AN INVESTIGATION OF SOIL/VEGETATION RELATIONSHIPS IN SOUTHEASTERN MANITOBA

A Thesis

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by

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ABSTRACT

One of the main objectives of this work was to obtain a detailed description of forest vegetation on mineral soils in southeastern Manitoba, as little botanical information is available on this area. Because of the cooperation of the Manitoba Soil Survey in the field, correlations could be made between forest vegetation and soil type. This relationship between forest vegetation and soil type is significant in many aspects of forest management.

Accounts of climate, geology and soils are given, followed by a description of the forest vegetation. The important role of recurrent fires in the development of forest vegetation in southeastern Manitoba is emphasized. Early literature on the south-east is considered in order to compare the vegetation of nearly one hundred years ago with that of the present day.

Three very broad forest-soil types are recognised:

1. The coniferous, hardwood, and mixed stands on the Podzol and Grey Wooded Soils developed on sandy morainic till, dumed sand and glacial sandy outwash.
2. The coniferous, hardwood and mixed stands on the Eluviated Grey Wooded and Grey Wooded soils developed on glacial outwash or aeolian and lacustrine deposits over calcareous boulder till.
3. The hardwood stands on the Grey Wooded Soils and Degraded Blacks on calcareous boulder till or calcareous boulder till with[a] thin mantle of lacustrine sand or clay.

Each group has characteristic assemblages of species in the minor vegetation. These three groups can be subdivided according to drainage class. In the first group coniferous stands which are composed of jack pine (Pinus banksiana) for the most part with some red pine (Pinus resinosa) in places, are found on

the freely drained sites and a few imperfectly drained sites. The latter sites commonly support hardwood stands or mixed jack pine and hardwood. Aspen (Populus tremuloides), Balsam poplar (Populus balsamifera), and white birch (Betula papyrifera) are the commonest hardwoods in the area. In the second group jack pine forms pure stands in some sites but is usually found mixed with aspen or birch. Either of the latter species may form pure stands in these sites. There is an indication from the stands examined that the hardwood stands on the freely drained sites in this group would be succeeded by jack pine if left undisturbed for a sufficient length of time. Hardwood stands of aspen, birch, and balsam poplar are dominant on the soils of the third group. The early literature suggests that the red and white pines were more widespread a century ago. The red pine probably occurred with jack pine on the sandy soils and white pine (Pinus strobus) on the calcareous boulder till soils.

A brief consideration of indicator species points to a need for intensive studies before arriving at any definite conclusions on the interpretation of vegetation.

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CHAPTER I

Introduction

The history of the study of the vegetation of most countries has been a progression from reconnaissance, to primary survey, to intensive studies, and finally to experimentation and management. (Cain and Castro 1959). The aim of the reconnaissance survey is to obtain a general impression of the landscape and its vegetation cover. The primary survey, according to Tansley (1946), consists of recognising and describing the major plant associations, making lists of their floristic composition, studying their relationships, and recording their distribution on maps. Both the reconnaissance and primary surveys are extensive and general. Some questions can be answered at this level of investigation and many other problems are uncovered to be left for more intensive studies at a later date. An intensive survey generally deals with a smaller area than the primary survey and the studies tend to be detailed and concerned with particular problems instead of general ones. The reasons for these different types of survey may be purely scientific, as in the promotion of ecological understanding, or they may be economic as in the surveying of woodland for the volume of its forest products. The scientific description of vegetation in Canada is far from complete and consequently ecological investigations have not, for the most part, progressed beyond the level of the primary survey.

This project is at the primary survey level. The area chosen was south-eastern Manitoba and the objectives were to obtain a detailed description of forest vegetation on the mineral soils there and, where possible, to relate the observed distribution of vegetation to soil, physiography and history. South-

eastern Manitoba, as considered here, is that area comprising Townships one to six, Ranges nine to seventeen East of the Principal Meridian. (In the remainder of the thesis Township is abbreviated to T, Range to R, and East of the Principal Meridian to E.P.M.). This region lies within the South-eastern Forest Section of the Manitoba Forest Service and has been surveyed in connection with the latest Forest Inventory of Manitoba (Gill 1956). However, no detailed botanical work has been done in this part of the province apart from an account of the minor vegetation in the pine forests (Ritchie 1959). The area of study is included in the proposed Piney map sheet of the Manitoba Soil Survey and, by the cooperation of the survey in the field, possible correlations between vegetation cover and recognised soil types could be investigated. This relationship between forest types and soil types has a high economic value in many aspects of forest management. Once these correlations have been established for a particular region, a soil survey and map could afford the basis for estimating the areas of potential forest types and their productive capacities.

A literature review completes the introductory chapter. The rest of the work is arranged into three main chapters: an account of the most important environmental factors, a description of the forest vegetation and a consideration of soil/vegetation relationships.

Literature Review

EARLY LITERATURE ON THE VEGETATION OF SOUTHEASTERN MANITOBA

One of the earliest descriptions of the south-east is found in the story of Sanford Fleming's trip across Canada in 1872 (Grant 1873). The first twenty miles of the route from the North-west Angle to Oak Point is described as flat and marshy with dense forests of scrub pine (jack pine), spruce, tamarack, and

here and there aspen and white birch.

R.S. Kelly (1873) who made the first timber cruise in the south-east describes the country as nothing but muskegs and "brules" with the exception of a few ridges. His course was along the Seine River to the vicinity of Marchand, south to Bedford, then to near Woodridge, then to the hills north of Carrick and south to the hills which make a semicircle west, north, and east of Piney.

The locations of Marchand, Bedford, Woodridge, Carrick and Piney can be seen in Figure 1. They are represented by the letters, M, B, W,C and P respectively. The additional letters, MR, BA, W , V, S, SJ, StL and SU represent the Marchand Ranger Station, Badger, Wampum, Vassar, Sandilands, South Junction, St. Labre and Sundown respectively.

On his return north he came out on the Dawson Road near where it crosses the Whitemouth river. He found jack pine on the dry ridges everywhere from La Broquerie south-east and red pine when he reached the hills north-west of Piney. White pine was first encountered on the better soils near Piney.

In a description of the County of Carillon (T4-6 R3-17 EPH) Dr. G.M. Dawson (1893) mentions the presence of red pine, Banksian or scrub pine, and white pine on dry ground, and tamarack and cedar in the swamps. "All the ordinary eastern spruces and firs" are also reported to be present. "Of deciduous trees, the poplar is most common, and generally represented by the aspen or balsam poplar, willows of many species form thickets in the swamps and along the edge of woods. Elm, oak, birch and the ash-leaved maple also occur sparingly". In a description of the county of Manchester (T1-3 R1-17 EPM, R1-2 WPM) mention is made of a large quantity of red pine which had been cut in recent years on the dry ridges near Pine Creek which runs into Roseau Lake from the north. The timber cut on Pine Creek was floated into Roseau Lake, and thence

by the West Roseau river to the Red river.

There was a heavy demand for lumber in the latter part of the nineteenth century as settlement in the Red River valley rapidly proceeded. Red and white pine logs were in greatest demand but probably white spruce, cedar and jack pine were also cut. The Sprague lumber company cut timber at Moose Lake following a disastrous forest fire in that vicinity in 1891 and the cut is believed to have been largely white and red pine, although it is likely that white spruce would also be cut. (C.B. Gill 1956).

As even these early reports mention extensive fire damage, it is uncertain what the climax vegetation might be. It is evident that the red and white pines were more abundant in the latter part of the nineteenth century but there is no indication that they were ever dominant on the well drained soils. According to Pelly's report (1873) red pine had no greater range in 1873 than it has now but white pine may have extended westward to range 12. At present its western outlier is in T3 R15 EPM.

LITERATURE ON SOIL/VEGETATION RELATIONSHIPS

Relationships between soils and forest vegetation have been known for a long time to North Americans. The early settlers in the Lake States region, for example, regarded "white pine soils" as fair pasture, "Norway pine soils" as mediocre fields, and "jack pine soils" as soils unsuited for agricultural use. (Mayr 1890). Since early observations such as these it has been discovered that soil influences are further complicated by other factors particularly climate and the dynamics of forest vegetation. Under different climatic conditions vegetation on soils of similar parent material, texture, drainage and nutrient content may vary greatly. The relationship between soil and vegetation, particularly in areas suffering recurrent disturbances, involves not only the existing

forest cover but the entire succession cycle from pioneer to climax types. (Wilde 1958).

In the literature, forest/soil relationships have been treated mainly from a dynamic point of view and several examples of succession on different soil types in neighbouring regions of the United States and Ontario can be cited. These relationships however may vary from place to place because of different climatic conditions, and may bear little resemblance to those in southeastern Manitoba. Alway and McMiller (1933) found, on the sandy soils of an island in a northern Minnesota lake, four different forest types: jack pine, Norway pine, white pine and maple-basswood. In the surrounding region the maple-basswood and white pine types are found on the heavier drouth-resistant, productive soils whereas the Norway pine and jack pine are characteristic of the deep sands, the most unproductive soils of the region. The occurrence of the maple-basswood type along with the Norway and jack pine forest types is explained in terms of a maple-basswood upland forest climax in the region, even on such sandy soils. The succession as traced by Kittredge (1934) is from a jack pine forest type, through a Norway pine then White pine type to the maple-basswood forest. The maple-basswood is believed to be present on the sandy soils of the island because of protection from fires for a sufficient length of time.

In parts of northern Minnesota jack and red pine are replaced by a fir-spruce-birch community in natural succession (Buell and Niering 1957).

The Abies-Tilia forest in Itasca county, Minnesota is considered the climax forest of the area but is local being largely confined to heavy clay soils. On the sandy drift there is an edaphic climax of Norway and White pines or jack pines. (Grant 1934).

In northern Lower Michigan the succession is from aspen to Acer-Fagus

on the better upland soils, to white and red pines on the poorer sandier soils, and to Abies, Thuja and Picea on the lowland and bog soils. (Gates 1930).

The course of succession on the clay and sandy clay soils in the Upper Peninsula of Michigan has also been traced. The pioneer aspen is replaced by white pine, yellow birch, hemlock and sugar maple. A latter decline in white pine leaves a mixed hardwood-hemlock forest (Graham 1941).

On the podzols and brown podzolic soils of Algonquin Park, Ontario, three pioneer types are recognised by Martin (1959). They are the Betula papyrifera-Populus forest, the Acer rubrum - Betula papyrifera forest and the Pinus banksiana forest. The two former are replaced by an Abies-Picea glauca forest and the latter by Pinus strobus. These in turn are succeeded by a mixed hardwood forest of Acer saccharum, Betula lutea and Fagus grandifolia. This is dominant until replaced by Tsuga canadensis and Thuja occidentalis.

