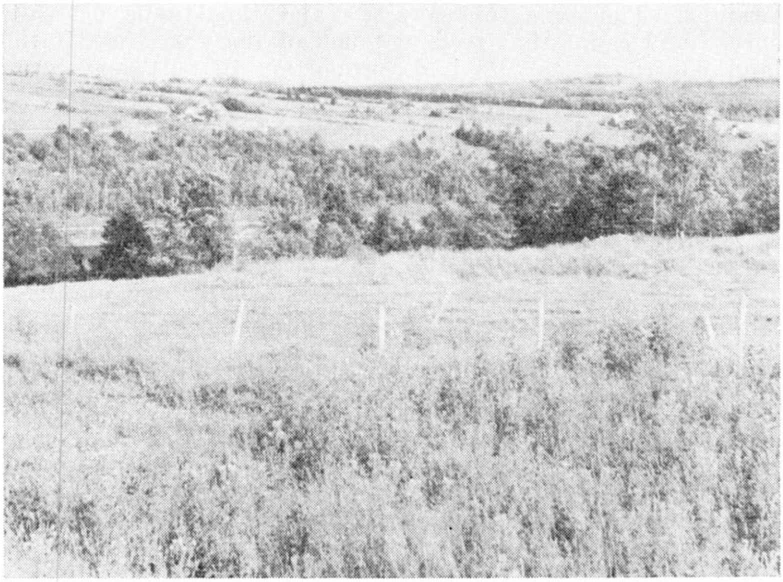

Fig. 4. Sugar Maple—Ash Zone; St. John River Ecoregion. Rolling agricultural lands north of Woodstock, N. B.; the St. John River is in the foreground. The scattered woodlots are highly productive for quality hardwoods.

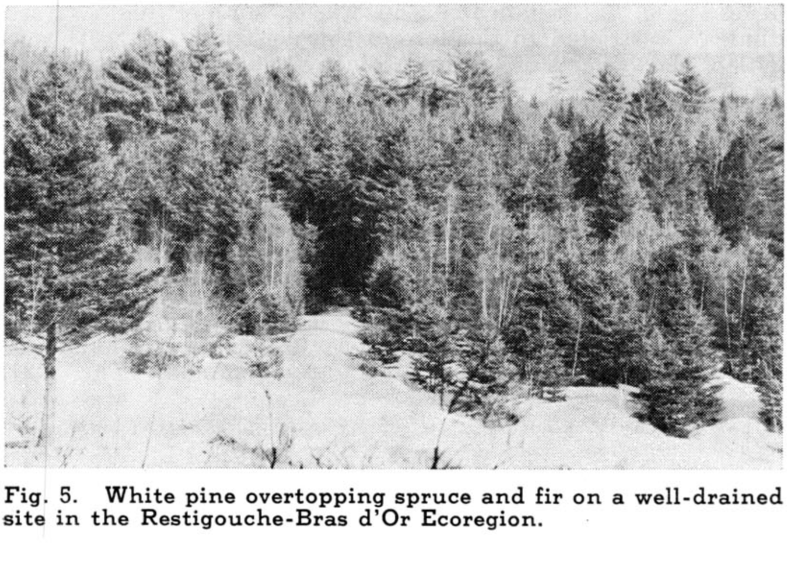

Fig. 5. White pine overtopping spruce and fir on a well-drained site in the Restigouche-Bras d'Or Ecoregion.

drained soils are classed as "minimal podsols" and are characterized by a duff mull humus, a thin, often discontinuous A_2, and a firm granular structure in the B horizon. In the southern part of the District, harder bedrock of schists and argillites predominates, broken by granites, shale and slate. Rough, stony soils of a lighter texture are common here, but the slightly calcareous tills found to the north also occur.

The District is bounded on the north and northeast by high elevations and a cool, humid climate. Rough topography and coarse soils border it on the south.

Sugar Maple — Hemlock — Pine Zone

Two Ecoregions are combined in this zone. One is northern and is characterized by spruce, fir and pine forests among scattered hardwood stands; the other is more southerly and tolerant hardwoods are found on a wider range of sites. Hemlock is sparse in the former, and common on slopes and valley bottoms in the latter. The soils are more strongly podsolized, and consequently the demanding species characteristic of the Sugar Maple — Ash Zone are rare.

2. Restigouche — Bras d'Or Ecoregion

Portions of the Upper Saint John Valley, the north shore of New Brunswick, and the lowlands of eastern Nova Scotia are grouped together in this Ecoregion. Poor quality tolerant forests of beech and sugar maple with scattered yellow birch are found on the higher land, but the slopes and valley bottoms are dominated by balsam fir, white spruce, black spruce, and white pine. The relation of pine to spruce and fir on upland sites is illustrated in Fig. 5. Red spruce and hemlock occur only locally, and wire birch is essentially absent.

The lesser vegetation is similar to the depauperate ground cover of northern coniferous forests. Wood-sorrel, wood fern, maianthemum and bunchberry predominate under softwood stands on well-drained sites. Dogtooth-violet, yellow violet and zigzag smilacina, common to the south, are rare. Beaked hazel is abundant under tolerant hardwoods where wood-sorrel and hobblebush are sparsely represented.

Well-drained sites that under natural conditions support softwood forest present little difficulty to the management of balsam fir, white spruce and white pine. The fir and spruce do not appear to be as long lived as in areas of higher precipitation, so that the pines are to be favoured with a spruce and fir understory. Of the hardwood species, yellow birch probably could be grown in one-log trees on most of the hilltop sites. The apparent susceptibility of the Ecoregion to fire places protection from fire or the use of fire in silviculture in a prominent role.

The outstanding climatic features are a relatively low summer temperature and a moderate summer precipitation. Average summer temperatures range from 60 to 62 degrees, Fig. 3(b), compared with 62 degrees and up in the Magaguadavic — Hillsborough Ecoregion and most of the Red Spruce — Hemlock — Pine Zone. A similar difference may be observed for potential evapotranspiration, Fig. 3(c). The summer precipitation and storage change data, Figs. 3(a) and 3(d), show the Restigouche — Bras d'Or Ecoregion generally without a water deficiency, and having between 10 and 12 inches of precipitation during the summer months.

The soils of this Ecoregion vary considerably and are described under the Site Districts. The relief is low and rolling, as most of the Districts occupy broad valley basins or low elevations on the rain-shadow side of uplands.

Edmundston District: Comprises the upper Saint John River valley, above Grand Falls. Balsam fir, white spruce and black spruce dominate uncleared portions of the valley bottoms, but white pine is sufficiently abundant to indicate that it once thrived. Hemlock and red spruce are rare.

Tolerant hardwood forests in which yellow birch is prominent border the District above the 800- to 1,000-foot contour interval. The site pattern is characteristic of a deep, broad valley with outlying hills. The soils are mainly loams and sandy loams derived largely from slate, argillite and quartzite. Most of the bedrock has a strong, vertical cleavage, locally with calcite veins. The strong relief and deep cleavage ensure good drainage, and tree roots frequently penetrate the bedrock. The valley-bottom soils have been greatly influenced by the material deposited in Glacial Lake Madawaska (Lee, 1955), which was centered in the District. Heavy, glacio-lacustrine clays and clay loams, as well as more recent alluviums, are found here. The gently rolling land has been extensively cleared, but some hardwoods remain on steep slopes and hilltops; softwoods occupy the poorly drained depressions.

Plaster Rock District: Located in the valley of the Tobique River where a particularly dry, cold, micro-regional climate prevails. Much of the valley is either so flat or so poorly drained that zonal sites are uncommon, but those observed tend to support tolerant hardwoods with balsam fir, and scattered white and red pine. Hemlock and red spruce occur locally, mainly on moist slopes. Black spruce, white spruce, and the pines characterize the cold, ill-drained flats. Pure stands of white spruce occur on abandoned famland.

Higher land, supporting mainly tolerant hardwoods borders the District on all sides. The red sandy-loam and clay-loam soils derived from Carbiniferous siltstone and shales contain some calcareous fragments, but tend to be acid throughout the profile. The heavy texture and gentle relief make for poor drainage. Droughty, gravelly-loam tills derived from slightly calcareous sandstones and conglomerates are also common. The preponderance of flat, sandy, or ill-drained sites influences both management and forest operations.

Restigouche District: The broad, strongly dissected valleys of the Restigouche and Upsalquitch river systems comprise the core of this District. Most of it is in the rain shadow of a 1200 to 1500-foot upland to the southwest. Yellow birch is common among the hardwoods; white pine, red pine and jack pine occur with spruce and fir on valley bottoms and lower slopes. A history of severe fires attests to the relatively dry climate.

The District is bordered by higher land on the west and south, and by less rugged topography on the east. The distribution of sites is dominated by the long steep slopes of the strongly rolling terrain. The soils are loams and sandy loams derived from argillaceous metamorphic rocks containing small amounts of lime. The deep cleavage of the surface bedrock permits good drainage and deep rooting. Coarse sandy and gravelly soils occur locally along the narrow valley bottoms. Repeated fires during the last 30 years have reduced some of the forest to intolerant hardwood species, but the soils are such that high productivity can be expected when a coniferous forest is restored.

Jacquet River District: Comprises gently rolling landforms on horizontally stratified bedrock along the south side of the Bay of Chaleur. The District is essentially a coastal plain below 500 feet in elevation, distinctly moderated by the Bay of Chaleur, and in the lee of the broad upland to the southwest. Tolerant hardwoods, with spruce, fir and white pine predominate. Red spruce occurs locally in the south; hemlock is sparse. The flat, frequently ill-drained, coastal portion is mainly coniferous, although black ash swamps are common.

Higher elevations, between 700 and 1,000 feet, coincide with the gradual predominance of coniferous species on the southwest. The soils are heavy marine and lacustro tills on the lowlands along the coast, and sandy loams derived from a complex of sandstone and argillaceous bedrocks farther inland. Large parts of the District have been either burned or recently settled.

Sevogle District: Situated on the eastern approaches to the New Brunswick Highlands. It is in the rain-shadow of the Highlands, but moist air masses often approach directly from the Atlantic. Sugar maple, beech, white pine and red spruce occur throughout, but extensive areas are entirely coniferous. Yellow birch is more abundant in the higher western half; hemlock is found mainly in the eastern portion. Dense spruce and fir, with scattered white pine and the occasional stand of jack pine, dominate the slopes and broad valley flats.

The low relief of the Eastern Lowlands borders the District on the east while higher elevations and a predominantly coniferous forest occur along the west. Light, sandy-loam soils derived from metamorphic schists and argillites are found in much of the wide band between the Lowlands and the Central Highlands, but stony loams occur locally. The District is suited to the production of one-log yellow birch in addition to red spruce, white spruce, and white pine.

Guysborough— Bras d'Or District: Comprised of a series of low hills on the eastern Nova Scotia mainland, and the central lowlands of Cape Breton Island. The District is sufficiently removed from the Atlantic Ocean to sustain warmer temperatures and lower precipitation than along the coast, but it is not as protected as the East River trench to the west. Much of the District was once cleared for sheep pasture and this land is reverting to white spruce with balsam fir.

Scattered stands of tolerant hardwoods remain, and hemlock and white pine are found locally. Red spruce is rare, usually on steep slopes or along water courses.

The District is bounded by the Antigonish lowland on the west, by a coniferous forest on the south, and by the moist uplands to the north. Several hills rising above 800 feet in elevation are excluded, and will be described in the Cape Breton Hills District. The bedrocks are variable, including granites and volcanics, and softer sandstones, shales and conglomerate. Most of the soils are sandy loams derived from both the hard metamorphics and the mainly siliceous sedimentary beds. Compaction of the surface horizons has resulted on soils used for sheep pasture, and this may lead to difficulty in forest management until normal aeration is restored.

3. Magaguadavic — Hillsborough Ecoregion

The inland portions of southern New Brunswick and central areas in Prince Edward Island and Nova Scotia support forests with much in common, and are considered together in the Magaguadavic — Hillsborough Ecoregion. Tolerant hardwoods, locally of good quality, are abundant on upland sites. Red oak and black cherry are widely distributed. Mainly coniferous forests are found on the steep slopes of narrow valleys, on broad valley bottoms, and on outwash plains. Balsam fir, hemlock, white spruce, red spruce and white pine predominate on the valley tills; white pine, balsam fir and black spruce on the sandy outwashes. Intolerant stands of red maple, wire birch and aspen are also prominent.

Species of the forest floor that distinguish the Ecoregion include dogtooth-violet, cucumber-root, yellow violet and zigzag smilacina. These plants are not limited to the Ecoregion, but are more widely distributed here and contribute to the distinctive nature of the vegetation.