In these neighbouring States and in Ontario, therefore, aspen, birch, jack pine and even the red and white pines are all regarded as merely seral stages in the succession to a climax type which varies from region to region. Often, however, the hypothetical climax is never reached because of local conditions such as recurrent fires.

CHAPTER II

ENVIRONMENTAL FACTORS CONSIDERED

Climate

Climatic data (Atlas of Canada 1957) for southeastern Manitoba, the Port Arthur area (Great Lakes - St. Lawrence Forest), the extreme south-west of Manitoba (Grassland) and The Pas (Boreal Forest) are compared in summary form below.

Comparison of Climatic Data for Southeastern Manitoba and Neighbouring Regions

	Port Arthur	Southeastern Manitoba	Southwestern Manitoba	The Pas
Mean total annual * precipitation (ins.)	26 - 28	20 - 22	16 - 20	16 - 18
Growing season precipitation (ins.)	12 - 15	12 - 15	9 - 15	9 - 12
Length of growing season (days)	160-200	160-200	160-200	140-200
Mean annual maximum temperature (°F.)	90 - 95	90 - 95	95 - 100	90 - 95
Mean annual minimum temperature (°F.)	-30- -40	-40- -50	-20- -60	-40 - -50

The south-east has a higher mean total annual precipitation than the grassland to the west and boreal forest to the north but has a lower precipitation than the Port Arthur region which is well within the western boundary of the Great Lakes - St. Lawrence Forest. This forest region reaches its western limits in southeastern Manitoba (Rowe 1959). The boreal forest has the shortest growing season and the grassland the greatest temperature extremes. The mean annual minimum temperature of the Port Arthur region is the highest of the four regions.

*All values are given as ranges.

The normal mean daily maximum temperatures (Connor 1959) of various points in Manitoba representing the south-east, the southwestern grassland area, and the boreal forest respectively are given as follows:

°F

	May	June	July	August	September
Sprague	63.3	72.3	77.9	74.8	64.0
Winnipeg	65.2	73.6	79.3	76.9	65.9
The Pas	59.7	70.0	75.4	72.1	60.7

Temperatures are consistently the highest in the grassland region and lowest in the boreal forest throughout the summer months.

The Thornthwaite method of using meteorological statistics to arrive at a knowledge of real factors in climate has been used by Sanderson (1948) in connection with climatic elements in Canada. As a result of this work southeastern Manitoba appears to occupy an important position with respect to the moisture regions of Canada. These regions are based on the relation of water deficiency to water surplus and their limits appear as north-south lines. Water surplus is defined as the result of precipitation in excess of need after the soil moisture has been replenished. The water need is the amount of moisture that would be transferred from the surface of the earth to the atmosphere if it were available. The most important boundary is the 0 isopleth which divides areas of predominant water surplus from those of predominant water deficiency. It extends from southeastern Manitoba, where it corresponds roughly to the eastern boundary of the study area, north to the Arctic ocean. To the east of the line the climates

are moist and to the west, as far as the Rockies, they are dry.

The south-east has a lower average annual water deficiency (2 - 4") than south-central and south-west Manitoba (4 - 6") and a higher average annual water surplus (2 - 4") than the western areas (0 - 2"). The computed water surplus for Sprague is given as 2.1". East of the Manitoba - Ontario border there is a water deficiency of less than 2" and a water surplus which gradually increases from 4" in western Ontario to 50" in the Maritimes.

The climate of southeastern Manitoba is microthermal, moist subhumid according to Thornthwaite's classification.

Geology

The solid rocks, which are overlain by Pleistocene and recent deposits, consist of Pre-cambrian formations to the east and Ordovician to the west with an unconformable contact buried beneath heavy drift deposits along a line running approximately through Sprague and Nadeshville (C.B. Gill 1956). This underlying rock however has little effect on the soils of the district which are practically all derived from superficial deposits.

Most of the following information on Pleistocene deposits is taken from the work of W.A. Johnston (1921, 1946). The surface geology of southeastern Manitoba has been complicated by the differential deposition of material by two glacial ice sheets and by the reworking of the surface deposits by the waters of glacial Lake Agassiz I and II. During the Wisconsin period the Keewatin ice sheet advanced into southeastern Manitoba from the north-west depositing calcareous clay loam to clay till containing boulders and fragments of limestone and dolomitic rocks. Calcareous till is found south of the Sandilands Forest Reserve in the Sundown, Piney, Sprague and Middleboro districts. The lobe of ice which

moved in from the north-east, on the other hand, deposited a siliceous sandy till containing Pre-cambrain rock fragments. The high land running from north of the Marchand Ranger Station south-west to Bedford and then south-east to South Junction in the form of an arc, appears as an end moraine formed by this ice lobe. These sandy morainic deposits are modified by wind action in places to form dunad areas. According to Elson (1957) the drift from the north-west is early Kankato and that from the north-east, late Kankato and Valders.

These drift deposits were reworked by the waters of glacial lake Agassis during two successive periods of inundation. The lake, which was formed in front of the ice sheet, extended, in its early stages, east to Rainy Lake and passed to the south of Red Lake in Minnesota. A series of bench deposits of sand and gravel marks the shore lines of Lake Agassis at different stages of its existence. The higher land in the Bedford Hills area which is the only part of the south-east that appears not to have been covered by the lake is surrounded by a series of these beaches. There are four series of beaches connected with the southward outflow of Lake Agassis: the Herman, Norcross, Tintah and Campbell beaches, named from the highest to the lowest. Of these, the Campbell beach is the best developed and is nearly continuous round the upland area in southeastern Manitoba. The highest beach near Woodridge has an elevation of 1250 feet. It is 125 feet above the level of the Campbell beach in the vicinity, and is probably the highest Norcross beach.

East and south of the Bedford Hills area are terraces of water worked till which may be calcareous or mixed. In many places the calcareous till is overlain by a mantle of sandy outwash from the Bedford Hills.

As a result of this complicated geological history the soils of southeastern Manitoba are highly varied.

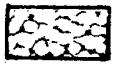
L E G E N D

Recent Deposits

Unconsolidated Rocks upon which soils are developed

Soils

Muck and peat 

Dune sand 

Alluvial sand and silt 

Symbol

Hay marsh 

Pleistocene Deposits

Unconsolidated Rocks upon which soils are developed

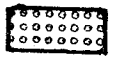
Beach sand and gravel

Lacustrine sand, silt and clay (includes some alluvial, flood plain deposits)

Glacial till or boulder clay and outwash sand and gravel

Soils


Gravelly sand and coarse sand.


Fine sand and sandy loam.


Sandy loam.


Clay loam and clay.


Fine sandy loam.


Stony loam


Fine sand and sandy loam.

Figure 1. Surface Deposits in Southeastern Manitoba (T1-6, R9-13 E.P.M. and adjacent parts of T6 and R14)

(After W.A. Johnston 1921)

Soils

Only those soils on which the vegetation was examined are included in this account. This omits the organic deposits and a large number of the gleisolic soils which are widespread in the region. The superficial deposits from which the soils are derived have been described above. For the purposes of description the soils are divided into three broad groups on the basis of parent material. They are as follows:

1. The podsol and grey wooded soils developed on sandy morainic till, dumed sand, and glacial sandy outwash.
2. The Miseque grey wooded soils and grey wooded soils on glacial outwash, aeolian and lacustrine deposits over calcareous boulder till.
3. The grey wooded soils and degraded blacks on calcareous boulder till or calcareous boulder till with thin mantle of lacustrine sand or clay.

1. Sandilands Series.

This soil is described as a minimal podsol developed on fine to coarse siliceous sandy morainic till which has been affected by wind and wave action. The topography may be level or undulating. The soil which is excessively to well drained is characterised by the absence of conspicuous horizon development. Complete profile descriptions of the Sandilands series and the Dumed Phase of Sandilands are given in the appendix.

All profile descriptions and photographs given in the appendix are those of the Manitoba Soil Survey. The photographs are of typical profiles within the series but only in the Vassar series are the photograph and the description of the same profile.

Further information on these soils must await the publication of the Soil Survey Report of the Piney area.

Lancaand Series.

This soil is a gleyed podzol developed on the same parent material as the Sandilands series. The profile is imperfectly drained, the impeded internal drainage being due to topographical position and the presence of a fluctuating water table. The topography is level to gently sloping. The soil is characterised by distinct horizon differentiation. The Ae and B horizons are strongly mottled with iron concretions. The profile description in the appendix is representative of the series.

Woodridge Series.

This is a grey wooded soil developed on a thin deposit of siliceous fine to coarse sand over calcareous coarse sandy to gravelly beach and outwash deposits. The profile is well to somewhat excessively drained with little or no surface runoff but extremely rapid internal percolation. The topographical position occupied by this soil is that of very gently sloping beach ridges. This profile differs from an orthic grey wooded soil in that the leached horizon may have been subjected to podzolisation processes. A sesquioxide horizon appears to merge with the B2 horizon. The description in the appendix is typical of this series.

Birch Hill Series.

This is an orthic grey wooded soil developed on coarse sandy to gravelly beach and outwash deposits. The profile is well to excessively drained. The topography associated with this soil is that of variable sized beach ridges to irregular very gently sloping hillocks. The profile described in the appendix is typical of the series.

Sirko Series.

This is a gleyed grey wooded soil developed on the same parent material as

that of the Birds Hill series. The profile is imperfectly drained due to position and the occurrence of a high water table. The topography is level to very gently sloping. A profile description is given in the appendix.

Pine Ridge Series.

This is an orthic grey wooded soil developed on slightly to moderately calcareous very fine to coarse sand which may contain thin lenses of coarse sand and gravel. The profile is well to somewhat excessively drained. The topography is gently sloping. A typical profile is described in the appendix.

Winterrosen Series.

This is a gleyed Grey Wooded soil developed on the same parent material as the Pine Ridge series. The profile is imperfectly drained due to slow runoff and impeded internal drainage. The topography is level to irregular, very gently sloping. There is no profile description available at present but a few general remarks are given in the appendix.

2. The Grey Wooded soils in which the Ae horizon has been subjected to podsolisation processes are referred to here as Bisequa Grey Wooded soils. There are two leached horizons in these profiles: that of the grey wooded sequence, and that of the podzol sequence. There are also two illuviated horizons: the zone of iron accumulation of the podzol, and the zone of clay accumulation of the grey wooded soil.

Reynham Series.

This is a Bisequa Grey Wooded soil developed on shallow sandy outwash (12 - 30" thick) over calcareous boulder till. A podzol solum generally less than 12" thick occurs in the Ae horizon of the Grey Wooded soil developed on this material.

The complete profile is well drained. This soil is found in irregular gently sloping areas. A typical profile is described in the appendix.