The light-textured soils and coniferous lower slopes present little difficulty to forest management. White birch and other intolerant hardwoods occupy some of this land, but their replacement by spruce, fir and pine can be expected. The fir is not so long-lived or of as good quality as in other parts of the Maritime Provinces; 60 to 80-year-old stems are frequently decadent. Sugar maple, beech and red maple reproduction comprise the aggressive competition on tolerant hardwood sites. Quality sugar maple and yellow birch could be grown on some soils if suitable treatments were carried out (Jarvis, 1956). Much of the land has been cleared for agriculture and where it has reverted to white spruce (or in a few places white pine) these species do well.

The climate (Fig. 3) differs from that of the surrounding ecoregions in the low summer precipitation, warm summer temperature and high potential evapotranspiration. A water deficiency prevails throughout most of the Ecoregion, the LaHave District in Nova Scotia being the exception. Since water deficiency data were not available for stations indicating the high temperatures and relatively low summer precipitation, this exception may be an inadequacy of the available data.

Rolling, drumlinoid topography and moderately deep sandy-loam soils are frequent. Sandy outwash soils are locally abundant in southern New Brunswick.

Pokiok District: Located on the southwestern extension of the hard, granitic intrusive which forms the spine of the New Brunswick Highlands. The relatively high elevations of this District, occasionally up to 800 feet, create a more moist climate than is found on either the east or west. Although an abundance of conifers on middle and upper slopes distinguishes the District, it is nevertheless part of the Magaguadavic — Hillsborough Ecoregion. Red spruce and yellow birch are abundant, while much of the white pine is limited to the broad valleys.

The higher land coincides with the underlying granitic and metamorphic bedrocks to form the east and west borders of the District. Some of the soils are light and sandy, and are derived from coarse grey granite. Others are moderately heavy, stony, and slightly limy, and are derived largely from the slates, argillite and schist. The flat, sandy soils of the Becaguimec valley are derived from softer Mississippian sandstones and conglomerates. Much of the poorly drained land tends to form a neutral muck or swamp. Sugar maple and yellow birch are suitable for management on the uplands; red spruce, balsam fir, white pine, and white spruce will do well on the middle slopes, flats, and valley bottoms.

Magaguadavic District: Consists of a low-lying plain, mainly below 500 feet in elevation, and protected on the west by the higher land of the Pokiok District and on the south by uplands along the Bay of Fundy. The summer temperature and water deficiency charts in Fig. 3 indicate the warm, dry climate. Pine predominates on sandy outwash soils, and occurs in association with beech, sugar maple, red maple and red oak on the low ridges. Black ash, red spruce, cedar and red maple occur in the extensive swamps.

The eastern border of the District coincides with the limit of slightly limy loams, derived from slate, quartzite and calcareous shales, that cover much of the area (Wicklund and Langmaid, 1953). Higher land forms the limit on the north and south. Sandy and gravelly soils are common along the Magaguadavic River. Repeated burning has all but eliminated the former pinery that prevailed on dry to well-drained portions of the District. Although only locally abundant now, red pine and white pine are more suited to the climate and soil than spruce or balsam fir.

Mt. Pleasant District: Located on strongly rolling terrain to the east of the former, this District is similar in climate, but differs in its light granitic soils. Beech, sugar maple, red maple and red oak are characteristic. The white pine common with the hardwoods on slopes and ridges is illustrated in Fig. 6. Locally, it forms pure stands, sometimes with spruce and fir on the valley bottoms, but early records indicate that it was formerly more abundant. Red spruce and hemlock are common on slopes and in narrow valleys. Much of the District is now covered with poor quality hardwoods.

Shallow, gravelly-loam soils derived from hard igneous and metamorphic rocks cover most of the District. Slightly limy loams occur locally on the west. Sandy plains are found along the main drainages. On the north, the District is bordered by the heavy soils of the Central Lowlands, on the west by the somewhat limy soils of the Magaguadavic District, and on the south and east by coastal influences from the Bay of Fundy. White pine, red pine, and red spruce appear to be the most suitable species.

Grand Lake District: Comprises a series of lowlands and valley slopes along the Saint John River and the adjacent Grand Lake system. The micro-regional climate is moderated

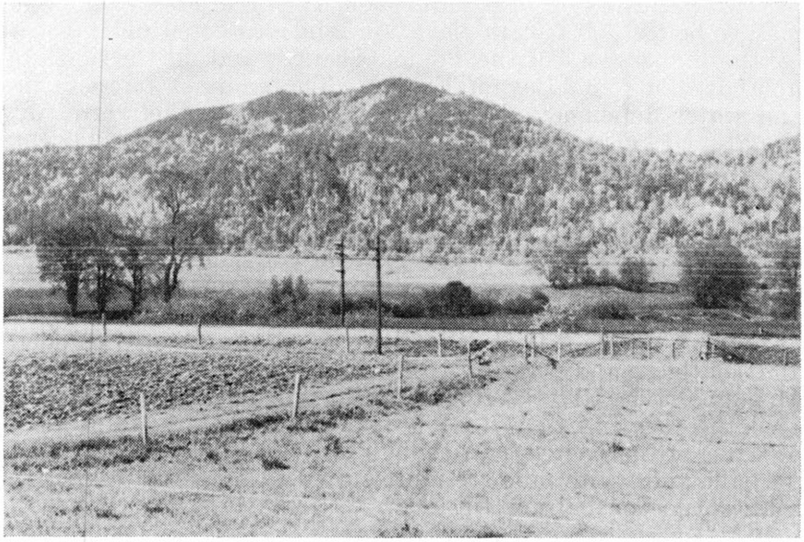

Fig. 6. Hills near Welsford, New Brunswick, illustrating the mixing of white pine with broadleaf species on slope sites. The patches of pure conifer indicate shallow, azonal soils.

Fig. 7. White pine along the Nashwaak River, New Brunswick. Because of the demand for white pine few stands of this quality remain.

somewhat by the relatively large bodies of water that occupy almost half the District and tend to prolong the growing season. Sugar maple, beech, hemlock and red spruce are found on the zonal sites; tolerant hardwoods occur in pure stands on ridges. Basswood and butternut are found along the Saint John River; red oak, bur oak, silver maple and red ash, along the River and near the lakes. The excellent quality of the white pine on the lighter soils is illustrated in Fig. 7.

The flat, ill-drained tableland of the Central Lowlands forms the border of the District on the north and south, while a series of moist upland flats form a border on the east. The soils are mainly heavy clay loams derived from shales, sandstones, siltstone and conglomerate (Stobbe, 1940). In many places they have weathered deeply, and the slopes are highly productive. Sands, gravels and recent sandy alluvium are common along the River. Except for the poorly drained lands, most of the District has been settled. Apple orchards are widespread. The spruces and balsam fir are well suited to the ill-drained land, but because of clearing and burning they are not always present. Wire birch and red maple occur as weed species on burned areas and on abandoned farms.

Sussex District: The core of the District is the Kennebecasis — Petitcodiac Valley, protected by hills on the west, south, and east. Fig. 3(d) indicates the dry micro-regional climate. White pine, jack pine, and black spruce dominate on sandy soils. Sugar maple, beech, white pine, hemlock, yellow birch and scattered red spruce are found on slopes that have not been cleared.

The borders of the District are located on the north near the 400-foot contour and on the south near 600 feet. On the east it is bordered by the heavy soils of the Eastern Lowland. The soils of the District include sands, sandy loams, and gravels, some of which are limy (Aalund and Wicklund, 1950). They are derived from Carboniferous sandstones and conglomerates, slightly calcareous slate, shale and conglomerate, and scattered ferromagnesian outcroppings. Most of the District was once cleared for agriculture, but portions are reverting to white spruce. Slightly limy soils could be managed for sugar maple, but pine and spruce are probably the most desirable species.

Hillsborough District: Comprised of rolling land below 500 feet in elevation in central Prince Edward Island and protected by distance from the desiccating winds off the Gulf of St. Lawrence. The water deficiency indicated in Fig. 3(d) distinguishes the climate. Sugar maple and beech with scattered yellow birch predominate on uncleared areas; hemlock and red spruce are limited to lower slopes and moist sites. The characteristic relief pattern is illustrated in Fig. 8.

The District is bounded on the north and west by coniferous forest on less rolling land, swept by continuous light winds and cooler temperatures from the Gulf of St. Lawrence. The soils are mainly loams and sandy loams of high fertility derived from red micaceous sandstones (Whiteside, 1950). Coarser soils derived from sandstone and conglomerate occur in the southeast. White pine is widespread on light soils and, with red pine, should be favoured on abandoned lands of this type. Pure stands of white spruce occur on old fields of heavier texture; this species appears to be well suited to the District, especially in view of its resistance to wind desiccation.

East River — Antigonish District: Formed in a system of valleys and lowlands centered in the Pictou Basin and east in the valley of the East River and the Antigonish Lowland. The climate is warm and dry, as indicated by the temperature and water deficiency charts in Fig. 3. Beech and sugar maple predominate, but white pine, white spruce, and balsam fir are widely distributed. Black spruce is common on poorly drained land.

The boundary of the District is along the 500- to 700-foot contour interval. The soils are clay loams, gravelly clay loams and sandy loams described by Cann and Wicklund (1950). They have been derived mainly from Carboniferous shales, siltstone and conglomerate, but metamorphic and intrusive slates, argillite and volcanics are common in the central part of the District. Much of the land was once cleared, but parts have reverted to white spruce. The first crop of spruce has grown well, but compaction of the soil due to clearing and pasteuring may prove to have been detrimental. There may be some advantage in managing pine on the lighter soils.

LaHave District: Comprises a bowl-shaped depression in the south-central portion of western Nova Scotia. The weather data in Fig. 3 indicate an area of relatively low rainfall and high temperatures. The forest is mainly beech, sugar

Fig. 8. Rolling forest and agricultural lands in the Hillsborough District, Prince Edward Island. As a rule only the steep slopes with scattered rock outcroppings have been left uncleared.

Fig. 9. A pure stand of white pine regenerating on an abandoned field in the LaHave District, southern Nova Scotia.

maple and red oak, with white pine abundant on the lower slopes and valley floors. Black cherry is common, and red spruce and hemlock are found on moist sites and lower slopes. The Lahave valley is one of the few in the Maritime Provinces where white pine forms pure stands on abandoned fields, Fig. 9.

The District is limited mainly to the drumlinized loam soils overlying slate and argillite bedrocks. The surrounding quartzite and granite bedrocks form the higher elevations of adjacent districts. The soils are loams and sandy loams, mostly podsolic rather than podsols, and are generally deep with good drainage. The better soils have been cleared, but some good stands of tolerant hardwood remain. Pine and, in some areas, white spruce and red spruce, appear to be the most desirable species.

Sugar Maple — Yellow Birch — Fir Zone

The zone is distinguished by a predominantly hardwood forest in which yellow birch was formerly large and abundant, This forest is characteristic of relatively high elevations, which, when viewed from a distance on overcast days, frequently may be shrouded in low cloud. Much of the yellow birch has been killed by the outbreak known as 'dieback' (Clark and Barter, 1958), but the forest descriptions that follow refer to conditions prior to such disturbances. The Sugar Maple — Yellow Birch — Fir Zone differs from others in the abundance of yellow birch, white spruce and balsam fir in the hardwood stands, the lack of appreciable hemlock on mixedwood slopes, and the general restriction of white pine to sandy and gravelly soils of the valley bottom. All forests of this type in the Maritime Provinces have been included in the heterogeneous Maritime Uplands Ecoregion.

4. Maritime Uplands Ecoregion

Just as the areas of high elevation in the Maritime Provinces are separated by great distances, so also are the components of this Ecoregion. The hardwood forests on large parts of the uplands are remarkably similar considering the distances separating them. Sugar maple, beech and yellow birch are the most abundant species on the hills, although beech is absent from some of the northern areas. White spruce, red spruce and balsam fir form mixedwoods with sugar maple, yellow birch and red maple on steep slopes. Hemlock is found on ravine slopes in several Districts. Balsam fir, black spruce, white spruce and white pine predominate in the valley bottoms. In a few areas, the higher hills are capped by conifers.

One of the outstanding features is the aggressive nature of the shrub competition in the mixedwood and hardwood stands. Mountain maple, beaked hazel and hobblebush sprout vigorously and grow rapidly on most sites. Hazel has been observed two inches in diameter at breast height and fifteen feet tall. Upwards of 5,000 stems per acre of mountain

Fig. 10. The luxuriant undergrowth of a yellow birch forest on a moist site in the Maritime Uplands Ecoregion.

maple are not unusual, comprising a basal area of from 20 to 60 square feet per acre. A yellow birch — sugar maple stand with luxuriant undergrowth is illustrated in Fig. 10. Characteristic species of lesser vegetation include wood-sorrel, wood fern, and shining clubmoss, abundant on almost all sites. Zig-zag smilacina, yellow violet and dogtooth-violet are rare. Blueberries (although cultivated in a few areas), sheep laurel. and wintergreen are uncommon in most districts.