Vassar Series

This is a Bisequa Grey Wooded soil developed on sandy outwash (12 - 30" thick) over slightly to moderately calcareous lacustrine clay, clay textured till or varved clay to fine sand. A Podzol solum generally less than 12" thick occurs in the Ae horizon of the Grey Wooded soil developed on this material. The profile is well to somewhat excessively drained with little or no surface run-off and rapid to moderately slow internal drainage. The topography is level to irregular very gently sloping. The profile description is given in the appendix.

Moose Lake Series.

This is a bisequa grey wooded soil developed on aeolian and lacustrine very fine sand to silty clay loam calcareous stratified sediments. The profile is moderately well to well drained. The topography associated with this soil is irregularly level to irregularly very gently sloping. The profile description in the appendix is typical for the series.

Birch Point Series.

This is an Orthic Grey Wooded soil developed on the same parent material as the Moose Lake series. The profile is moderately well to well drained. The topography is smooth level to irregularly very gently sloping. No profile description is available at present.

Hungarian Series.

This is a Gleyed Grey Wooded soil developed on the same parent material as the Moose Lake and Birch Point series. The profile is imperfectly drained. The topography is similar to that of the Birch Point series. No profile description

is available but a few remarks are given in the appendix.

3. Carrick Series.

This is an Orthic Grey Wooded soil developed on strongly calcareous sandy loam to silty clay boulder till and water-worked boulder till. A very thin mantle (0 - 6") of lacustrine sand to clay may occur above the water-worked till. The profile is well drained with moderate surface run-off and moderate internal percolation. The topography is irregular very gently to irregular gently sloping. A typical profile is described in the appendix.

Piney Series.

This is a Gleyed Grey Wooded soil developed on the same parent material as the Carrick series. The profile is imperfectly drained due to slow surface run - off and slow internal percolation. The topography is irregular level to very gently sloping. The profile description in the appendix is typical of the series.

Acland Series.

This is a gleyed degraded black soil developed on the same parent material as the Carrick and Piney series. The profile is imperfectly drained. The topography associated with this soil is irregular level to depressional. No profile description is available but a few general observations are given in the appendix.

Brokenhead Series.

This is a Gleyed Grey Wooded soil developed on a thin deposit of slightly to moderately calcareous lacustrine clay over strongly calcareous boulder till. The profile is imperfectly drained due to slow surface run-off and slow internal percolation. The topography associated with this series is irregular level to irregular

very gently sloping. No profile description is available for this series but a few general remarks are given in the appendix.

Pine Valley Series.

This is a gleyed degraded black developed on a shallow deposit of slightly to moderately calcareous clay which may have a boulder till substrate within 30 inches of the surface. The profile is imperfectly drained due to slow surface run-off and slow internal percolation. The topography is smooth level to irregular very gently sloping. A few general remarks about the profile are given in the appendix.

Malonton Series.

This soil is a peaty meadow developed on slightly to moderately calcareous very fine to coarse sand. The profile is poorly to very poorly drained. The topography is depressional to level.

This series is characterized by a dark coloured Ah horizon generally more than 3 inches thick which grades into dull coloured gleyed horizons that usually contain accumulated calcium carbonates. The Ah horizon will generally effervesce with dilute HCl. (The Malonton series should have been included in group 1.)

CHAPTER III

VEGETATION

Brief General Description of the Area in Relation to the Forest Regions of Manitoba

The south-east corner of Manitoba lies within the Great Lakes - St. Lawrence Forest Region of Canada, (Rowe 1959). This Region reaches its western limits in southeastern Manitoba where there is a considerable intermixture of species from the Boreal Forest which lies to the north and east. Many of these boreal species have spread due to recurrent fires and felling. It can be seen from Figure 2 that the area of study, which is represented by the blue patch, also includes part of the narrow strip of Boreal forest to the east. The area of study as a whole therefore, can be said to have strong boreal affinities.

The Great Lakes - St. Lawrence Forest is described as being of a very mixed nature, characterised by white and red pine (*Pinus strobus*, *P. resinosa*), eastern hemlock (*Tsuga canadensis*) and yellow birch (*Betula lutea*). The two latter species are not present in Manitoba and the red and white pines occur to a very limited extent at the present day. Fires and logging have favoured the development of jack pine, (*Pinus banksiana*), on the dry sandy soils of the south-east. Aspen (*Populus tremuloides*), Balsam poplar (*Populus balsamifera*) and Paper birch (*Betula papyrifera*) occur throughout the area on a variety of soils.

Much of the south-east is low lying poorly drained country covered with deep organic deposits, the drier parts of which have a dense forest cover of

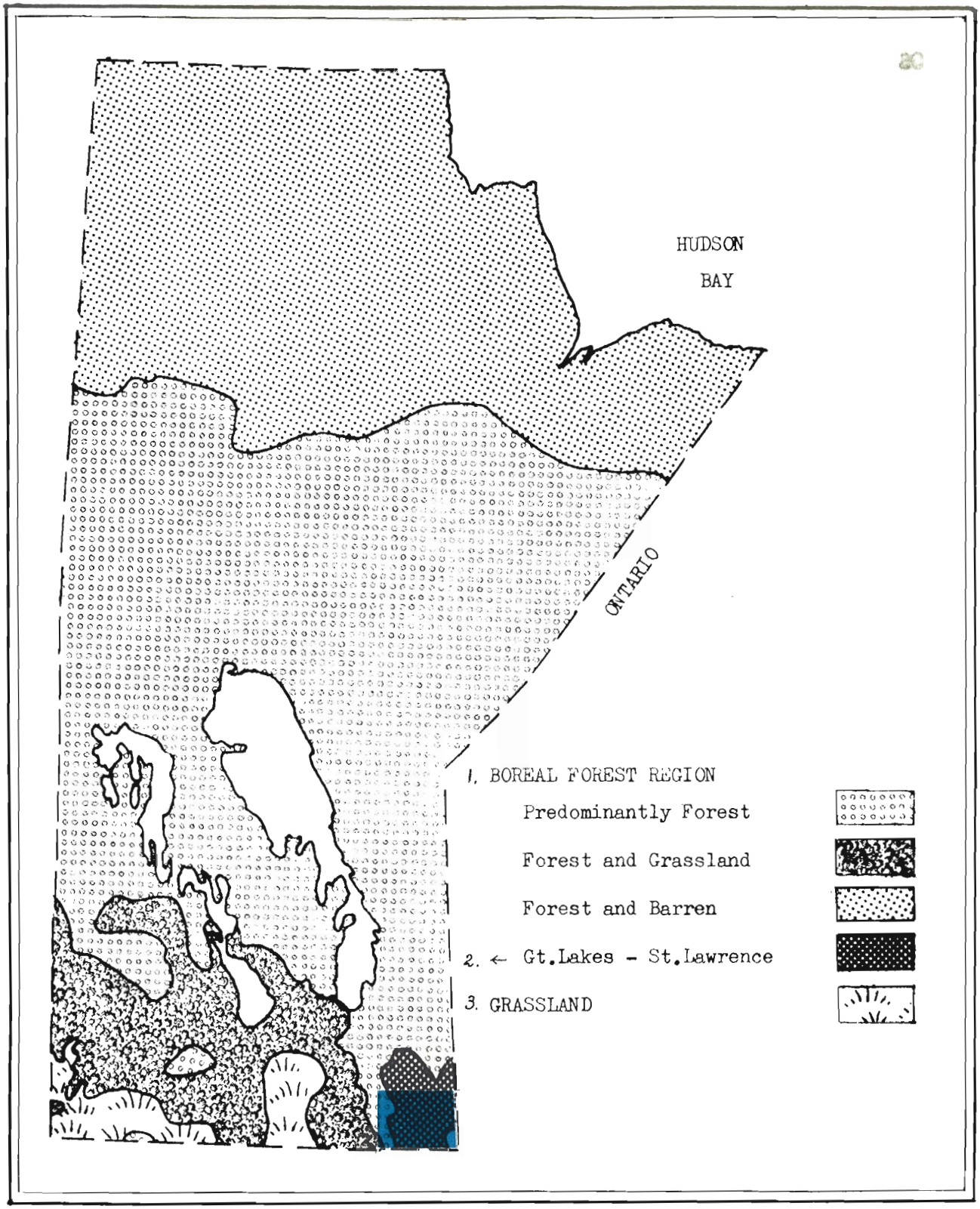


FIGURE 2. Study Area in Relation to Forest Regions of Manitoba.

black spruce (Picea mariana) with tamarack (Larix laricina) and cedar (Thuja occidentalis) in places. The wettest areas support only a fen type of vegetation. Thickets of willow (Salix sp.) and Alder (Alnus rugosa) are also common. No work was done on these areas because of their inaccessibility.

Several tree species are present in the south-east which are not usually found growing naturally elsewhere in Manitoba. Notable examples are Pinus strobus, Pinus resinosa, and Thuja occidentalis. The two latter species have a few isolated outliers elsewhere in Manitoba. The following photographs illustrate different forest types in Southeastern Manitoba.

Field Procedure

The forest stands selected for examination were those on the most commonly occurring mineral soils of southeastern Manitoba. As far as possible only the maturer stands relatively free from recent disturbances were chosen. Suitable sites were located with the help of aerial photographs and soil maps, and a representative area, 100 feet x 100 feet, within a uniform stand was marked out for closer study. Over fifty such plots, scattered throughout the townships being mapped by the Soil Survey, were examined during the course of the summer. The locations of these plots are indicated by dots on the map in Figure 9. Of these plots nineteen had jack pine as the dominant tree, twenty-two had aspen and three had birch while the others supported mixed stands. Twenty-five metre quadrats were placed haphazardly within the plot and within each quadrat the presence of every species was noted and assigned a number on the Braun-Blanquet (1932) cover-abundance scale:

X - sparsely or very sparsely present, cover very small.

1 - plentiful but of small cover value

Figure 3. Stand of Jack Pine on dry sandy soil.

Figure 4. Solitary Red Pine with dense stands of Jack Pine in background on dry sand.

Figure 5. Black Spruce Bog.

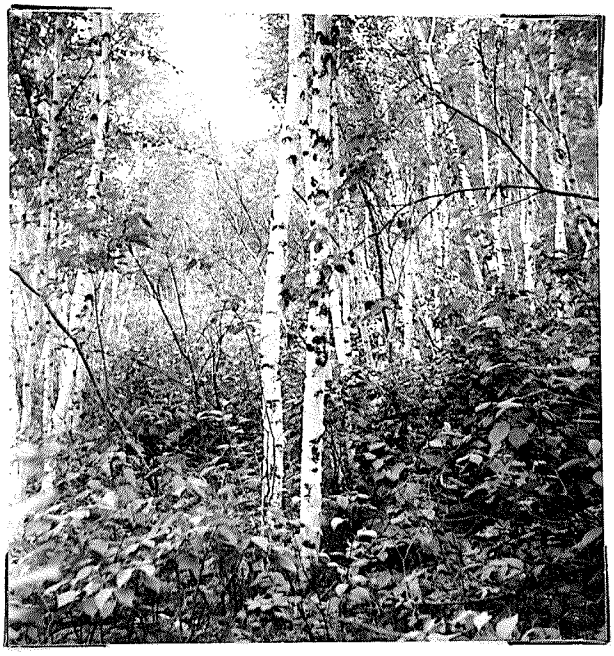


Figure 6. Stand of Birch with understory of Corylus Cornuta on fine sandy slope.