Most of the silvicultural problems centre on the shrub competition. Spruce and balsam fir logged from mixedwood slopes are replaced by mountain maple, and long periods are required for the release of suppressed seedlings (Vincent, 1956). The suppression of hardwood reproduction by mountain maple for periods of 10 to 15 years has been noted by Drinkwater in Nova Scotia (1957). Methods of shrub control such as those described by Jarvis (1956) would encourage yellow birch, white spruce and sugar maple on the hardwood sites.

Climatic data for the Ecoregion are sparse. However, records for Summit Depot and Kedgwick, in northwestern New Brunswick indicate the high precipitation and low summer temperatures plotted in Fig. 3. None of the other uplands are distinguished in the charts, but the data are not available. Rain and fog are observed regularly on these uplands when no precipitation occurs on the surrounding lowlands.

Despite the prevalence of hardwood forests with luxuriant broadleaf undergrowth, most of the soils are podsols with a broadleaf mor humus. In many places the leached layer under sugar maple is more than two inches deep. Moderately deep melanization is found in some of the Districts in Nova Scotia, but it is usually associated with local depressions. The soils are mostly fertile, stony loams and silt loams of moderate depth.

Glazier Lake District: The Maine — New Brunswick Highlands, frequently rising to 1,500 feet with deep intervening valleys, form the core of this District. The general elevations are high enough to obtain cooler temperatures and greater precipitation than in the adjacent Edmundston District. Mixed forests of sugar maple, yellow birch, red spruce, white spruce, and balsam fir prevail on upper slopes and most hilltops. Spruce, fir, red maple and the birches are found on the slopes. White pine is common on sandy valley bottoms, and trembling aspen occurs in stands originating after fire.

The borders of the District coincide with elevations between 800 and 1,000 feet. The soils are mainly stony, silt loams derived from slate, argillite and sandstone. Some of the bedrock is resistant to weathering and shallow soils with rock outcroppings can be found. The rough topography contributes to difficulty in logging operations.

Gounamitz District: The strongly rolling approach to the New Brunswick — Gaspé Upland in northwestern New Brunswick makes up this District. Sugar maple, beech and yellow birch dominate the hilltops; balsam fir, white spruce and black spruce form coniferous stands in the valley bottoms.

Fig. 11. Deeply fissured argillite bedrock turned up by a windthrown sugar maple. The size and number of roots illustrates the deep rooting on the shallow soils in the Gounamitz District.

Mixed stands of balsam fir, yellow birch, white spruce, red maple and white birch occupy the long slopes. Red spruce is found locally.

Coniferous forests at high elevations limit the District on the north while on the south it is bordered by relief generally less than 1,000 feet above sea level. The topography to the east is somewhat less rugged. The soils are rubbly silt loams derived from soft slates and argillites with a deep vertical cleavage. Bedrock is often near the surface, but so fractured that it is readily penetrated by tree roots, Fig. 11. The land rises and falls sharply so that swamps are uncommon. Little of the District has been cleared and stands of fire origin are infrequent. The soft bedrock permits general accessibility for forest operations.

St. Quentin District: The broad, somewhat dissected plateau making up this District divides the Restigouche, Upsalquitch, and Saint John Rivers. Only locally does it rise above 1,500 feet in elevation, but precipitation is high. Sugar maple and yellow birch are abundant; the maple is reported to be free of stain on limy soils. Lower slopes and glacio-fluvial flats are mainly coniferous, and formerly supported white pine.

The District is limited on the south and north by lower elevations and a drier climate; more rugged relief borders it on the east and west. The soils are derived from soft slates, shales and argillites. They are loamy and commonly contain calcareous fragments, a feature which distinguishes this District from much of the Gounamitz District to the west. Coarse, rubbly tills are found locally on lower slopes and swamps are more common than in the last District. Portions have been cleared, and large areas have been burned in recent dry years. Yellow birch, white spruce and sugar maple are the most suitable species for rolling upland areas; pine, balsam fir and the white and black spruces are to be preferred in valleys. Red spruce occurs occasionally and may do well on particular sites.

Gulquac — Rocky Brook District: Distinguished by strongly rolling to mountainous highlands, rising 1,500 to 2,000 feet above sea level and separated by deep, broad valleys. The District forms the height of land between the Upsalquitch, Saint John and Miramichi Rivers, and is relatively cool and moist. Sugar maple, yellow birch, balsam fir and red spruce, with the occasional stand of beech, are characteristic of the hilltops. The tendency for spruce and fir to cap the higher hills, with sugar maple on the middle slopes is illustrated in Fig. 12. The valley stands are mainly balsam fir and spruce with scattered white pine. Quality red spruce is an important component on mixedwood slopes in the south. Large cedar are common in the swamps.

The District is bordered on the west and south by lower elevations and on the east by a mainly coniferous forest on higher land. The soils are coarse sandy-loams derived from granite, gabbro, quartzite, argillite and schist; bare bedrock and granite boulder pavements occur locally.

Napadogan District: Occupies the broad southern approach to the New Brunswick Highlands and covers much of the height of land between the Saint John and Miramichi Rivers. Elevations range from 800 to 1,800 feet above sea level. High precipitation and cool temperatures result. Sugar maple and yellow birch, generally of good quality, are abundant. Beech is common on exposed sites. A few red spruce, white spruce and balsam fir occur with the hardwoods on hill-

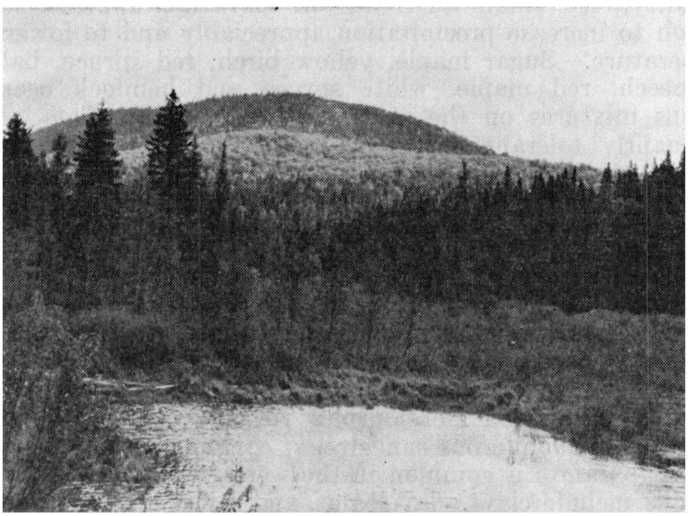

Fig. 12. Tolerant hardwood stands may be found on the low hills and middle slopes, rather than on the hilltops, in the higher land near the border of the Fir—Pine—Birch Zone.

tops and slopes, but form softwood stands with hemlock and scattered white pine on lower slopes and flats. Swamps support cedar, black spruce, red spruce and balsam fir.

Lower elevations border the District on the west, south, and east. The more rugged terrain with a greater prevalence of softwood forest forms a transition on the north. The slate, quartzite, schist, argillite and granite bedrocks have weathered irregularly to form broken topography. Calcareous fragments are found in some soils; others are granitic. The soils are mainly sandy loams, usually deep, but bedrock exposures are common on the higher hills. The District has produced quality sugar maple, yellow birch, red spruce and white spruce for many years, especially on the slightly limy soils. However, a number of silvicultural problems make the re-establishment of these species difficult.

Lepreau — Kierstead District: Kierstead Mountain and the Kingston and Belle Isle Ridges, which rise 600 to 800 feet above a lowland plain, form the core of this District. Included is an area west of the Saint John River, where the low, rugged terrain supports a similar forest. Because of the high humidity, the small difference in elevation appears to be enough to increase precipitation appreciably and to lower the temperature. Sugar maple, yellow birch, red spruce, balsam fir, beech, red maple, white spruce and hemlock occur in various mixtures on the steep slopes and upland flats. Predominantly tolerant hardwood stands are confined to dry, exposed sites. Poorly drained lands with red spruce, black spruce, balsam fir and red maple are common in the western portion.

The District is largely bordered by lower elevations; on the southwest a coastal forest without hemlock or pine occurs. The shores of the Saint John River, where it passes through the District, are related to the Grand Lake District, but they have not been distinguished on the map. The upland of hard volcanic and altered metamorphic rocks is overlain in places by raised Carboniferous sandstones, conglomerates, and limestones. Granite is common in the western part. The resulting soils include clays, clay loams, and sandy loams depending on the prevailing bedrock. The heavy soils are associated with the sedimentary bedrocks and igneous extrusives; the coarser soils overlie granites and are frequently shallow. Some of the District has been cleared, but the farms are reverting to white spruce and balsam fir.

Fundy Mountain District: Consists of a broad upland on the north side of the Bay of Fundy, rising to 1,400 feet above sea level. Although somewhat influenced by the climate of the Bay of Fundy, most of the effects of fog are limited to the lower elevations in the Spruce — Fir Coast Zone. Hill-tops on the rolling land above 700 to 800 feet in elevation support mainly tolerant hardwoods, especially on the north slope of the upland. Mixedwood stands of yellow birch and balsam fir are found on gentle slopes and upland flats. Red spruce and white spruce are distributed throughout, but hem-lock is limited to steep slopes away from the Bay of Fundy.

The District is bordered by the 600- to 800-foot contour level on all sides. The bedrock of granite, gabbro, and vol-canics forms an oval tableland dissected by deep, narrow val-leys. The soils are chiefly loams and sandy loams, moderately rich mineralogically. In many places the till is three feet or more in depth, but elsewhere it may barely cover the bedrock. Much of the District was cleared during the early settlement of New Brunswick and then abandoned. Now, most of this land has reverted to a coniferous forest of balsam fir, red spruce and white spruce. As the tolerant hardwoods seldom obtain satisfactory height growth, the District is probably best suited to conifers.

Cobequid Mountain District: Consists of the flat-topped upland in Nova Scotia known as the Cobequid Moun-tains, rising in places to 1,200 feet above sea level. Although the west end of these mountains is strongly influenced by the climate of the Bay of Fundy, and grades into the colder, wetter Spruce — Fir Coast Zone, most of the District is only moder-ately cool and moist. Flat portions of the upland with poor air drainage are boreal in character, but adjacent low ridges support short-boled beech and sugar maple, with yellow birch, fir, red spruce and white spruce. Hemlock is common in ravines along the steep slopes of the upland.

The 400- to 600-foot contour interval limits the District on all sides except the west where the Spruce — Fir Coast Zone rises to about 700 feet above sea level. The granitic, sedi-mentary, and volcanic complex of bedrocks comprising the upland have produced sandy loam soils of great variety (Wicklund and Smith, 1948). Those derived from the ferro-magnesian intrusives are richer than soils formed from sandstones. Seepage sites are common. In spite of the steep slopes, the soils are relatively deep and are productive where not exposed to excessive desiccation from wind. Part of the plateau was once cleared and is now used for blueberries. Exposure to wind affects a large part of the District and susceptible species such as red spruce and yellow birch will be stunted unless protected by a wind-tolerant one. Although access to the plateau is difficult, much of the land is gently rolling, and difficult logging operations are restricted to the mountain slopes.

Musquodoboit Hills District: The core of the District is a range of hills, beginning with the Rawdon Hills on the west, and extending easterly on both sides of the Musquodoboit River Valley to the ridge overlooking the West St. Mary's River. These hills are far enough inland to be away from the cold summer temperatures of the Atlantic Coast, and are high enough to produce the local climates that encourage tolerant hardwoods. Red spruce, white spruce, balsam fir and hemlock cover the upland flats, lower slopes, and valleys.

For the most part, the District borders follow the 500-foot contour. The bedrock includes quartzite, argillite and granite, overlain locally by sedimentary beds. The soils are mainly sandy loams, with heavier textures near the lowlands. Shallow soils and outcroppings of bedrock are common. Yellow birch, white spruce and red spruce appear to be well suited for intensive management, but the birch will be short.

Pictou Uplands District: Composed of the forests on the high land of the Pictou — Antigonish Highlands. The District is also removed from the direct effects of the Atlantic, but elevations are high enough to give abundant precipitation and cool temperatures. Yellow birch, sugar maple and beech are common in the mainly tolerant hardwood forest. Red spruce, white spruce, hemlock and balsam fir are scattered on the upland flats, and form coniferous stands on the lower slopes and valley bottoms. Red spruce is sparse ln the east side of the District.

Lower elevations border the District on all sides. The hard igneous and metamorphic rocks have produced rich, sandy loams of moderate depth. Some of the bedrock has a strong cleavage that permits deep rooting and good drainage. Deeply melanized soils are common locally; bare bedrock is rare. The rolling topography affords more protection from wind for the managment of yellow birch and red spruce than is available in some of the other Districts. Access to the higher elevations is difficult and broad uplands are not extensive. Pure stands of white spruce have been established on abandoned farmlands.

Cape Breton Hills District: Comprised of a series of hills and uplands mainly above 500 feet in elevation and extending from Canso Strait northward in an approach to the Cape Breton Plateau. The climate is largely determined by air masses moving in from the Gulf of St. Lawrence; the moderate elevations obtain moisture and temperature relationships comparable to those prevailing throughout the Ecoregion. Sugar maple, beech, yellow birch and red maple occupy the upper slopes and high ridges; balsam fir, white spruce, hemlock, and intermittently, red spruce, cover the upland flats and ravine slopes. The luxuriant hardwood forest of the Grand Anse valley in northern Cape Breton Island is illustrated in Fig. 13.

Higher elevations distinguish the District from the slightly warmer and drier Guysborough — Bras d'Or District on the south and east. The 1,000- to 1,100-foot contour interval marks the border with the coniferous Fir — Pine — Birch Zone to the north and east. A narrow coastal strip along the west is exposed and somewhat drier than most of the District, but it is not shown separately on the map. Hard igneous and metamorphic bedrocks predominate, locally overlain by sedimentaries. Sandy loam and loam soils have been derived; most are moderately deep, but shallow soils occur on ridges and steep slopes. Seepage sites are common on the slopes. Yellow birch, and occasionally sugar maple, may develop satisfactorily in the protection of deep valleys. White spruce and balsam fir are probably most suited to sites on hilltops and valley bottom flats.

Red Spruce — Hemlock — Pine Zone

This Zone combines the two Ecoregions in the Maritime Provinces in which red spruce and hemlock attain their greatest prominence. One includes most of the interior of western

Fig. 13. A luxuriant hardwood forest in the Grand Anse valley of northern Cape Breton Island.

Nova Scotia, where red oak is a common associate; the other occupies much of the lowland of central Nova Scotia and eastern New Brunswick. Heavy soils and imperfect drainage prevail in the latter Ecoregion; sandy, generally shallow soils in the former. Red spruce and hemlock have been depleted in both, but remnants of old-growth forest indicate the former importance of these two species. It is the forests of this zone which, more than any other, represent a distinctive forest in the Maritime Provinces.

5. Clyde River — Halifax Ecoregion

An association of red spruce, hemlock, white pine, balsam fir and red maple, interspersed with red oak, distinguishes the interior of western Nova Scotia from the eastern and central portions of the Province, and from the coastal periphery. Fire has played a prominent role in the destruction of much of the former forest. But white pine, red spruce, and locally hemlock, are found under the red oak and red maple, suggesting a return to a mainly coniferous forest. Early records (Smith, 1801) indicate that beech was formerly abundant on the ridges and that rock barrens were common. Beech is still found on the ridges in some areas, but may have been depleted by the fires. Red oak, red maple, and white birch are now abundant. Excellent stands of old-growth red spruce and hemlock, illustrated in Fig. 14, remain on those portions of the Ecoregion that have not been burned. These occasionally suffer seriously from hurricanes and gale force winds (Johnson, 1955).

Much of this Ecoregion is distinguished by what Roland (1944) refers to as a "Southwestern Flora". He indicates a total of 75 species that occur either only in this area and in southern New England, or are found locally in other parts of eastern Canada but are more abundant in this part of Nova Scotia. Characteristic species include highbush blueberry, inkberry and greenbrier. Witch-hazel is abundant in red oak stands. Fire appears to have been responsible for extensive barrens in the southwestern part, now covered by sheep laurel, blueberry, bearberry, witherod and black huckleberry.

Two problems in forest management of the Ecoregion are the frequent wind damage from hurricanes and the high hazard of fire. Hurricane winds may be expected at almost any season of the year, and are a threat to all classes of forest. In spite of the relatively high precipitation, fire appears to have been common from earliest times. Reporting on a summer of systematic traverses through western Nova Scotia, Titus Smith (1801) repeatedly draws attention to the fire barrens, extensive burned forest, and the large areas of windfall which he attributed to hurricanes. Shrub competition is intense on some of the so-called fire barrens, and conversion to full stocking will be difficult. Regeneration of red spruce, black spruce and balsam fir is usually good following partial

Fig. 14. Eastern hemlock on the lower slope of South Mountain, Annapolis District. Photo by M. H. Drinkwater.

cutting of the mature softwood, but may be lacking on clear cuts. Hemlock and white pine are more scattered. Because much of the oak is not of good quality, conifers should be favoured on these lands.

The outstanding feature of the climate is the high potential evapotranspiration, Fig. 3(c), mapped as a Mesothermal Climate (Thornthwaite, 1948). This reflects the low latitude and warm temperatures, which in other parts of Canada support tolerant hardwoods. Beech, sugar maple and red oak are found on the higher ridges, but the high precipitation appears to favour spruce and hemlock. Although there are few stations that indicate a water deficiency, precipitation is least during the summer months and droughts are common.

Granites, slates and argillite predominate, and the soils range from coarse, loamy sand to loams. A stony till supporting oak and pine is illustrated in Fig. 15. Boulder-strewn,

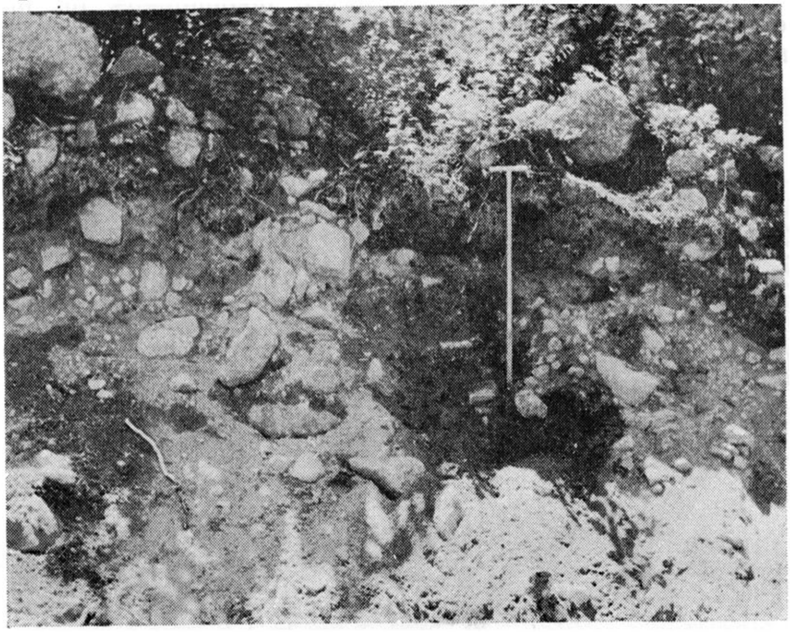

Fig. 15. The coarse, bouldery loamy sand characteristic of much of the Atlantic Upland in Nova Scotia. This site supports red maple, white pine, red oak and white birch of fire origin, but red spruce, black spruce and hemlock are likely to follow.

bedrock plains and poorly drained soils are common. Many of the coarse soils tend to form a pan in the lower B horizons when exposed to drying, but serious deterioration of the soils has not been observed under forested conditions.

Clyde River District: Situated in the most southerly portion of Nova Scotia that is not directly affected by the cold and fog of the Atlantic Ocean. The growing season is hot and droughty on the shallow soils, in spite of the relatively high precipitation. The warm climate is indicated by the presence of plants that otherwise occur no further north than southern Maine (Roland, 1944). The natural vegetation over much of the District appears to have been white pine and red oak, but repeated burning has reduced many of the former pine sites to a shrub cover of three-tooth cinquefoil, bearberry, and broom-crowberry. Sand plains supporting low shrubs and scattered black spruce are shown in Fig. 16. The unstocked, boulder-covered terrain, now dominated by shrubs, may never have supported pine. Black spruce predominates on ill-drained lands; red oak covers the ridges. Hemlock and red spruce are found in the few unburned areas.

Fig. 16. Sandy barrens in the Clyde River District, southwestern Nova Scotia. Black spruce is regenerating slowly, but it is not so well suited to the sandy soil as is pine.

The cold, moist climate of the Spruce — Fir Coast Zone borders the District on the south, 10 to 12 miles in from the coastal headlands. The border is marked by the absence of red spruce and white pine. The Mersey River District to the east is less extensively burned and has few barrens, while on the west the Wentworth Lake District supports more tolerant hardwoods. The soils are mainly coarse, bouldery, sandy loams and loamy sands derived from granite, quartzite and argillite. Shallow soils and bare bedrock are common, as are glacio-fluvial outwash plains. Reforestation of the sand-plain barrens would be desirable, but planting on the stony, shallow-till barrens will be difficult due to the absence of humus and the intense shrub competition. Some of these lands are burned frequently to culture blueberries, a profitable crop on the poor soils.

Mersey River District: Located in a broad band between the cool Spruce — Fir Coast Zone along the Atlantic, and the warm, relatively dry, Sugar Maple — Hemlock —Pine Zone of the Lahave Valley. Due to the proximity of the Atlantic, temperatures are lower and the precipitation somewhat higher in this District than in much of the Ecoregion. The resulting forest is almost entirely coniferous—red spruce, hemlock, white and red pine, black spruce, balsam fir, and scattered white birch and red maple. Although fires are common, they do not appear to have been so widespread as in the other Districts.

The absence of red spruce and hemlock limits the District on the south, while the tolerant hardwoods of the Lahave District form the north border. The soils are mainly sandy loams derived from slate, schist, granite and quartzite, with exposed bedrock common in many places. An important feature in the forest management is the relative absence of extensive red oak and red maple found in the other Districts.

Fisher Lake — Halifax District: Comprised of the broad, granitic portion of the Atlantic Upland, extending in a long arc from west of Lake Rossignol to Halifax. White pine, red spruce and hemlock are the common species on zonal sites that have not been burned. Beech, sugar maple and red oak are found on exposed slopes and hilltops, particularly around lakes. Fire stands of red oak, red maple and white birch, often mixed with white pine and black spruce, are abundant. Balsam fir and black spruce dominate on ill-drained lands.

The District is bordered on almost all sides by lower elevations, somewhat deeper soils and more abundant tolerant hardwood. A cool, moist climate with less oak is found on the east. The soils are mostly shallow, loamy sands derived from the underlying granites. In view of the infertile soils, and the poor quality of the broadleaf species that have followed fire, the pines probably should be favoured. Red spruce and balsam fir may or may not regenerate following removal of the coniferous stands. Although the District is relatively flat, the shallow soil, hard bedrock, and extensive swamps and lakes make for difficult logging.

Wentworth Lake District: An extensively drumlinized area of hardwoods mixed with red spruce and hemlock, between the cold west coast of Nova Scotia and the granitic Atlantic Uplands. Precipitation is relatively low, as indicated by data for Digby and Saulnierville. According to the local inhabitants, the cool summer temperatures found along the coast do not prevail inland. As the precipitation does not increase inland as rapidly as the temperature increases, somewhat larger water shortages may develop in this District than in the previous three. Sugar maple, beech, red spruce and yellow birch predominate on the hills; red spruce, hemlock, balsam fir, red maple and yellow birch on the lower slopes. Swamp stands are composed of black spruce, fir, and locally white cedar.

The cool summer temperatures of the Spruce — Fir Coast Zone border the District on the west; the higher land, shallow soils, and a mainly coniferous forest border it on the east. The soils are loams and sandy loams derived from slates, schist, quartzite and granite. Most of them are deep in the form of rolling drumlins, but shallow soils overlying slates and granites are found locally. On deep soils the tolerant hardwoods are of good quality, while red spruce and white and red pine appear to do well on all sites.

Annapolis District: The trough between the North Mountain escarpment and the Atlantic Uplands makes up the core of this District. High summer temperatures prevail because of the protection by North Mountain from the low temperatures of the Bay of Fundy. The sites used for apple orchards are on the rich tills of the valley slopes; the dry, sandy soils of the valley floor are more prone to drought and frost.

Sugar maple, beech, red spruce and hemlock are characteristic of zonal sites, while tolerant hardwoods with scattered red oak prevail on dry, exposed locations. Red pine, white pine and red oak are found on the valley bottom sand plain. Tree distributions in the valley have been discussed in detail by Roland (1946).