Figure 7. Aspen on calcareous boulder till soil.

Figure 8. Balsam Poplar and Aspen on calcareous boulder till soil.

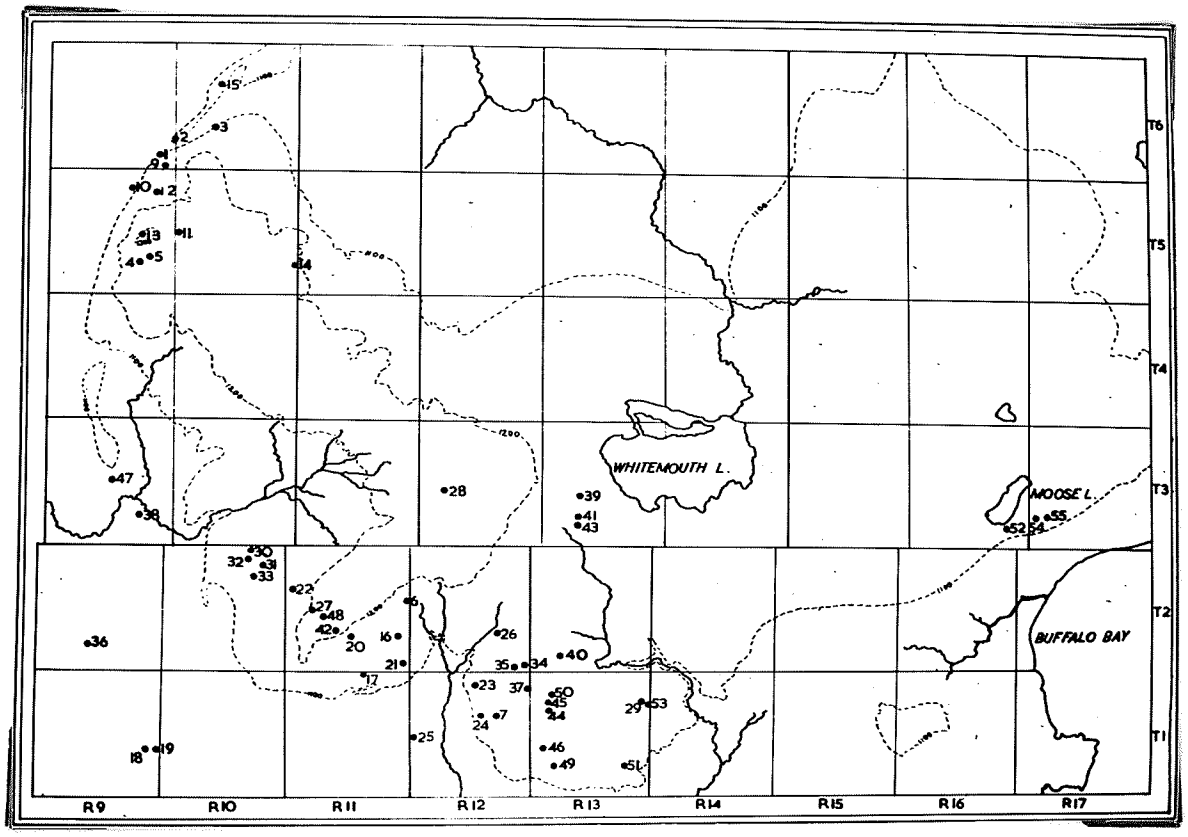


Figure 9. Location of Plots in Southeastern Manitoba

2 - very numerous, or covering at least 1/20 of the area.

3 - any number of individuals covering 1/20 of the area.

4 - any number of individuals covering 1/2 to 3/4 of the area.

5 - covering more than 3/4 of the area.

The percentage presence or frequency of every species in each of the plots was also estimated. Cores were taken using an increment borer from six trees in each plot to determine ages. Thirty diameters at breast height were measured at random and the height of the stand was estimated visually. Since the counting of all trees in a plot proved difficult and time consuming the density was estimated in each of four bands running lengthwise and breadthwise across the plot and an average of the four was taken. The width of the band was 6 1/2', measured by holding a metre stick out to either side of oneself. The number of tree trunks hit by the sticks were counted, the sticks being folded back when necessary to pass between trees, (Phillips 1959). Photographs were taken of the vegetation. The soil information was obtained from soil pits dug within the plots.

Description of Forest Vegetation

Here the plots are grouped together for the purpose of straightforward description according to the dominant tree. It is evident however that this is not the best possible classification as there are differences in minor vegetation within any the jack pine stands, and similarities in minor vegetation between some of the jack pine and some of the aspen stands. A better classification is proposed in the next chapter where soil is also taken into account.

JACK PINE PLOTS

Ten plots are located on the Sandilands series, a minimal podzol develo-

ped on siliceous fine to coarse sand, which is widespread in the Sandilands Forest Reserve. The topography is level to undulating. The locations are shown in Figure 9 by the dots numbered 3, 4, 5, 11, 12, 13, 29, 35, 26 and 53. The last two, 26 and 53, representing the duned phase of Sandilands, can be separated from the others as somewhat drier, more exposed sites.

In all plots jack pine forms pure stands except for plot number 12 which has the occasional aspen present. The tree data are presented in Table I.

TABLE I

TREE DATA FOR SANDILANDS SERIES

Plot No.	Age (years)	Diameter* (inches)	Basal Area (square inches)	Density (no./plot)	Height (feet)
3	53	5.5	29.2	235	50 - 60
5	45	7.0	31.2	112	40 - 60
11	44	4.4	12.6	262	30 - 40
29	60	6.4	35.3	202	40 - 60
35	48	6.1	35.3	176	40 - 50
4	54	6.6	33.2	172	50 - 60
12	40	5.8	20.4	160	40 - 45
26	66	6.7	23.8	206	30 - 40
53	63	7.6	35.2	109	40 - 45

The average age of the trees is around fifty years with just a few reaching an age of more than eighty years. No stands with an average age of less than forty years were examined. Very little correlation was noted between age and diameter, the diameters ranging from 3" to 9.5" with an average of about 6". The average basal area, estimated by converting the diameters of thirty trees

* Calculated from the six trees whose ages were determined.

in each of ten plots, is 29 sq.in., with a range of 12.6 sq.in. to 35.3 sq.in. The trees vary in density from 109 to 262 trees/plot with an average of 185 trees/plot. The heights of the trees are, in general, between 30' and 60', the shortest trees being found in the dumed sites.

The subordinate vegetation can be grouped into several distinct strata and will be described accordingly:

1. Tall shrubs
2. Short shrubs (< 3 feet)
3. Tall herbs and grasses (> 4 inches)
4. Low herbs and prostrate shrubs

Within category 1 are those shrubs which are normally three feet or more in height, e.g. Prunus virginiana. Short shrubs are those which are usually considerably less than three feet, e.g. Vaccinium angustifolium. Prostrate shrubs such as Arctostaphylos uva-ursi are separated off in category 4 with herbs less than 4 inches in height. Grasses and herbs not included in 4 are placed in category 3. The nomenclature of the higher plants is that of Scoggan (1957). Where there is only one variety name to a species it will be given the first time the species is mentioned and thereafter omitted.

The following description does not include the two dumed sites, 26 and 53, which will be described separately. The tall shrubs Rosa acicularis, Amelanchier, sp., and Prunus virginiana are present in all plots usually forming a dense cover. Prunus pennsylvanica is frequent. Apart from Corylus cornuta which is only sparsely present in two plots, no other tall shrubs are present. Of the short shrubs Vaccinium angustifolium is most abundant, occurring in all ten plots and forming a dense cover in most cases. Prunus pumila and Symphoricarpos albus are frequent. Juniperus communis, Cornothus ovatus, Vaccinium myrtilloides, Spiraea alba and Amorpha canescens are occasionally present. The most commonly occuring taller herbs are Apocynum androsaemifolium, Lithosper-

stunted. Prunus pumila and rather stunted Vaccinium angustifolium are frequent. Although not present in the two plots described, Hudsonia tomentosa was seen growing well on such sites elsewhere. The occasional Apocynum androsaemifolium, Solidago hispida, Melampyrum lineare and Campanula rotundifolia is encountered. Festuca ovina var. saximontana and Agrostis scabra are quite common. Arctostaphylon is common but has little cover value. Gaultheria procumbens is the only other plant in this category occurring in both plots. Of the mosses, Polytrichum spp., and Cerratodon purpureum are the most abundant. The lichen Peltigera canina is common in both plots. In plot 26 the ground is densely covered with species of Cladonia and where there are gaps in the forest it forms a dense carpet to the exclusion of everything else except a few grasses. In plot 53 there is very little Cladonia present, more than 75% of the ground being covered with pine needles. It is possible that the Cladonia was killed in a fire which left its mark on the tree trunks at and below the level of the needle litter.

The height and density of the shrub stratum in the jack pine stands described vary considerably as can be seen from Figures 10, 11, 12 and 13. At one extreme there are the duned sites with an almost complete absence of shrubs and at the other, plot 35 with a tall, fairly dense shrub layer.

Table II gives species composition and some quantitative data for the plots which have been discussed.

Jack pine stands, very similar floristically to those described on the Sandilands series, are found on the Woodridge series, a grey wooded soil developed on siliceous medium to coarse sand over calcareous coarse sand or gravel. Plots 1, 2 and 15 are located on this series at various points on the Campbell beach north of Marchand Ranger Station.

Tree data is given in Table III.

Figure 10. Jack pine with tall shrub stratum of Amelanchier sp. and Prunus pensylvanica in Plot 35.