North Mountain forms one boundary of the District; the shallow soils and coniferous forests of the Fisher Lake — Halifax District form the other. The soils are deep red sands and sandy loams (Harlow and Whiteside, 1943), well-drained where there is moderate relief. They have been derived mainly from the underlying soft, red Triassic sandstones. Shallow coarse tills derived from granites occur locally on the western slopes of South Mountain, and loams derived from slate and shale are found on the eastern portion. Although the District is thickly settled, parts are being allowed to revert to forest. Red and white pine should be favoured to replace wire birch on sandy soils; red spruce and red oak are well-suited to the better sites.

6. Maritime Lowlands Ecoregion

Red spruce, black spruce, balsam fir, red maple, hemlock and white pine comprise a distinctive forest association on the gentle relief of the lowlands in all three Maritime Provinces. Jack pine is abundant on sandy soils, and black spruce swamps and peat bogs cover extensive areas. Red maple and wire birch, rather than red oak, predominate as fire types. Beech often forms pure stands on exposed ridges, with scattered spruce and fir, but sugar maple and yellow birch may be found on the larger hills.

The lesser vegetation of this Ecoregion reflects the generally poor drainage and repeated cutting and burning. Witherod and rhodora are the common shrubs in areas of repeated disturbance; in places they may so effectively control a site that they exclude the softwood regeneration. Sheep laurel, mountain-holly and speckled alder are other aggressors. Common smaller plants include wintergreen, gold-thread, naked miterwort, bunchberry, bristly clubmoss, sphagnum and Schreber's moss. Mountain maple, wood fern and wood-sorrel are present, but not as abundant as in the more humid Ecoregions. The relatively clean forest floor under white pine, spruce, fir and cedar on a moderately well-drained loam is illustrated in Fig. 17.

Problems in the silviculture of this Ecoregion lie in the conversion of wire birch and shrub-covered waste lands to suitable softwood species and in the establishment of a suitable pine on the sandy soils where jack pine once predominated. Black spruce regenerates on these sites, but does not grow as well as the pines. Nickerson (1956) has suggested that in addition, it may be detrimental to the soil. Most of the land dominated by shrubs is poorly drained, but appears to be a good site for the spruces. Remnants of the oldest stumps on some of these sites have been identified as pine, hemlock and cedar.

Fig. 17. White pine, hemlock, cedar, spruce and fir on a moderately well-drained site at the Acadia Forest Experiment Station, Maritime Lowland Ecoregion.

The summer precipitation, Fig. 3(a), ranges from 8 to 10 inches with an average summer temperature of from 62 to less than 64 degrees. The precipitation is moderately low, and the temperatures just above average, for the Maritime Provinces. A small water deficiency occurs in many parts.

On the whole, the Ecoregion is slightly cooler than the adjacent Magaguadavic — Hillsborough Ecoregion.

Features that are probably more important than climate are the heavy texture of the soil and the poor drainage. The zonal, well-drained site is rare. Where it occurs, the local climate and species distribution are so influenced by the surrounding swamps and bogs that the forest on the zonal site reflects many characteristics of poorly drained land. It is possible that if lighter soils and more relief were present, this Ecoregion could support extensive stands of tolerant hardwoods, and would then form part of the Sugar Maple — Hemlock — Pine Zone. However, those are not present, and available information indicates that the forest on the zonal sites is sufficiently different from those of other Ecoregions to warrant a separate description.

Oromocto District: Comprised of gently rolling land centered on the Oromocto River in the western end of the New Brunswick Lowlands. Portions of the District are above 400 feet in elevation, but the Oromocto valley is broad and flat. Beech, sugar maple, red spruce, balsam fir and white pine are found on the occasionl exposed ridge. Balsam fir, hemlock, red maple, red spruce and yellow birch prevail on the zonal site. The hemlock and yellow birch are rare on disturbed areas. Poorly drained land with black spruce, red spruce, balsam and cedar is widespread. Red and white pine are common on the lighter soils.

Soils containing calcareous fragments and supporting tolerant hardwood forests border the District on the west, while the coarse soils with pine and hardwood border it on the south. The Saint John Valley surrounds the remainder. The bedrock consists of sedimentary sandstone, siltstone and shale. Stony, red clay-loam soils predominate; they tend to be poorly drained except on steep slopes and where the bedrock is close to the surface. Red sandy loams derived from slightly calcareous sandstone and conglomerate as well as recent sandy alluvial soils occur locally. Much of this District was once settled and extensively cleared and burned. Weed species such as wire birch and alder cover some of this land, but it is reverting slowly to red spruce, white spruce and balsam fir. In the few areas where red pine has become established following fire, the good growth suggests that this tree should be encouraged by planting. For the most part, the topography and soil are not adverse for forest operations.

Nashwaak — Miramichi District: Consists of the strongly dissected portion of the New Brunswick Lowland centered on the Nashwaak and Miramichi Rivers. Tolerant hardwoods occur on the ridges and some of the long steep slopes. However, much of the land is either flat or gently rolling, and balsam fir, red spruce and hemlock with red maple and yellow birch comprise the stable forest on zonal sites. Repeated burning has encouraged jack pine on a wide range of conditions. White pine is common; frequently it forms pure stands on the light soils along the rivers.

Coarse soils and mainly hardwood forests form the western border of the District, while flat, ill-drained land forms the east, and south borders. Stony clay loams and loams derived from sandstone and shale are most wide-spread, but sandy and gravelly soils occur along large rivers. Shallow soils are found in many areas, but bedrock outcroppings are uncommon. The poorly drained sites appear to be well suited to spruce, balsam fir, and in some areas, jack pine. Regeneration following cutting is usually good for all species except jack pine. In a few areas the latter appears to do better than any other tree and it would be a preferred species if methods can be found to regenerate it.

Bantalor District: Consists of the flat, slightly elevated but undissected height of land between the St. John and the Miramichi Rivers. The extremely flat land appears to permit cold surface air to accumulate and a boreal type of forest prevails. Black spruce dominates and barren, raised peat bogs cover large areas. Jack pine, so abundant to the north and east, is rare. Red spruce, black spruce, balsam fir, hemlock, birch and cedar are common species in remnants of stable forest on the moist sites.

More strongly dissected topography forms the boundary of the District on almost all sides. The bedrocks are flat Carboniferous sandstones and mudstones. The heavy, basal till smeared over the bedrock allows little internal drainage. Slopes are therefore moist, and flat hilltops and depressions form swamps, shallow soils and gravels may be well-drained. Fires have been frequent in parts of the District and wire birch, red maple and white birch predominate locally. The prevalence of swamps has probably limited the spread of the fires, but many of the wet lands show evidence of being burned. The poor drainage restricts forest operations to some extent, but a moderately well-drained slope that permits road construction is usually present along streams.

Harcourt District: Consists of the flat lowland plain forming the height of land between the St. John River and Northumberland Strait. Although poorly drained land predominates, a widely distributed surface layer of ponded sand tends to permit seasonal droughtiness. Black spruce swamps and peat bogs are common. Fires have been frequent, and jack pine, with an understory of black spruce and balsam fir, is the common cover type. However, reports of an early tanbark industry indicate that the original forest was well stocked to hemlock. It appears to have grown with red spruce, black spruce, and white pine. Hemlock and red spruce are now rare, except along the streams.

The District is bordered on the north and south by rolling terrain and on the west by the absence of jack pine. The stunting effect of winds from the Northumberland Strait is the limiting factor on the east. The soils are heavy clays and clay loams, often overlain by a shallow layer of fine sand. Some of the clays on low-lying land near the coast are of marine or lacustrine origin. Although hemlock was formerly abundant, jack pine and red pine appear to be well adapted to the seasonally wet land and should be favoured over the slower growing black spruce.

Allardville District: Comprised of a broad, somewhat elevated flat between Miramichi Bay and Chaleur Bay. Most of the District is gently rolling, but a few rivers cut across with deep, narrow valleys. Some of the well-drained ridges support red spruce, hemlock, beech, yellow birch and red maple. Pure stands of jack pine, and jack pine with black spruce, red spruce and balsam fir predominate on the older burned land. Repeated recent burning has reduced portions of the District to pin cherry and white birch. Wire birch is a recent invader.

The District is bordered on the south and west by rolling topography and more abundant hardwood. Wind effects from the Gulf of St. Lawrence extend inland five to eight miles along the north and east. The soils are clays, sandy clays and sandy loams, most of them shallow, the lighter soils being on the ridges. They are derived from the underlying sandstones, siltstone and shale. Red spruce appears to do well on deep soils that have not been burned. Jack pine and black spruce are of good quality on sandy, ill-drained uplands; balsam fir is reported to be inferior.

Petitcodiac District: The portion of the rolling Petitcodiac River valley covered by heavy clay-loam soils forms the core of this District. Local geological uplifts have tilted many of the sedimentary bedrock strata, and several ranges of low hills occur. Tolerant hardwoods are found on the exposed sites, but hemlock, yellow birch, red spruce, black spruce, fir, pine and the occasional sugar maple and beech prevail on the slopes and lower ridges. Repeated cutting and burning have spread jack pine, black spruce, wire birch, red maple and white birch over much of the District.

Tolerant hardwoods and better drained soils form the southern and western boundaries of the District. Flat, ill-drained sites border it on the north, and coastal effects on the east. The soils are mainly red clays and clay loams, but sandy loams derived from conglomerates and sandstones occur locally. Much of the District has been settled and a patchwork of forest and agricultural lands prevails.

Northumberland Shore District: Comprised of a five to 20-mile wide belt of coastal forest along the Northumberland Strait from Chaleur Bay to Pictou on the mainland, and from North Point to west of Summerside on Prince Edward Island. Open-grown trees in the District lean away from the direction of the wind; their crowns are usually one-sided and damaged. Second growth stands appear unusually short unless there is a taller old-growth forest in the area to act as a shelterbelt. Winds from Chaleur Bay and the Northumberland Strait dominate the north, central and eastern portions. Coastal fog and winds from the Bay of Fundy influence the central portion. Average summer wind speeds along the coast are almost double those of inland stations (Brougher and Thomas, 1948). Black spruce, jack pine, white spruce, red spruce and red maple are the most abundant species, although hemlock and white pine are not uncommon. Prior to the repeated burnings, red spruce, hemlock, and white pine were probably more abundant. Tamarack occurs with black spruce on the extensive bog land. Beech and sugar maple are found on a few slopes near the larger streams.

The border of the District follows a line where winds from the Gulf of St. Lawrence appear to be unimportant in the establishment and growth of new stands. On Prince Edward Island the border also follows the edge of the heavy soils. Most of the soils are the clays and loams derived from red sandstones and shales or from lacustrine materials. Red sandy loams with slightly better drainage are more common in the east. Repeated fires have encouraged jack pine, and on many sites it appears to be better suited to the soil and climate than red spruce. Red spruce suffers particularly from exposure to the wind. White spruce is to be preferred over jack pine as a wind resistant species for sites along the coast-line and for shelter-belts.

Prince Edward Shore District: Mainly well-drained, light, sandy soils along the north shore of Prince Edward Island distinguish this District. The prevailing climate and exposure to wind is similar to that of the last District. However, jack pine is rare, and red spruce and hemlock are less common. White spruce, black spruce, balsam fir, red maple and the occasional white pine are characteristic species. Beech and sugar maple may be found on ridges near the Hillsborough District.

The District is bordered on the west by heavy soils and by tolerant hardwoods on the south. The soils are almost entirely sandy loams derived from fine micaceous sandstones and siltstone. Sand dunes and bars are found along the coast. Species suited to the District include white spruce, balsam fir and black spruce. White spruce has reforested much of the abandoned farm lands, and it is to be preferred over other species for its faster growth. Black spruce and scattered tamarack prevail on ill-drained and peaty sites.

Oxford District: Consists[1] of rolling land between the Cobequid Mountains and the Northumberland Strait. Geological lifting and tilting combined with stream dissection have produced high rolling hills. Sugar maple, beech and yellow birch are common on the upper slopes, but red spruce, balsam fir, black spruce and hemlock are found on upland flats as well as middle and lower slopes. Jack pine, aspen, spruce and wire birch are abundant after fire on lowland flats.

The District is bounded by the steep slopes of the Cobequid Mountains on the south, and by coastal effects on the other sides. The soils are variable and include, clay loams derived from sandstone and shale, sandy loams from hard sandstone and conglomerate, as well as sands and gravels along the river courses (Whiteside, *et al.*, 1945). Most of the District has been either cleared or burned. Sites presently supporting red maple, white birch and trembling aspen are better suited to the red spruce and white spruce that are gradually increasing. Softwoods have not always restocked the abandoned farm land in this District as they have in much of Nova Scotia, and the spruces and pines may have to be favoured by planting.