Figure 11. Jack pine with Pteridium aquilinum in Plot 4

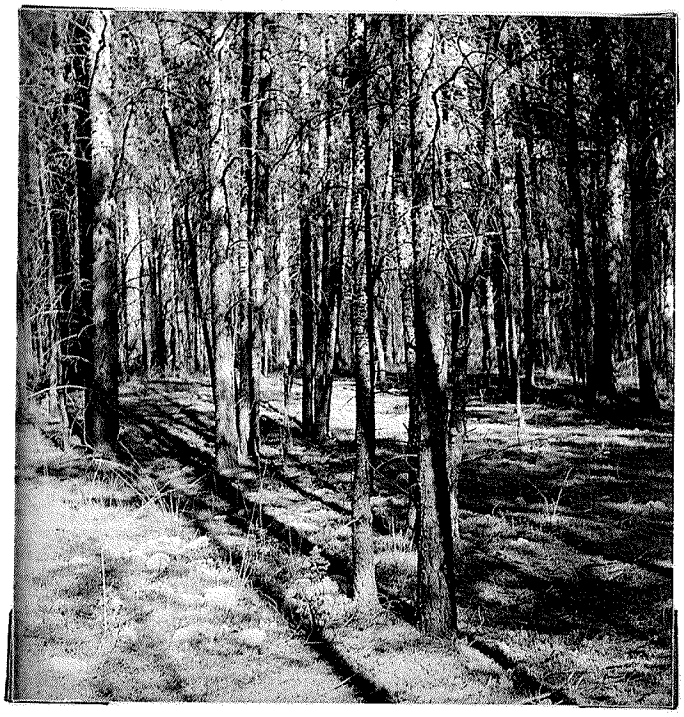


Figure 12. Jack pine with ground cover of *Cladonia* in Plot 26 on the Dunod Phase of the Sandlands Series.

Figure 13. Ground cover of lichens on the Dunod Phase of the Sandlands Series.

TABLE II

Frequency (F) and Cover/Abundance Data for Jack Pine

Plots on the Sandilands Series

Plot No.	3		5		11		29		13		35		4		12		26		53	
	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A
Rosa acicularis	84	3	88	3	40	2	36	1	16	+	60	2	56	2	4	+	4	+		
Amelanchier sp.	28	1	56	2	36	1	64	2	68	3	60	2	32	1	24	1			8	+
Prunus virginiana	68	2	68	2	36	1	36	1	12	+	5	+	24	1	20	1	4	+		
Prunus pensylvanica					20	1	8	+	32	2	85	3								
Corylus cornuta	16	+							4	+										
Vaccinium myrtifolium	100	3	80	3	92	3	84	3	100	4	95	3	64	2	84	2	24	1	84	2
Prunus pumila	12	+	36	2	20	1	16	+	24	1	20	1	20	1			28	1	32	1
Symphoricarpos albus	4	+	32	2	24	1	4	+			20	1	8	+						
Juniperus communis	20	1																		
Cornothus ovatus					8	+														
Vaccinium myrtilloides											5	+	4	+	8	+				
Spiraea alba					12	+														
Amorpha canescens			4	+																
Lithospermum canescens	16	1	28	1	40	2	48	2					20	1	24	1				
Solidago hispida	32	1			28	1	8	+	8	+	5	+	8	+			4	+	32	1
Apocynum androsaemifolium	24	1	16	+	12	+			4	+	45	+	8	+	8	+	8	+		
Campanula rotundifolia	44	2	8	+	8	+	4	+	32	1	5	+							4	+
Galium septentrionale	52	2	60	1	44	2			4	+	80	2								
Aster laevis	60	2							28	+	10	+	4	+	44	2				
Pteridium aquilinum			16	+			40	1	4	+			96	4	100	5				

cont'd

	3		5		11		29		13		35		4		12		26		35	
	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A
Melampyrum lineare			36	+	48	2	100	2			45	1	4	+					4	+
Lathyrus venosus	20	1											8	+	88	2				
Lathyrus ochroleucus	4	+	8	+																
Vicia americana	8	+									5	+								
Anemone patens	44	2			48	2			40	2										
Zizia aptera			20	1	8	+							4	+	8	+				
Equisetum hyemale var. affine					40	1									40	1				
Asclepias ovalifolia					4	+														
Heuchera richardsonii					4	+			4	+					4	+				
Senecio canus									4	+										
Liatris ligulistylis							4	+												
Salsoma stellata													20	1						
Oryzopsis asperifolia	96	3	96	3	92	3	100	3	96	3	60	3	80	2	100	4			4	+
Oryzopsis pungens	56	2	52	2	28	1	24	1	8	+			16	1	16	1			4	+
Andropogon gerardi	52	2	28	1	76	2														
Festuca ovina var. saximontana																	52	1	56	1
Agrostis scabra																	44	1	4	+
Arctostaphylos uva-ursi	100	4	72	2	100	4	92	4	88	3	5	+	4	+			52	2	16	+
Gaultheria procumbens	84	2	88	3			72	2	60	2	80	2	80	2	52	2	4	+	32	1
Melanthemum canadense	76	2	84	2	60	2	48	1	100	2	30	1	100	2	76	2			20	1
Antennaria spp.	40	1	8	+	52	2	32	1	36	1	10	2	12	+	4	+				
Anemone quinquefolia	88	2	64	2	72	2			72	2	15	+	76	2	100	2				
Fragaria virginiana	24	1			32	1					40	1								

cont'd

	3		5		11		29		13		35		4		12		26		35	
	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A
Linnaea borealis	28	1					25	1					20	1						
Chimaphila umbellata	12	+					12	+					8	+						
Potentilla tridentata											10	+	12	+						
Pyrola secunda	4	+	12	+			16	+					52	2						
Viola adunca	32	1	32	1	36	1			32	1			8	+	48	2				
Selaginella rupestris																	4	+		
Lycopodium obscurum											5	+								
Pleurozium schreberi	70	3	56	3			84	3	36	1	80	3	92	4	24	1	24	1		
Rhytidium rugosum	52	2	16	+			28	1	36	1			40	2			8	+		
Polytrichum spp.	8	+	4	+			20	1					4	+			32	1	48	1
Ptilium crista-castrensis							8	+							8	+				
Dicranodon purpureus																	48	+	20	1
Cladonia spp.	72	2	24	1	100	2	44	2	36	1							96	3	4	+
Peltigera canina									4	+							48	1	20	1

TABLE III

Tree Data for Plots on Woodridge Series

Plot No.	Age (years)	Diameter (inches)	Basal area (sq. ins.)	Density (no/plot)	Height (feet)
1	49	5.3	15.2	506	35 - 45
2	57	5.4	27.3	150	35 - 45
15	50	6.0	30.3	124	35 - 50

The jack pines which form pure stands in these plots are, on an average, about fifty years old. Again there is little correlation between age and diameter, the latter ranging from 3" to 10.5" with an average of nearly 6". The average basal area is 27.6 sq. ins. Density of trees ranges from about 100 to 500 trees per plot. In general, the trees along the length of this beach ridge are somewhat shorter than those of comparable ages on the Sandilands series and appear rather decadent in comparison. The pines here, as in some of the Sandilands sites, suffered considerable ice damage during the previous winter. Several badly bent trees can be seen in Figure 16 while others have the tops broken off.

The same three tall shrubs which are constantly present in the Sandilands plots are found in all three sites here. Prunus pensylvanica occurs in one of the plots. Vaccinium angustifolium is again the most abundant short shrub followed by Symphoricarpos albus. Juniperus communis, Ceanothus ovatus and Prunus pumila are also found. Galium septentrionale has a frequency of 100% in each of the plots. Anemone patens, Lithospermum canescens, Campanula rotundifolia, Aster laevis, Solidago hispida, the two species of Lathyrus and Vicia americana are frequent. The three grasses mentioned before are again the most commonly found. Arctostaphylos uva-ursi forms a dense ground cover in all three plots. Maianthemum canadense and Anemone quinqui-

folia occur frequently along with Viola adunca and Antennaria spp. Fragaria virginiana, Potentilla tridentata, Gaultheria procumbens and Linnaea borealis are also found. With the exception of Ptilium crista-castrensis which is not present here the same mosses and lichens are found in similar quantities. A complete species list with some quantitative data is given in Table IV.

No significant floristic differences are evident between these jack pines stands on the Woodridge series and those on the Sandilands series. While the height of the shrub stratum in the former stands is usually about three to five feet high there is great variation in the Sandilands series. Jack pine stands on the Woodridge series are shown in Figures 14, 15 and 16.

WOODRIDGE SERIES

Figure 14. Jack pine with Amelanchier in Plot 1.

Figure 15. Jack pine with Juniperus in Plot 2.

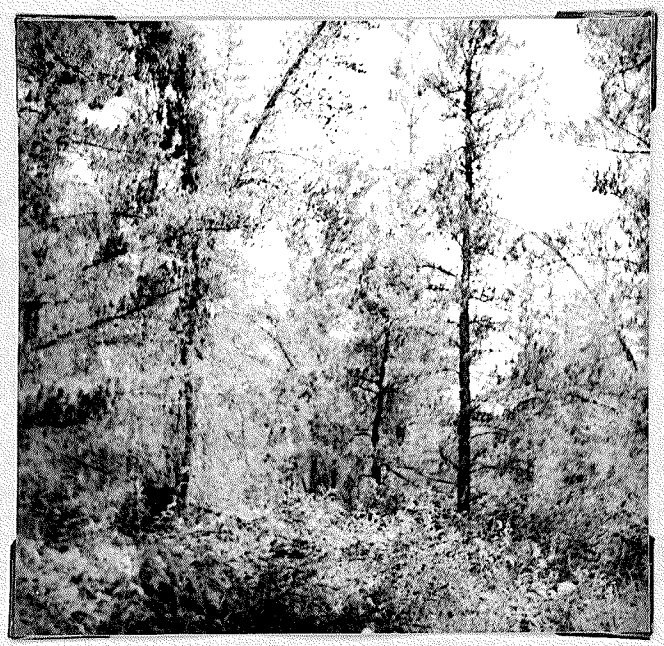


Figure 16. Ice damaged jack pine on Woodridge series.

TABLE IV

Frequency and Cover Abundance Data for

Jack Pine Plots on Woodridge Series

Plot No.	1		2		15	
	F	C/A	F	C/A	F	C/A
Rosa acicularis	52	2	52	2	88	3
Amelanchier sp.	92	3	56	2	100	4
Prunus virginiana	40	2	40	2	28	1
Prunus pensylvanica					12	+
Vaccinium angustifolium	80	3	84	3	92	4
Prunus pumila					12	+
Symphoricarpos albus	72	2	68	2	76	2
Juniperus communis	4	+	56	2		
Ceanothus ovatus	16	+			32	1
Galium septentrionale	100	2	100	2	100	2
Anemone patens	52	2	20	1	16	+
Thalictrum venulosum	20	1			4	+
Lithospermum canescens	48	1	4	+	26	1
Solidago hispida	8	+	20	1	8	+
Campanula rotundifolia	20	1	8	+	4	+
Aster laevis	36	1	48	1		
Lathyrus venosus			4	+	52	2
Lathyrus ochroleucus			20	1		
Vicia americana	32	1	36	1		
Lonicera dioica	20	1				
Apocynum androsaemifolium			24	1		
Melampyrum lineare					4	+
Lilium philadelphicum					4	+
Oryzopsis asperifolia	100	3	80	3	80	3
O. pungens					8	+
Andropogon gerardi	44	2	16	+	56	2
Muhlenbergia glomerata var. cinnoides			4	+	8	+
Agropyron trachycaulum var. glaucum					16	+
Agropyron trachycaulum var. unilaterale			8	+		
Arctostaphylos uva-ursi	92	3	96	4	96	4

Plot No.	1		2		15	
	F	C/A	F	C/A	F	C/A
Gaultheria procumbens			56	2	44	2
Maianthemum canadense	68	2	72	2	100	2
Antennaria spp.	36	1	28	1	56	2
Anemone quinquefolia	96	2	52	2	100	2
Viola adunca	56	2	44	2	44	2
Fragaria virginiana	44	1	12	+	28	1
Linnaea borealis	16	+	40	2		
Chimaphila umbellata			4	+		
Potentilla tridentata			92	2	32	1
Pyrola secunda					4	+
Selaginella rupestris	4	+				
Pleurozium schreberi	52	2	68	3	52	2
Dicranum rugosum	32	1	72	2	32	1
Polytrichum sp.			16	+		
Cladonia spp.	56	2	54	2	12	+
Peltigera canina	4	+				

Two plots, 27 and 42, are described on the Birds Hill series, an orthic grey wooded soil developed on calcareous stratified coarse sand and gravel beach deposits. Topographically these plots resemble those on the Woodridge series, being situated on gravel ridges. Table V gives the tree data for these plots.

TABLE V

Tree Data for Jack Pine Plots on Birds Hill Series

Plot No.	Age (years)	Diameter (inches)	Basal Area (sq. inches)	Density (no/plot)	Height (feet)
27	54	5.6	25.5	116	30 - 35
42	51	5.6	19.6	195	30 - 40

The jack pine are around fifty years old with an average diameter of 5.6". In general they are rather short, being between 30 and 40 feet in height.

The average basal area is about 23 sq. ins. and tree density is, on an average, 156 trees/acre.

Floristically these plots are similar to the ones already described on the Sandilands and Woodridge series. The frequency and cover values of the species present are given in Table VI.

TABLE VI.

Frequency and Cover/Abundance Data for Jack Pine

Plots on Birds Hill Series

Plot No.	27		42	
	F	C/A	F	C/A
Rosa acicularis	76	3	92	3
Amelanchier sp.	92	3	56	2
Prunus virginiana	32	2	8	+
Prunus pensylvanica	16	+		
Corylus cornuta	20	1		
Salix spp.			4	+
Symphoricarpos albus	96	3		
S. occidentalis			76	3
Vaccinium angustifolium	28	2	88	3
Ceanothus ovatus	16	+	32	1
Prunus pumila			68	2
Galium septentrionale	84	2	96	2
Solidago hispida			32	1
Lithospermum canescens	36	1	4	+
Campanula rotundifolia	16	+	4	+
Vicia americana	56	2		
Lathyrus venosus	52	2	44	2
Rhus radicans	52	2		
Anemone patens	16	+		
Anemone canadensis	28	1		
Apocynum androsaemifolium	24	1	12	+

Plot No.	27		42	
	F	C/A	F	C/A
Lonicera dioica			4	+
Heuchera richardsonii			28	1
Monarda fistula	32	1	28	1
Asclepias ovalifolia			8	+
Solidago missouriensis	20	1		
Thalictrum venulosum	8	+		
Erigeron glabellus	8	+		
Oryzopsis asperifolia	32	1	100	3
Andropogon gerardi	92	3		
Muhlenbergia glomerata	4	+		
Schizachne purpurescens	4	+		
Agropyron trachycaulum			8	+
Koeleria cristata	4	+		
Equisetum hyemale	4	+		
Prenanthes alba	4	+		
Liatris ligulistylis	4	+		
Melampyrum lineare	4	+		
Arctostaphylos uva-ursi	100	4	80	3
Fragaria virginiana	64	2	96	3
Antennaria spp.			52	2
Maianthemum canadense			16	+
Gaultheria procumbens			52	2
Viola adunca	12	+		
Anemone quinquefolia	16	+		
Chimaphila umbellata	4	+		
Pleurozium schreberi	16	+	76	3
Polytrichum sp.	8	+	24	1
Dicranum rugosum			12	+
Rurhynchium spp.			52	2
Cladonia spp.	52	2	16	+
Peltigera canina			8	+

Figure 17 shows the typical vegetation on the Birds Hill series.

Figure 17. Jack pine with Symphoricarpos in Plot 42 on Birds Hill series.

Only one plot, 48, is located on the Pine Ridge series, an orthic grey wooded soil developed on 30" or more of slightly to moderately calcareous sand over calcareous till. The plot is located on a low ridge.

The trees are rather young, being forty-one years old on an average, with a mean diameter of 4.3" and short, less than 40 feet tall. The average basal area is 13.2 sq. ins. and the density is 199 trees/plot. From the following table it is evident that this plot can be classed with the other jack pine stands regarding floristic composition.

TABLE VII

Frequency and Cover/Abundance Data for Plot on Pine Ridge Series.

Plot No.	48	
	F	C/A
Rosa acicularis	48	2
Prunus virginiana	16	+

Plot No.	43	
	F	C/A
Amelanchier sp.	4	+
Vaccinium angustifolium	64	3
Symphoricarpos albus	36	1
Prunus pumila	36	1
Aster laevis	68	2
Lithospermum canescens	16	+
Campanula rotundifolia	8	+
Melampyrum lineare	20	1
Solidago hispida	4	+
Apocynum androsaemifolium	12	+
Galium septentrionale	8	+
Andropogon gerardi	92	4
Oryzopsis asperifolia	16	+
Arctostaphylos uva-ursi	72	2
Gaultheria procumbens	100	3
Maianthemum canadense	56	2
Antennaria spp.	32	1
Potentilla tridentata	20	1
Viola adunca	36	1
Pleurozium schreberi	56	2
Dicranum rugosum	48	2
Polytrichum sp.	4	+
Cladonia spp.	100	4

The remaining three jack pine dominated plots are rather different in the composition of the subordinate vegetation from those previously described. These plots are located on the bisequa grey wooded profiles of the Vassar and Moose Lake series. Plots 37 and 44 are on the Vassar series, a bisequa grey wooded soil developed on 6 - 30" sand over lacustrine clay.

Birch is frequently mixed with the jack pines in 37 while jack pine forms a pure stand in 44. Tree data are given in Table VIII . The jack pines are

about fifty years old and the birch somewhat less. The average diameter of the pines is 7.2" and of the birch 5.5". The number of trees in each plot is about 200. The average basal area of the jack pine is 45.4 sq. ins. and of the birch 28.3 sq. ins. The jack pine are about fifty feet in height and the birch are between thirty and fifty feet high. A few aspen are also present in plot 37.

TABLE VIII

Tree Data for Plots on Vassar Series

Plot No.	Age (years)	Diameter (inches)	Basal area (sq. ins.)	Density (no.plot)	Height (feet)
Jack Pine.					
37	52	8.0	45.4	109	50 - 60
Birch					
37	43	5.5	28.3	64	30 - 50
44	49	6.3	36.3	195	50 - 60

Amelanchier and *Rosa acicularis* are the dominant tall shrubs with frequent *Corylus cornuta* and *Prunus pensylvanica*. *Vaccinium angustifolium* and *Diervilla lonicera* are co-dominant in the short shrub stratum. The most abundant tall herbs are *Pteridium aquilinum* and *Lathyrus venosus*. *Oryzopsis asperifolia* again is the dominant grass. Several species occur in the ground layer of these plots which are not found in the plots previously described. Of these *Rubus pubescens* and *Cornus canadensis* are most common. The complete species list with frequency and cover values can be seen in the following table.

Figures 19 and 20 show typical vegetation on the Vassar Series.

TABLE IX

Frequency and Cover/Abundance Data for Jack Pine Plots on Vassar Series

Plot No.	37		44	
	F	C/A	F	C/A
Amelanchier sp.	84	3	40	2
Rosa acicularis	72	2	56	2
Corylus cornuta	44	2	4	+
Prunus pensylvenica	32	1	4	+
Prunus virginiana	8	+		
Salix sp.	12	+	4	+
Diervilla lonicera	88	3	100	5
Vaccinium angustifolium	96	4	88	3
Symphoricarpos albus	16	+		
Vaccinium myrtilloides	8	+		
Pteridium aquilinium	96	3	68	2
Lathyrus venosus	54	2	28	1
Aster ciliolatus	20	1	4	+
Clintonia borealis	28	1	4	+
Heuchera richardsonii	8	+		
Streptopus roseus var. perspectus	28	1		
Apocynum androsaemifolium	8	+	20	1
Epilobium angustifolium	4	+	36	1
Aralia nudicaulis			20	1
Campanula rotundifolia			4	+
Melampyrum linearo			16	+
Equisetum hyemale			44	2
Oryzopsis asperifolia	100	4	100	4
Galium septentrionale			4	+
Rubus pubescens	52	2	56	2
Cornus canadensis	54	2	12	+
Anemone quinquefolia	16	+		
Galium triflorum			16	+
Maianthemum canadense	40	2	76	2

Plot No.	37		44	
	F	C/A	F	C/A
Linnaea borealis	4	+	96	2
Fragaria virginiana	32	1	32	1
Gaultheria procumbens	56	2		
Epigaea repens var. glabrifolia			16	+
Pyrola secunda	20	1	16	+
Chimaphila umbellata			4	+
Pyrola asarifolia	12	+		
Pleurozium schreberi	8	+	40	2
Eurhynchium and Brachythecium spp.			84	4
Dicranum rugosum			28	1

Although only one jack pine plot, 45, is located on the Moose Lake series, a bisequa grey wooded soil developed on 30" or more of stratified medium to fine lacustrine sediments over calcareous till, it is evident from a glance at tree data in Table X and species list in Table XI that this site resembles the previous two plots more than any of the others. Figure 21 shows a jack pine stand on the Moose Lake Series.

TABLE X

Tree Data for Jack Pine Plots on Moose Lake Series

Plot No.	Age (years)	Diameter (inches)	Basal Area (sq. ins.)	Density (no/plot)	Height (feet)
45	50	6.3	29.2	217	50 - 60

TABLE XI

Frequency and Cover/Abundance Data for Plot on Moose Lake Series

Plot No.	45	
	F	C/A
Alnus rugosa var. americana	70	2
Amelanchier sp.	4	+

Figure 19. Jack pine in plot 44 with Diervilla lonicera and Pteridium aquilinum.

Figure 20. Jack Pine and birch in plot 37.