Windsor — Truro District: Comprised of a lowland surrounding Cobequid Bay in Nova Scotia, and extending from the Cobequid Mountains to the Annapolis Valley. Scattered sugar maple, beech and yellow birch occur locally on the low ridges, but the spruces, fir, white birch, red maple, hemlock and white pine form a relatively stable forest on zonal sites. The clearing and abandoning of farm land has allowed pure stands of white spruce and balsam fir to be established in many areas; repeated burning has encouraged wire birch, white pine, red pine and black spruce in others. Black spruce flats and swamps are common in the west. White elm, black ash, and occasionally sugar maple and beech, may be found along the river systems.

Higher land and lighter soils border this District on all sides. The soils are mainly red clays derived from shale and sandstone, but sandy loams are found on the ridges in some areas (Cann, *et al.*, 1954). Alluvial and lacustrine soils are common along the rivers. Red spruce, white spruce and red pine appear to be well suited to all but the wettest sites. Much of the central part of the District is under agriculture.

St. Mary's River District: Centered on the somewhat elevated sedimentary bedrocks that form the Truro — Guysborough trough. The mainly flat, ill-drained topography favours balsam fir, white pine, red spruce and hemlock on zonal sites where tolerant hardwoods are found in Districts to the north and south. White pine, red maple and black spruce are scattered on the extensive barren lands where sheep laurel and bracken dominate. The barrens appear to have originated with repeated burning.

Tolerant hardwood forests border the District on all sides except the west, where lower elevations and heavier soils are found. Sandy loams derived from hard quartzose sandstone and conglomerate cover most of the District, but there is considerable variation, especially in depth. Portions of the District that were once cleared have reverted to a mainly coniferous forest. White pine, black spruce, balsam fir and red spruce appear to be the most adaptable species for management.

Sheet Harbour District: Consists of a broad band of low, rugged hills and upland flats on the Atlantic Uplands,

Fig. 18. Dense balsam fir regeneration on an old log cut, Sheet Harbour District. Photo by I.C.M. Place.

east of Halifax. It occupies a position geographically and climatically between the cold, wet Spruce — Fir Coast Zone on the south, and the higher Sugar Maple — Yellow Birch — Fir Zone to the north. Red spruce, balsam fir, yellow birch, hemlock, and white spruce are the common species on well-drained sites, but beech, yellow birch, red maple and sugar maple can be found on the higher hills. Exposed bedrock cliffs commonly support white pine and black spruce. Although somewhat dissimilar from the remainder of the Ecoregion, the District cannot be included elsewhere.

The north border is marked by higher land and more abundant tolerant hardwoods, while on the south, coastal influences form a boundary five to 20 miles inland. The soils are sandy loams of great variability derived from slates, argillites and granites, but deep, rich tills are found, alternating with coarse, shallow tills and bare bedrock. Red spruce, white spruce and balsam fir grow well in most of the District; yellow birch is well suited to deep soils on protected sites. Pine should be favoured on shallow, exposed soils and on talus slopes. Regeneration to conifers is usually good, as illustrated in Fig. 18. The rough topography, hard bedrock, and shallow soils make most of the District difficult for logging.

Spruce — Fir Coast Zone

Two coniferous Ecoregions, one with abundant red spruce and one with no red spruce, comprise a zone of spruce—fir forests along the shores of the Bay of Fundy and the Atlantic Coast of Nova Scotia. Hemlock and white pine are absent. Red maple and white birch are the common hardwoods, although beech and sugar maple occur on a few of the higher hills. Late springs, cold summers and frequent fogs (Putnam, 1952) are the outstanding features of the climate. Where the winds are strong and continuous the trees are short and stunted. However, spruce and fir growth appear to be good on the more protected sites and on the better soils.

7. Fundy Bay Ecoregion

A stable association of red spruce, balsam fir, and red maple, with scattered white spruce, white birch and yellow birch characterizes the zonal site. Beech and sugar maple are found locally on the higher elevations of North Mountain and the Fundy Upland. The mixed nature of the forest is apparent in Fig. 19 where the yellow birch has been damaged by dieback. Hemlock and white pine occur only along the inland border of the Ecoregion. Stands of fire origin are uncommon. Except on North Mountain, red spruce is the common species seeding in on abandoned farmland.

The lesser vegetation is distinguished by a number of species of boreal affinity. Cowberry, or rock cranberry, is common on the dry rocky sites, and cloudberry is found in the peat bogs. Canada raspberry, the boreal variety of the wild red raspberry, is common. Mountain-ash is abundant in most of the Ecoregion and often attains diameters of more than 10 inches.

Fig. 19. Decadent yellow birch and balsam fir representative of the Fundy Bay Ecoregion.

The most important deterrent to rapid growth appears to be wind. This is discussed under the Atlantic Shore Ecoregion where it is more severe. Trees on headlands and exposed ridges have a short, broken appearance, even in dense stands. Although damage from salt spray may be important, it does not account for the appearance of the trees on inland ridges. Trees do well in areas near the coast protected from wind, but ridges miles from the direct effect of salt spray look the same as coastal headlands. Shelterbelts of a wind-resistant species such as white spruce have been observed providing effective protection, and should be stressed in the silviculture of the Ecoregion. Shallow soils and extensive bare bedrock will make this difficult. Regeneration of conifers is usually good on the deeper soils, but red maple of sprout origin tends to dominate in a few areas.

The climate is distinguished by the low summer temperatures indicated in Fig. 3(b); they are comparable to those of the northern coniferous portions of New Brunswick. In addition, precipitation is high and fog is frequent. Although the spring warm-up is late, the winters are not as cold as in the interior of New Brunswick and Nova Scotia. Judging from the similarity in climate, the Fundy Bay Ecoregion appears to be well suited to some of Canada's West Coast species.

The soils and underlying bedrocks are particularly variable. Slates, shales, sandstones, and volcanic, hard metamorphic and igneous rocks are found along the New Brunswick coast, while basalt and lava underlie North Mountain. The soils range from coarse sandy loams to clay loams, many of them shallow over the bedrock.

Musquash District: Consists of the low hilly portion of the New Brunswick coast, located mainly on high-base bedrocks along the southwest. The terrain is rough and exposed bedrock is common. Red spruce, white spruce, black spruce, and balsam fir occur on slopes exposed to the Bay of Fundy. Red maple and yellow birch are common with the conifers on protected sites; red maple also forms pure stands in a few areas. White cedar is abundant on a wide range of sites, including the bedrock ridges. The subarctic cloudberry and black crowberry are common in a type of coastal peat bog.

The north border of the District, about ten miles inland, is marked by the presence of white pine, hemlock, and appreciable sugar maple and beech. The soils are shallow, stony, sandy loams derived from granite, gabbro, volcanic rocks, sandstones and, in a few areas, limestone. Much of the District has been heavily cut over and partially cleared, but a coniferous cover has returned in many places. White spruce should be preferred on exposed sites.

Chignecto District: Consists of the northeastern portion of the Ecoregion, much of it adjoining low mountains of the Fundy Uplands and the Cobequid Mountains. Red spruce is more abundant along the coast and in the abandoned fields than in the Musquash District. Balsam fir and white spruce grow with it. Yellow birch, white birch and red maple are scattered, limited mainly to protected sites. Beech may occur locally at high elevations; sugar maple is rare. Almost all the land that is not in use for agriculture is stocked to a dense, predominantly coniferous forest.

The limit of white pine and hemlock, up to ten miles inland, forms the border of the District. However, because extensive clearing was once carried out in the District, the pure

Fig. 20. In many parts of the Maritime Provinces the abandoned fields are quickly stocked to even-aged stands of white spruce. A young stand on recently abandoned land is illustrated in the middle background, and an older stand behind it

stands of red spruce on abandoned land is an equally good boundary feature. White spruce, illustrated in Figure 20, predominates on the abandoned farmland farther inland. The soils include clay loams derived from sandstones, shales and volcanic rocks; marine and estuarine clays around the Bay of Fundy coast; sandy loams derived from sandstones, conglomerate and hard igneous and metamprphic bedrocks, and local deposits of sands and gravels. Although the indigenous species grow moderately well, the climate suggests that several West Coast species could be introduced. Exceptionally good growth has been observed on early Norway spruce plantings. Wind effects are not so pronounced in this District as in the last, but shelterbelts could be used to advantage.

North Mountain District: Consists of the north slope of the Mountain, rising to about 600 feet above sea level. The high elevations of the District form a barrier to the cold air moving off the Bay of Fundy, protecting the Annapolis District Red spruce is only moderately abundant in the stable forest and it is scattered in the softwood stands on abandoned fields. Sugar maple and beech are limited mostly to the higher elevations where they may be above the level of the cold air from the Bay of Fundy. Mountain-ash is common, often exceeding a foot in diameter. The stands on the upper slopes of North Mountain are greatly stunted.

The District is bordered on the south by the abrupt escarpment of North Mountain. The virtual absence of red spruce forms the western boundary. The soils are reddish-brown clay loams derived from trap rock and fine grained sandstone. Some of the soils are shallow, and seepage sites are common. White spruce, red spruce and balsam fir appear to be well suited to the District. With the existing road system, the topography and soil present little difficulty to logging.

8. Atlantic Shore Ecoregion

White spruce, black spruce and balsam fir, predominate in this Ecoregion. Heart-leaf birch is scattered, mixed with the conifers, and red maple and yellow birch are found locally on the better soils. White pine, beech and hemlock may be found along the inland border. Red spruce is absent. Bare bedrock is common, with the result that the stands tend to be open. In areas of eastern Nova Scotia, illustrated in Fig. 21, the fir tends to be dense. Most of the stands are windswept and therefore stunted.

A few boreal species such as mountain-ash, cowberry and Canada raspberry distinguish the lesser vegetation. However, the most prominent feature is the absence of the 'southwestern flora' (Rolland, 1944) from the southern portion of the Ecoregion. Most of the herbaceous species associated with rich tolerant hardwoods are also absent, particularly in the Eastern Shore District.

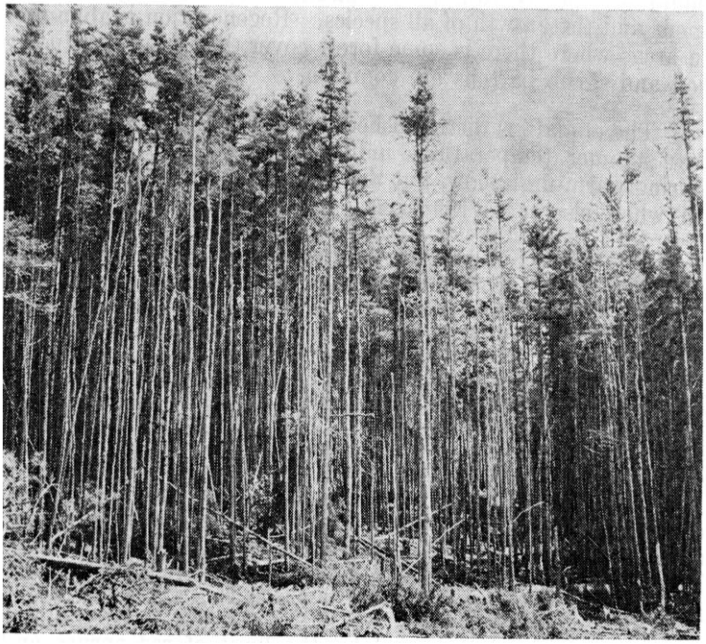

Fig. 21. Dense balsam fir, 40 to 50 years old and three to four inches in diameter, along the south coast of Cape Canso, East Atlantic District.

Silviculture in this Ecoregion will be governed to a considerable extent by efforts to reduce the effects of coastal winds on regeneration and growth. Continuous light winds such as those along the Atlantic Coast appear to increase transpiration loss in some species to the point where growth is restricted. F. H. Whitehead (1957) has discussed the importance of wind in decreasing the rate of dry weight increase, a response which he suggests should be attributed to 'drying out' of the plant. His evidence indicates that conifers are affected in much the same way as herbaceous plants, but that differences between species can be expected. Salt spray may be another factor, but its effects over long distances are questioned. White spruce achieves better form and growth along the coast than either black spruce or balsam fir. Appropriate shelterbelt reservations of a wind and salt resistant species could be expected to improve conditions for seedling establishment and the growth of all species. Regeneration is abundant in areas where there is some forest cover, but non-reproducing sod and shrub barrens are common.

The climate is distinguished by the high precipitation and low summer temperatures indicated in Figs. 3(a) and 3(b). Spring warm-up is slow, but the frost-free period is longer than anywhere else in the Maritimes.

The bedrock underlying the Ecoregion is argillite and slate, with local areas of granite and sandstones. The soils tend to be shallow and coarse textured. Exposed bedrock is common on the ridges and headlands.