Plot No.	45	
	F	C/A
Salix sp.	8	+
Rosa acicularis	56	2
Rubus ideaus	36	1
Symphoricarpos albus	20	1
Diervilla lonicera	16	+
Vaccinium angustifolium	84	2
Prunus pumila	8	+
Vaccinium myrtilloides	12	+
Epilobium angustifolium	44	2
Lathyrus venosus	16	+
Apocynum androsaemifolium	12	+
Vicia americana	8	+
Aster ciliolatus	8	+
Clintonia borealis	4	+
Aralia nudicaulis	4	+
Pteridium aquilinum	8	+
Melampyrum lineare	8	+
Galium septentrionale	4	+
Oryzopsis asperifolia	92	3
Gaultheria procumbens	52	2
Cornus canadensis	80	2
Maianthemum canadense	84	2
Linnaea borealis	80	2
Fragaria virginiana	76	2
Galium triflorum	28	1
Pyrola secunda	36	1
Pyrola sp.	8	+
Anemone quinquefolia	12	+
Viola adunca	4	+
Rurhynchium and Brachythecium spp.	32	1
Pleurozium schreberi	16	+
Dicranum rugosum	12	+

Moose Lake Series

Figure 21. Jack pine and Alnus rugosa in Plot 45.

MIXED JACK PINE STANDS

In the two remaining jack pine plots to be discussed, aspen is co-dominant in plot 28 and red pine in plot 7.

The soil in plot 28 is a gleyed podzol on siliceous sand, the Lonesand series. Tree and minor vegetation data are given in Table XII and Table XIII.

TABLE XII

Tree Data for Plot 28

	Age (years)	Diameter (inches)	Basal Area (Sq. ins.)	Density (no/plot)	Height (feet)
Jack Pine	46	9.6	46.6	75	40
Aspen	39	4.5	15.9	68	30 - 40

The jack pine on this site, although relatively young, are larger in diameter than those previously described. This suggests that growing conditions

are more favourable on the imperfectly drained sands. However, as only the one jack pine dominated stand was examined on these soils no definite conclusions can be drawn. Such sites are usually occupied by poplar stands.

TABLE XIII

Frequency and Cover/Abundance Data for Plot 28

Plot No.	28	
	F	C/A
Alnus rugosa	60	2
Rosa acicularis	8	+
Prunus pensylvanica	4	+
Salix spp.	8	+
Rubus idaeus	60	2
Vaccinium angustifolium	20	1
Spiraea alba	80	2
Prunus pumila	4	+
Aralia nudicaulis	44	2
Melampyrum lineare	60	2
Galium septentrionale	28	2
Apocynum androsaemifolium	12	+
Aster ciliolatus	12	+
Epilobium angustifolium	8	+
Equisetum hyemale	36	2
Campanula rotundifolia	4	+
Lithospermum canescens	4	+
Heuchera richardsonii	4	+
Andropogon gerardi	16	+
Oxytropis asperifolia	64	3
Poa palustris	24	1
Fragaria virginiana	92	3
Viola adunca	32	1
Cornus canadensis	12	+
Epigaea repens	24	1
Maianthemum canadense	20	1

Plot No.	28	
	F	C/A
Antennaria sp.	12	+
Pyrola asarifolia	8	+
Gaultheria procumbens	4	+
Rhynchium and Brachythecium spp.	20	1
Polytrichum sp.	8	+
Pleurozium schreberi	8	+

There are several species in the minor vegetation which are not found on the Sandilands series, the excessively to well drained member of the same catena. The moister conditions in plot 28 appear to be more favourable for the growth of such species as Rubus idaeus, Alnus rugosa, Poa palustris, Equisetum sylvaticum, and Cornus canadensis. Arctostaphylos uva-ursi and Cladonia, characteristic species of the Sandilands series, are absent. Otherwise the species composition of the two series is similar.

The soil in plot 7 is very variable and one half of the plot was noticeably moister than the other. However, as this was the only stand in which red pine,(Pinus resinosa) was abundant, data were obtained as usual. They are given in Table XIV and Table XV.

TABLE XIV

Tree Data for Plot 7

	Age (years)	Diameter (inches)	Basal Area (sq. ins.)	Density (trees/plot)	Height (feet)
Red pine	62	10	122.7	79	60 - 70
Jack pine	53	6	58.1	79	50 - 60

The vegetation here has species characteristic of both dry and moist sands. The species list is given in Table XV. Figure 22 shows red pine at the edge of plot 7.

Figure 22. Red pine on course sand and gravel at the edge of plot 7.

TABLE XV

Frequency and Cover/Abundance Data for Plot 7

Plot No.	7	
	F	C/A
Rosa acicularis	68	2
Prunus virginiana	64	2
Amelanchier sp.	40	2
Corylus cornuta	32	2
Prunus pensylvanica	20	1
Salix sp.	20	1
Vaccinium angustifolium	68	2
Symphoricarpos albus	28	1
Rubus idaeus	48	2
Lathyrus venosus var. intonsus	64	2
Galium septentrionale	72	2
Aster laevis	32	2

Plot No.	7	
	F	C/A
Solidago hispida	8	+
Lithospermum canescens	12	+
Pteridium aquilinum	44	2
Vicia americana	20	1
Polygala senega	4	+
Melampyrum lineare	4	+
Aralia nudicaulis	4	+
Rhus radicans var. rydbergii	4	+
Oryzopsis asperifolia	100	4
O. pungens	4	+
Gaultheria procumbens	68	2
Arctostaphylos uva-ursi	12	+
Fragaria virginiana	80	3
Cornus canadensis	60	2
Maianthemum canadensis	96	3
Pyrola sp.	28	1
Antennaria sp.	8	+
Anemone quinquefolia	48	2
Chimaphila umbellata	48	2
Linnaea borealis	68	2
Viola adunca	12	+
Pleurozium schreberi	52	2
Dicranum rugosum	24	1
Eurhynchium sp.	12	+

The development of jack pine stands in southeastern Manitoba has been greatly favoured by the high incidence of forest fires.

Jack pine cones are quite resistant to fire. The cones open best during dry weather when the temperature is at least 80°F. but many of them remain closed until they are exposed to fire or until the branches are subjected to higher temperatures near the ground after wind breakage or logging. The scales

of these serotinous cones are held together by a resin which softens enough to allow scale separation at a temperature of about 116°F(Rudolf 1958).

Large expanses of dry sandy soil are covered with trees less than thirty years old which have recently become established after fire. These stands were omitted from this investigation. In general the maturer trees in the region do not reach an age of more than sixty years. The oldest trees which were encountered were just over eighty years old and these were very occasional. In comparison Kittredge (1934) found stands of jack pine, 100 years old and 86 feet tall, on the outwash sands of Star Island in Northern Minnesota.

In the south-east jack pine occurs over a wide range of soil types but is in greatest evidence on the well drained Sandilands, Woodridge, Birds Hill and Pine Ridge series. Good stands are found on the Lonesand, Vasser and Moose Lake series which appear to be better sites for jack pine growth. However, the most commonly occurring trees on these series at the present day are aspen and birch. If left undisturbed for a sufficient length of time they would probably be succeeded by jack pine.

No jack pine stands were found on the highly calcareous boulder till soils such as those of the Carrick and Piney series.

MIXED BALSAM FIR STAND

Plot 95 is located on the Hungarian series, a gleyed grey wooded soil on fine to very fine lacustrine sand. Balsam fir and cedar with some birch, aspen and a few balsam poplars form a very dense stand. The trees are all between 50 and 70 feet in height. The balsam fir are fifty-five years old on an average with a diameter of 5.4 inches, the cedar fifty-seven years with a diameter of 3.7 inches, the birch fifty-four years with a diameter of 4.1 inches, and the aspen sixty-four years with a diameter of 13 inches.

The minor vegetation is rather sparse occurring in patches where light penetrates the dense canopy. The dominant species are those of the ground layer such as Rubus pubescens and Cornus canadensis. Petasites palmatus is the only tall herb that occurs frequently. The complete species list with quantitative data is given in Table XVI.

TABLE XVI

Frequency and Cover/Abundance Data for Plot 55

	F	C/A
Rosa acicularis	4	+
Diervilla lonicera	4	+
Petasites palmatus	54	1
Aralia nudicaulis	4	+
Botrychium virginianum	4	+
Aster ciliolatus	4	+
Oryzopsis asperifolia	24	1
Carex sp.	8	+
Rubus pubescens	100	2
Cornus canadensis	56	2
Trientalis borealis	44	1
Mitella nuda	40	1
Fragaria virginiana	32	1
Asarum canadense	32	1
Linnaea borealis	24	1
Galium triflorum	20	+
Maianthemum canadense	16	+
Pyrola sp.	12	+
Pyrola secunda	4	+
Anemone quinquefolia	4	+
Brachythecium and Rhynchium spp.	8	+
Abies balsamea seedlings	64	2
Populus tremuloides seedlings	12	+

An interesting fact about this plot is the frequent occurrence of balsam fir seedlings, less than 6 inches high, on the forest floor. This may be due to the absence of competition from minor vegetation.

Balsam fir is quite common in the vicinity of Moose Lake where it is usually associated with birch and aspen. Unfortunately at this point no more time was available in which to investigate further stands of balsam fir.

ASPEN STANDS

The hardwood stands in southeastern Manitoba comprise pure aspen and pure birch stands and mixtures of aspen, birch and balsam poplar. Aspen forms the commonest hardwood stands in the area and is particularly widespread on the heavier soils developed on highly calcareous parent material. Plots 18, 19, 23, 14, 17, 22, 39, 41, 43, 21, 25 and 33 are located on such soils. The Carrick series is represented by sites 18, 19 and 23, the Piney series by 14, 17, 22, 39 and 41, the Acland series by 43, the Erokenhead series by 21 and the Pine Valley by 25 and 33. Balsam poplar and birch are present to a lesser degree in some of the plots. The tree data is summarized in Table XVII.

TABLE XVII

Tree Data for Aspen Stands on Calcareous Boulder Till and Clay Soils

Plot	Age (years)	Diameter (inches)	Basal Area (sq. ins.)	Density (trees/plot)	Height (feet)
18	39	6.2	18.9	109	30 - 40
19	34	5.3	22.1	187	30 - 40
23	34	4.9	21.2	110	40 - 50
14	33	4.4	9.6	251	40 - 55
17	39	3.8	15.9	84	50 - 60
22	38	6.8	28.3	101	50 - 60
39	48	7.2	36.3	142	50
41	39	6.5	30.0	172	50

Plot	Age (years)	Diameter (inches)	Basal Area (sq. ins.)	Density (trees/plot)	Height (feet)
43	45	6.2	24.7	161	40 - 50
21	47	6.0	45.4	105	50 - 60
25	-	-	31.2	90	60
33	62	8.8	37.4	150	40 - 60

The aspen are in general, between thirty and fifty years old with a few reaching an age of more than sixty years. Diameters range from 3.8 to 8.8 inches with an average of 6 inches. The average basal area is about 27 square inches with a range of 9.6 square inches to 45.4 square inches. The aspen vary in density from 84 to 167 trees/plot, the mean density being 139 trees/plot. In plots 17, 22, 43, 25 and 33 the actual tree density is greater because of frequent balsam poplar. The heights of the aspen range from 30 feet to about 60 feet, the taller trees and also the older ones being found on the imperfectly drained series.