Cape Sable District: Consists of a coastal strip extending from Brier Island in western Nova Scotia to Mahone Bay on the south coast. The climate is somewhat warmer than in the Eastern Shore District, but is none the less cool and wet. Most of the original forest along the coast has been either cleared or burned, and white spruce, balsam fir and black spruce are the species becoming established. A dense cover of alder has taken over in some areas, however, and ericaceous shrubs in others.

The District is bounded by the limit of red spruce and white pine This line probably marks the inland limit of the cold and fog prevailing along the coast. The soils are mainly shallow sandy loams alternating with bare bedrock, but deeper soils in the form of drumlins can be found. Drainage is good, considering the high precipitation. White spruce and black spruce are probably the only trees well suited to the rigorous climate. Most of the District is accessible either by water or from coastal roads.

Eastern Shore District: Made up of a band of coastline, five to 25 miles wide, extending from Mahone Bay to the eastern end of Cape Breton Island. Although variations occur along the 250-mile length, there appears to be no justification for recognizing more than one District. The climate, especially during the growing season, is colder than in the Cape Sable District. The abundance of black spruce and balsam fir in comparison to white spruce also distinguishes the District. White spruce prevails along the immediate coast, but is less common inland; it may form nearly pure stands in cleared or disturbed areas. Tamarack is abundant on the flat, ill-drained portions of Cape Breton Island. Fires have been common in part of the District, but they appear to have been started by settlers to extend their pasture land. However, the presence of jack pine in several places on the Canso peninsula, and on Madame Island, suggests that the constant winds may create a droughtiness that is conducive to fire.

The mainland portion of the District is bordered by the limit of red spruce, hemlock and white pine, but on Cape Breton Island where red spruce is uncommon, by the limit of pine and hemlock alone. A few tolerant hardwoods are found in the valley of the Mira River. The soils include heavy clays derived from sandstones and shales on eastern Cape Breton Island, and sandy loams, mainly overlying argillite and granite, in the remainder of the District. Many of the sandy soils are shallow, and where burned or cleared, may remain barren for years. White spruce, black spruce and balsam fir are well suited to the rigorous climate, but their growth is slow and the stems frequently so dense (Fig. 21) that they require a long period to reach merchantable sizes. Much of the District is not accessible, and the small size of the timber makes conventional forest operations unrealistic. In the more protected portions, tree sizes could be increased by using shelterbelts of wind resistant species.

Fir — Pine — Birch Zone

Two types of coniferous forest are included in this Zone. Both have species of southern affinities such as red maple, yellow birch and white pine, but one is a region of high precipitation and few stands of fire origin; the other is drier and has an abundance of species whose distribution is related to repeated fire. A balsam fir, white birch, white spruce, and black spruce assocation is found in both Ecoregions. Yellow birch and red maple (without white pine) are characteristic of one; white birch, white pine, jack pine, aspen and black spruce of the other. Taken as a whole, this Zone forms the transition between the boreal spruce forests to the north and the mainly deciduous forests to the south.

9. New Brunswick Highlands Ecoregion

A predominantly coniferous association of balsam fir, white spruce, black spruce, white birch and white pine characterizes the well drained slopes. Mainly black spruce and balsam fir are found on the low mountains, but these sites are generally exposed and have shallow soils. Red spruce, red maple and yellow birch occur locally and sugar maple may be found in isolated pockets. White pine and jack pine, with black spruce and balsam fir, are found on gravelly soils along the rivers. Aspen, mainly of fire origin, is abundant on slopes to fire-swept valleys. Cedar swamps are scattered and white elm and black ash can be found along the rivers.

The ground vegetation is predominantly boreal, but a large number of sub-boreal species are present along the streams and in the cedar swamps. Mosses predominate, with Schreber's moss most common. Bunchberry, maianthemum, wintergreen, sheep laurel and blueberry are the common herbs and shrubs. Bigleaf aster is abundant under aspen stands. Wood fern, wood-sorrel, and mountain maple, although common, are not as widely distributed as in the Gaspé — Cape Breton Ecoregion.

Regeneration of conifers is usually good; the balsam fir is frequently dense. Because it is the most abundant species, epidemics of the spruce budworm, *Choristoneura fumiferana* (Clem.) are a threat to maturing forests. Much of the young fir can be shown to have originated following destruction of old growth forest by the budworm in the epidemic between 1913 and 1918. Control of such outbreaks by suitable cutting practices (Prebble, 1951) is the primary requirement in the forest management of the Ecoregion. Erosion of steep cut-over slopes and the regeneration of exposed, dry sites are other silvicultural problems. A few burned areas have not reproduced to softwoods, and support scattered birch and aspen.

Although climatic data are not available, most of this Ecoregion corresponds to the Central Highlands Region suggested by Purnam (1940, 1952). Meteorological data from Summit Depot and Kedgwick, although outside the Ecoregion, are probably representative and have been used in drawing the isopleths in Fig. 3. The climate is distinguished by low summer temperatures and a lower rainfall than that of the Gaspé — Cape Breton Ecoregion.

The underlying bedrock is unusually variable. Slates, argillite and schist alternate with volcanic rocks and granite. The soils range from rubbly sandy loams to shallow loamy sands and rock talus. The four Districts are distinguished primarily on differences in their relief, bedrock, and soils.

Kedgwick District: Consists of a broad rugged valley centered on the upper reaches of the Kedgwick River in northwestern New Brunswick It is protected on the west and south by the higher elevation of the Green River District The higher land apparently creates a rain-shadow, for fires are moderately frequent and white pine and aspen are abundant in parts of the District Balsam fir is the dominant tree, but white spruce, black spruce and white birch are common; white pine is scattered except in the fire stands. Red spruce is found mainly at high elevations, and yellow birch more commonly on slopes at low elevations Jack pine is found on the Quebec side of the Patapedia River, and may be expected in New Brunswick.

The limit of white pine is near the 1,500-foot contour and forms the boundary of the District Scattered sugar maple forming the southeast border are illustrated in Fig. 22. The soils on the steep terrain are rubbly sandy loams derived from slate, argillite and sandstone; calcareous fragments are found in a few areas. The deep cleavage of the bedrock promotes drainage and permits deep rooting, even in shallow soils. The spruces and fir regenerate well and are suited to the District. Logging tends to be difficult because of the rugged topography, but the soft bedrock in most of the District permits good roads.

Blue Mountain District: Made up of the band of horizontally stratified metamorphic bedrock between the hard core of the New Brunswick Highlands and the coastal lowlands along Chaleur Bay. Most of the District is rolling,

Fig 22 Scattered sugar maple on a northeast slope south of Rapids Depot. Spruce and fir are prominent on the hilltop.

but portions have been deeply incised by the rivers. White pine is generally abundant, but balsam fir, white spruce, black spruce and white birch predominate. Red spruce occurs at high elevations.

On the north, the District is bordered by lower elevations and the presence of sugar maple and beech. The south boundary forms along the rugged relief of the Nipisiguit District. The soils are sandy loams and loams, occasionally containing calcareous fragments, and are derived from shale, sandstone and volcanic rocks. In many areas they are poorly drained or shallow. Cedar and black spruce swamps are common. Fires have swept portions of the District, especially in the Upsalquitch River valley where jack pine, white pine and red pine occur. On well-drained sites the pines appear to do better than balsam fir.

Nipisiguit District: Formed on the broad, dissected peneplain, generally 2,000 feet above sea level, comprising the height of land between the St. John, Miramichi, Upsalquitch and Nipisiguit Rivers. The mountainous terrain produces great variability in climate, the higher mountains being frequently shrouded in cloud while the valleys are droughty and prone to burning. Fig. 23 illustrates black spruce and white pine in the valley bottom, and small dense black spruce on the hilltops. Balsam fir, black spruce and white spruce are found on the slopes, but balsam fir and white birch cover some of the hills where the soils are deeper. Jack pine is common where burning has been frequent, but some shallow soils have not regenerated.

The District is bordered by the 1,500-foot contour where it separates the rugged terrain from the more rolling relief of the adjacent Districts to the north and south. Tolerant hardwoods, mostly lying below 1,800 feet in elevation, form the west boundary. The granite and gabbro core of the New

Fig 23. Mountainous terrain in the Nipisiguit District. Black spruce and white pine are found in the valleys; unmerchantable black spruce on the hilltops.

Brunswick Highlands is the main underlying bedrock, but chlorite schists and argillites are common The resulting soils are variable; coarse, loamy sands on the granite; stony, sandy loams on the schists. The rugged terrain and shallow soils make for difficult logging.

Tuadook District: Comprised of the rolling land between the Nipisiguit District and the tolerant hardwoods to the south and east. The main rivers tend to follow broad, flat-bottomed valleys separated by irregular hills. Sugar maple may occur on favourable sites, but white birch, yellow birch and red maple comprise most of the broadleaf element in the mixedwood stands on the hills. Jack pine is common on burned land; when it is not present, scattered white pine overtops dense balsam fir, black spruce and white spruce. Red spruce may be abundant locally.

Rugged terrain above the 1,500-foot contour forms the western border of the District, while tolerant hardwoods border it on the south and east. The soils are stony, sandy loams derived from chlorite schists, argillites, quartzite and local outcroppings of granite and volcanic rocks. Sands and coarse gravels are common along the valleys. The pines and spruces are probably best suited to the District, as the fir tends to be somewhat inferior.

10. Gaspé — Cape Breton Ecoregion

Balsam fir, white birch, white spruce, and occasionally yellow birch, red maple and black spruce comprise the zonal association. Spruce is less prominent than in the New Brunswick Highlands Ecoregion and white pine is rare. Risk of fire appears to be low, for stands of fire origin are uncommon. Observations of the characteristic inverted soil profiles indicate that old growth forests are normally destroyed by wind, if not by insect attack. Balsam fir regenerates quickly, grows to large sizes, and remains sound for upwards of 100 years. The heart-leaf birch is characteristic, and although much of it was killed by 'dieback', it normally forms large, quality timber.

The lesser vegetation is luxuriant on all but the driest sites. Mountain maple and hobblebush frequently form a dense shrub canopy. Below it, wood fern covers wood-sorrel and numerous mosses. Schreber's moss and bunchberry are common on dry sites; spring-beauty and Dutchman's-breeches frequent rich seepage sites. Sheep laurel, wintergreen and blueberry are uncommon.

As in the New Brunswick Highlands Ecoregion, one of the major considerations in forest management is to reduce the susceptibility of the forest to attack by the spruce budworm (Prebble, 1951). Shrub competition, mainly from mountain maple, is a problem on much of the area, but according to Vincent (1956) suppressed regeneration of spruce and fir is available. The abundant advance growth of balsam fir under mature fir is illustrated in Fig. 24.

Fig 24. Balsam fir advance growth under old-growth fir, Green River District.

High summer precipitation, and low temperatures distinguish the climate. Meteorological records are not available for the Cape Breton Island portion, but surface runoff data for the Northeast Margaree River, which rises mainly in this Ecoregion, indicate 50 inches of runoff annually. Owing to the high elevations, fog and low clouds frequently shroud all but the lowest valleys. Tree growth is rapid in spite of the short season.

The underlying bedrock is mainly metamorphic: slate and argillite in New Brunswick; argillite, volcanics and granite in Cape Breton Island. The associated soils are moderately fertile and most are well drained.

Green River District: Consists of a broad ridge in northwestern New Brunswick, part of the Gaspé upland, rising in places to 2,000 feet above sea level. Air masses coming from the west are forced upward, producing the moist climate indicated by data from Summit Depot. The forest is mainly balsam fir, white birch and spruce, and differs from the Cape Breton Highlands District only in the greater height of the birch and fir. This appears to result from less exposure to wind.

Tolerant hardwoods form the south border of the District, about 1,800 feet above sea level, while white pine and stands of fire origin below the 1,500-foot contour form the boundary on the north. Stony loam and silt-loam soils derived from slates, argillite and conglomerate cover the strongly rolling terrain. Limy fragments may be found in much of the fractured bedrock. Although the soils are often shallow, the soft bedrock and strong vertical cleavage permit deep rooting. These features are equally favourable for logging operations because a bulldozer blade is usually sufficient to make rockcuts. However, the rough topography makes for difficult logging.

Cape Breton Highland District: Comprised of the upper slopes of the northern Cape Breton Highlands, mostly more than 1,000 feet in elevation, but not including the 1,500-foot level of the Northern Plateau. The moist climate results from air masses moving over the high elevations. Balsam fir, white birch and spruce form the characteristic association, Fig. 25, but continuous winds from the surrounding open water exert a strong influence on growth. For the most part, the trees are seriously shortened only on the ridges and exposed slopes. Growth is comparable to that of the Green River District on the protected sites.

The District comprises a belt of ridges and deeply incised valleys around the Cape Breton Plateau. The outside border is marked by the presence of tolerant hardwoods, mainly between the 700- and 1,100-foot contours; the beech and sugar maple may rise to higher elevations along the west than on the east. The inland boundary is located near the 1,500-foot contour which outlines most of the flat portion of the Northern Plateau. The eastern part of the District in the rain-shadow of the plateau tends to be drier, and may be comparable to the New Brunswick Highlands Ecoregion. The soils are variable, but consist mainly of sandy loams derived from sandstones, conglomerates, igneous and metamorphic rocks, and granite. Shallow soils and bare bedrock are frequent. An extremely rugged terrain results from the many narrow valleys through the District and makes for some of the most difficult logging in the Maritime Provinces.

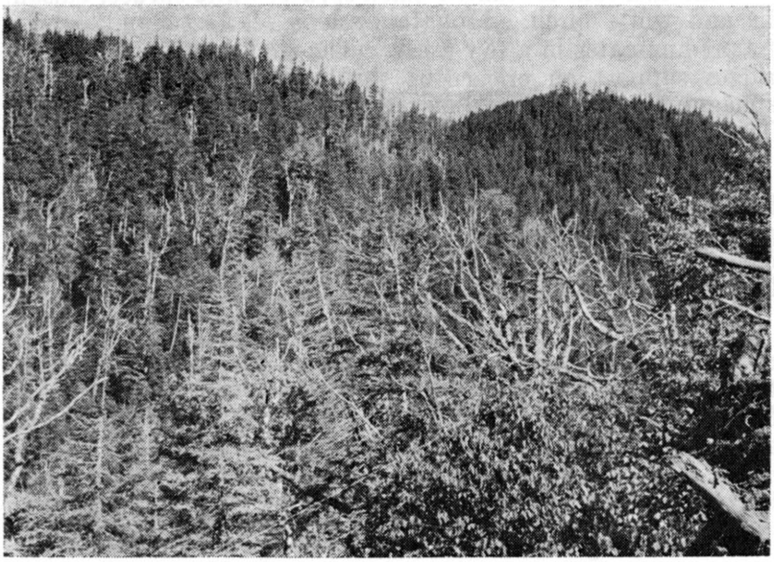

Fig. 25. Balsam fir, white birch and yellow birch on a slope, Cape Breton Highlands District, Gaspé-Cape Breton Ecoregion.

Spruce Taiga Zone

Short, dense spruce and fir alternates with shrub barrens and peat bogs on the flat central portion of the Cape Breton Plateau. The vegetation has been termed 'taiga' for its apparent similarity to Taiga described by Hustich (1949) in Quebec, and the northern taiga mapped by Alexin *etal.* (1957) in the Soviet Union*. Some features of the landscape suggest that the vegetation pattern is alpine. But there is such a similarity to the non-alpine forests of Quebec and Newfoundland that the Cape Breton Island component cannot be singled out. Some distinguishing characteristics are noted in the description of the single Ecoregion representing this zone in the Maritime Provinces.

11. **Cape Breton Plateau Ecoregion** (Cape Breton Plateau District)

Consists of the oval tableland forming the Cape Breton Plateau. The essentially stable association on the few deep, well-drained soils is stunted black spruce, white spruce, balsam fir and white birch. Mountain-ash is scattered and balsam fir predominates in a few areas. The shallow soils on the low ridges support an ericaceous shrub cover, while sedge and sphagnum bogs are found on seepage slopes and in depressions. The characteristic habit of the forest is illustrated in Figure 26.

Sheep laurel, rhodora, Labrador-tea and Schreber's moss figure most prominently in the lesser vegetation of the forested portions. The shrubs also form a dense cover on the exposed barrens, along with lichens and sphagnum. Roland (1944) lists a number of northern species found on the area.

Very little of the District is capable of an economic level of wood production, but a few sites are sufficiently sheltered to permit satisfactory height growth of spruce. Stunting from exposure to wind, as well as windthrow and crown breakage, limit the quantity of timber that can be grown on the better sites. Most of the latter are accessible from the Cape Breton Highland District.

Meteorological records from Burgeo, Newfoundland, where a comparable vegetation is reported, give an indication of the climate of the plateau. At Burgeo the June, July, August temperature is 53.3 degrees; the potential evapotranspiration of 17.8 inches almost equals the limit beyond which, according to Hare (1950), the climate is too severe for a closed forest.

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*These authors recognize a southerly closed-forest taiga in the Soviet Union, but do not equate the term to 'boreal' as suggested by Putnam (1952) and Wilde (1958).

Fig. 26. Dense black spruce and balsam fir on an upland site in the Cape Breton Plateau District.

The District is bounded by the 1,500-foot contour, depending on the local exposure. Other 1,500-foot uplands are found to the south, in the Cape Breton Highlands District, and if flat with dense stands and upland barrens, should be included. The soils are shallow sandy loams largely derived from the granite. Azonal soils include the shrub-covered bedrock and the peat bogs. Problems relating to poor drainage, and the presence of peat bogs on slopes create difficulties for logging.

SUMMARY

Objectives for a classification of forests to be useful in forestry practice are discussed. Forest site classification is recognized as the means for describing the forest environment on a local level and as the primary level of forest classification. It is therefore used as a basis for outlining large geographic areas within which site types support a relatively uniform ecological relationship and have a limited range in regional environment. The proposed classification is designed to divide the regional variation in vegetation and environment into a

system of segments to be shown in geographical units known as Ecoregions. These Ecoregions do not form continuous belts, but often consist of several widely scattered components. Smaller geographic units distinguished by locality and a local pattern of sites are called Site Districts. The Ecoregions are grouped into higher categories called Forest Zones, characterized by the predominating species in the stable forest.

Brief descriptions are given for the seven Forest Zones in the Maritime Provinces. Eleven Ecoregions, containing fifty-five Site Districts, are described. Extreme local variations in climate and tree distributions along the coasts and on the irregular uplands has contributed to the complexity of the subject.

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LIST OF COMMON AND SCIENTIFIC NAMES

Trees

Balsam fir.................. *Abies balsamea* (L.) Mill.
Basswood.................. *Tilia americana* L.
Beech...................... *Fagus grandifolia* Ehrh.
Black ash.................. *Fraxinus nigra* Marsh.
Black cherry............... *Prunus serotina* Ehrh.
Black spruce............... *Picea mariana* (Mill.) BSP.
Bur oak.................... *Quercus macrocarpa* Michx.
Butternut.................. *Juglans cinerea* L.
Eastern hemlock............ *Tsuga canadensis* (L.) Carr.
Heart-leaf birch............ *Betula cordifolia* Regel
Ironwood.................. *Ostrya virginiana* (Mill.) K. Koch
Jack pine.................. *Pinus banksiana* Lamb.
Mountain-ash.............. *Sorbus* L. (Spp.)
Norway spruce............. *Picea abies* (L.) Karst.
Pin cherry................. *Prunus pensylvanica* L.f.
Red maple................. *Acer rubrum* L.
Red oak................... *Quercus rubra* L.
Red pine.................. *Pinus resinosa* Ait.
Red spruce................ *Picea rubens* Sarg.
Silver maple............... *Acer saccharinum* L.
Sugar maple............... *Acer saccharum* Marsh.
Tamarack.................. *Larix laricina* (Du Roi) K. Koch
Trembling aspen............ *Populus tremuloides* Michx.
White ash.................. *Fraxinus americana* L.
White birch................ *Betula papyrifera* Marsh.
White cedar................ *Thuja occidentalis* L.
White elm.................. *Ulmus americana* L.
White pine................. *Pinus strobus* L.
White spruce............... *Picea glauca* (Moench) Voss
Wire birch................. *Betula populifolia* Marsh.
Yellow birch............... *Betula lutea* Michx. f.

Shrubs

Beaked hazel............... *Corylus cornuta* Marsh.
Bearberry.................. *Arctostaphylos uva-ursi* (L.) Spreng.

Shrubs (Cont'd.)

Black-crowberry	*Empetrum nigrum* L.
Black huckleberry	*Gaylussacia baccata* (Wang.) K. Koch
Blueberry	*Vaccinium* L. (Spp.)
Broom-crowberry	*Corema conradii* Torr.
Cowberry	*Vaccinium vitis-idaea* L. var. *minus* Lodd.
Greenbrier	*Smilax rotundifolia* L.
High-bush blueberry	*Vaccinium corymbosum* L.
Hobblebush	*Viburnum alnifolium* Marsh.
Inkberry	*Ilex glabra* (L.) Gray
Labrador-tea	*Ledum groenlandicum* Oeder
Mountain-holly	*Nemopanthus mucronata* Raf.
Mountain maple	*Acer spicatum* Lam.
Rhodora	*Rhododendron canadense* (L.) Torr.
Sheep laurel	*Kalmia angustifolia* L.
Speckled alder	*Alnus rugosa* (Du Roi) Spreng. var. *americana* (Regel) Fern.
Wintergreen	*Gaultheria procumbens* L.
Witch-hazel	*Hamamelis virginiana* L.
Witherod	*Viburnum cassinoides* L.

Mosses and Herbs

Bigleaf aster	*Aster macrophyllus* L.
Black raspberry	*Rubus occidentalis* L.
Bloodroot	*Sanguinaria canadensis* L.
Bracken	*Pteridium aquilinum* (L.) Kuhn var. *latiusculum* (Desv.) Underw.
Bristly clubmoss	*Lycopodium annotinum* L.
Bunchberry	*Cornus canadensis* L.
Buttercup	*Ranunculus* L. (Spp.)
Canada Maianthemum	*Mianthemum canadense* Desf.
Canada raspberry	*Rubus strigosus* Michx. var. *canadensis* (Richards.) House
Cloudberry	*Rubus chamaemorus* L.
Cucumber-root	*Medeola virginiana* L.
Dogtooth-violet	*Erythronium americanum* Ker
Dutchman's-breeches	*Dicentra cucullaria* (L.) Bernh.
Four-furrowed Enchanter's Nightshade	*Circaea quadrisulcata* (Maxim.) Franch. & Sav. var. *canadensis* (L.) Hara
Gold-thread	*Coptis groenlandica* (Oeder) Fern.
Goldie's fern	*Dryopteris goldiana* (Hook.) Gray
Maidenhair fern	*Adiantum pedatum* L.

Mosses and Herbs (Cont'd.)

Naked miterwort .... *Mitella nuda* L.
Schreber's moss .... *Pleurozium schreberi* (BSG.) Mitt.
Sedge .... *Carex* L.
Shining clubmoss .... *Lycopodium lucidulum* Michx.
Sphagnum .... *Sphagnum* Dill. (Spp.)
Spikenard .... *Aralia racemosa* L.
Spring-beauty .... *Claytonia caroliniana* Michx.
Sweet-cicely .... *Osmorhiza claytonii* (Michx.)
Wild ginger .... *Asarum canadense* L.
Wild red raspberry .... *Rubus strigosus* Michx.
Wood fern .... *Dryopterus spinulosa* (O.F. Muell.) Watt
Wood-sorrel .... *Oxalis montana* Raf.
Yellow violet .... *Viola pensylvanica* Michx. var. *leiocarpa* (Fern. & Weig.) Fern.
Zigzag smilacina .... *Smilacina racemosa* (L.) Desf.

GLOSSARY

Association—A recurring community of one or more tree species, occurring in combination.

Ecoregion—The geographic unit within which relationships between species and site are essentially similar, and within which silvicultural treatments may be expected to obtain comparable results; recognized by the characteristic species composition and development on the zonal site type.

Forest Classification—A systematic arrangement of forest land, or potential forest land, according to prescribed criteria; understood to exist simultaneously at different levels of abstraction as determined by the purpose and prerequisite criteria at each level.

Forest Zone—A group of ecoregions having affinities of dominant species composition.

Potential Evapotranspiration—The amount of water that will be lost from a land area covered with vegetation if there is adequate water in the soil at all times; an expression of atmospheric demand, regardless of whether the vegetation and supply of soil moisture are actually present.

Region—An area of any size throughout which accordant areal relationship between selected phenomena exists (Whittlesey, 1954).

Site District—A subdivision of the Ecoregion based on pattern of relief, drainage, or type of bedrock; may have ecological significance, but not by definition.

Site Type—A mappable unit consisting of the complex of physical and biological factors for an area which determine what forest or other vegetation it may carry (Br. Comm. For. Term. 1953), with the restriction that biological factors include only such aspects of plant and animal life as provide the physical requirements of the tree community.

Zonal Site Type—The site type exemplified by a well-drained, sandy-loam soil on a gentle mid-slope and characterized by the development of a zonal soil profile.