Associated with the aspen is a tall, usually very dense shrub stratum composed of Corylus cornuta, Rosa acicularis, Amelanchier sp., Prunus virginiana and Cornus stolonifera. Several species of Viburnum and Salix are also present in some plots.

The occasional short shrubby Fraxinus nigra and Acer spicatum may be found in this stratum. Of the shorter shrubs Rubus idaeus and Symphoricarpos albus are most common.

The most frequently occurring tall herbs are Aralia nudicaulis, Galium septentrionale, Petasites palmatus, Saniçula marilandica, Aster ciliolatus and Smilacina stellata. There is a greater number of grass species here than in the jack pine plots but the commonest appears to be Oryzopsis asperifolia. Fragaria virginiana, Maianthemum canadense, Galium trifolium, Viola spp., Asarum canadense and Cornus canadensis are the most frequent species in the ground layer. There

is no well defined moss layer but species of Brachythecium and Eurhynchium cover fallen trees.

Although plots 18, 19 and 23 are on a moderately to well drained soil while the others are on imperfectly drained soils, the species composition is quite similar. Some species, however, such as Cornus stolonifera, are more abundant on the moister soils. Tables XVIII and XIX give the species composition of the well drained and imperfectly drained soils respectively.

TABLE XVIII

Frequency and Cover/Abundance Data for Aspen Plots on Carrick Series.

Plot No.	18		19		23	
	F	C/A	F	C/A	F	C/A
Corylus cornuta	52	2	60	3	4	+
Rosa acicularis	84	4	60	2	88	4
Amelanchier sp.	52	2	60	3	68	3
Prunus virginiana	4	+	40	2	48	2
Prunus pennsylvanica	12	+	10	+	4	+
Cornus stolonifera	8	+	10	+	4	+
Salix sp.					52	2
Viburnum rafinesquianum	4	+	20	1		
Crataegus sp.			5	+		
Symphoricarpos albus	68	2	75	3	8	+
Rubus idaeus	8	+	5	+	96	4
Pteridium aquilinum	95	4			100	5
Aralia nudicaulis	20	1	10	+	44	2
Galium septentrionale	76	2	68	2	68	2
Apocynum androsaemifolium	4	+			8	+
Vicia americana	32	1	10	+		
Streptopus roseus	4	+			12	+
Lathyrus venosus	56	2				
Sanicula marilandica	36	1				
Anemone riparia			5	+		

Plot No.	18		19		23	
	F	C/A	F	C/A	F	C/A
Rhus radicans	16	1	55	2		
Malonia deflexa	4	+	5	+		
Melampyrum lineare					8	+
Steironema ciliatum					36	1
Habenaria viridis			5	+		
Taraxacum officinale	66	2	45	1		
Agastache foeniculum			20	1		
Pedicularis canadensis	8	+	10	+		
Achillea millefolium	8	+				
Cynoglossum boreale	4	+				
Thalictrum venulosum	24	1	60	2		
Trifolium sp.	32	1	45	1		
Crysopsis asperifolia	44	2	100	4	88	4
Andropogon gerardi			20	1		
Muhlenbergia glomerata var. cinnoides			5	+		
Poa pratensis	24	1	5	+		
Elymus canadensis	8	+	10	+		
Danthonia spicata			5	+		
Carex pensylvanica var. digyna	36	1				
Fragaria virginiana	96	2	100	2	96	2
Maianthemum canadense	64	2	100	2	88	2
Anemone quinquefolia	12	+	8	+	56	2
Cornus canadensis			8	+	8	+
Pyrola asarifolia					44	1
Pyrola secunda			4	+		

Figures 23 and 24 show aspen on the Carrick series with Pteridium Corylus and Amelanchier and Figures 25 and 26, Cornus stolonifera and Pteridium on the Piney series. A few charred stumps were present in plots 18 and 19 which also showed signs of having been grazed. The shrub layer of Corylus is short and discontinuous as can be seen in Figure 24. Figures 27, 28 and 29 show the vegetation on the Pine Valley and Acland series.

Aspen stands are also common on the medium to fine lacustrine sediments

TABLE XIX

Frequency and Cover/Abundance Data for Aspen Plots and the Piney, Acland, Brokenhead and Pine Valley Series

Plot No	14		17		22		39		41		43		21		25		33	
	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A
Corylus cornuta	92	4	80	4	100	5	50	2	12	+			92	4	88	4		
Rosa aciculeris	20	1	60	2	44	2	55	2	72	2	65	2	68	2	76	2	55	2
Amelanchier sp.	8	+	4	+	4	+	30	1	40	1	90	3	68	3	48	2		
Prunus virginiana	56	2	12	+	12	+	15	+	16	+	20	1	20	1	32	2	30	1
Cornus stolonifera	40	1	80	4	8	+	65	3	92	4	60	2	56	2	40	2	65	2
Prunus pensylvanica					8	+												
Alnus rugosa			4	+	4	+											55	2
Salix spp.	12	+					15	+	12	+	10	+	12	+	4	+	20	1
Fraxinus nigra	4	+	4	+			10	+	8	+			4	+				
Viburnum trilobum			4	+			35	1			5	+			40	2	5	+
Viburnum lentago							5	+	8	+					40	2		
Viburnum rafinesquianum							30	1	12	+	20	1	40	2	4	+		
Shepherdia canadensis									12	+	15	+	12	+				
Acer spicatum	28	1					15	+										
Rubus idaeus	32	1	80	3	72	3	5	+			10	+			60	2	20	1
Symphoricarpos albus			20	1	4	+			40	1	5	+	12	+	8	+		
Ribes hirtellum	8	+	24	1	4	+	35	1	24	1	5	+			48	2		
Ribes triste			4	+											4	+		
Diervilla lonicera					56	2	5	+			60	2	24	1				
Lonicera oblongifolia									12	+	5	+					25	1
Spiraea alba			52	2														

Plot No.	14		17		22		39		41		43		21		25		33	
	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A
Aralia nudicaulis	36	1	84	2	48	2	100	4	60	2	85	3	96	3			55	1
Pteridium aquilinum					20	1	20	1					8	+				
Galium septentrionale	56	2	56	2			95	2	80	2	5	+	100	2	96	2	45	1
Apocynum androsaemifolium			4	+	28	1	5	+			15	+	4	+				
Smilacina stellata	84	2	32	1			15	+	54	2	60	2			24	1	65	2
Streptopus roseus							10	+	8	+			24	1	4	+		
Petasites palmatus	48	2	44	2	96	3	80	3	54	2	80	2	76	2	56	2	36	1
Sanicula marilandica	96	2	16	1	20	1	15	+	24	1	10	+	80	2	48	1	4	+
Botrychium virginiana	8	+	12	+			10	+	12	+	25	1			4	+	8	+
Aster ciliolatus	72	2	56	2	52	2	55	2	58	2			56	2	84	2	56	2
Lathyrus venosus	12	+			60	2	35	1	12	+	35	1						
Vicia americana	4	+	4	+	16	+	15	+	4	+							4	+
Actaea rubra	12	+					5	+	8	+			4	+	24	1		
Aster latériflorus	4	+							32	1							20	1
Rhus radicans			16	1			40	1					8	+				
Helenia deflexa							5	+					12	+				
Steironema ciliatum			4	+					4	+					8	+	15	+
Taraxacum officinale	44	1	20	1	80	2	10	+	24	1			44	2	40	1		
Epilobium angustifolium							5	+	8	+					8	+		
Habenaria viridis							5	+									10	+
Lonicera dioica	4	+	8	+					4	+					16	+		
Cirsium sp.	16	+							8	+							15	+
Anemone canadensis			12	+	16	+			12	+			8	+	28	1	5	+
Clintonia borealis	8	+	16	+			10	+										
Thalictrum venulosum							55	2					84	2				
Petasites vitifolius															20	1	20	1
Anemone riparia															8	+		

Plot No.	14		17		22		39		41		43		21		25		33	
	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A
Melampyrum lineare																	60	1
Eupatorium maculatum																	15	+
Coua rivale															4	+		
Erigeron philadelphicum					4	+												
Heuchera richardsonii					4	+												
Mentha arvensis			4	+													15	+
Solidago gigantea var. leiophylla					48	2	35	1			15	+	8	+			25	1
Aster simplex											25	1						
Gentiana macounii															4	+		
Dryopteris spinulosa															4	+		
Cicuta maculata															20	1		
Oryzopsis asperifolia			36	1	54	2	55	3	88	4	75	3	80	3	80	3		
Schizachne purpurascens	36	2																
Muhlenbergia glomerata var. cinnoides							10	+										
Calamagrostis canadensis							5	+										
Carex sartwellii											20	1						
Juncus filiformis											10	+						
Lusula acuminata	28	1																
Fragaria virginiana	100	2	100	2	92	2	90	2	100	2	100	2	100	2	88	2	100	2
Maianthemum canadense	60	2	72	2	100	2	70	2	72	2	70	2	100	2	92	2	5	+
Rubus pubescens							60	2	56	2	60	2					60	2
Galium triflorum	28	1	32	1	40	1	10	+	44	1	20	1	12	+	66	1	55	2
Anemone quinquefolia	16	1	28	1	28	1	5	+	32	1	15	+	24	1	36	1	30	1
Cornus canadensis	76	2	28	1	8	+			32	1			100	2			16	+

Plot No.	14		17		22		39		41		43		21		25		33	
	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A
Trientalis borealis	56	2					20	1	12	+								
Mitella nuda	32	1	28	1														
Asarum canadensis	32	1	68	2			30	1	72	2			12	+			32	1
Viola spp.	52	2	20	1	44	1	80	2	48	1	40	2			44	2		
Trifolium spp.					4	+							16	+				
Pyrola asarifolia			12	+					52	2	20	1						
Pyrola secunda					4	+	10	+	4	+	45	2	48	2				
Polygonum sagittum	4	+																
Linnaea borealis							20	1										
Eurhynchium and Brachythecium spp.	52	2	40	2	8	+			20	1			32	1	44	2	8	+
Peltigera canina			4	+									4	+				

Figure 23. Aspen with Pteridium and Amelanchier in Plot 23

Figure 24. Aspen with short Corylus and Pteridium in Plot 18.

Figure 25. Aspen with Cornus stolonifera and Amelanchier on Plot 41.

Figure 26. Cornus stolonifera, Rosa and Pteridium in Plot 41.

Figure 27. Aspen with Lonicera oblongifolia and Amelanchier in Plot 25.

Figure 28. Aspen with tall shrub layer of Alnus in Plot 33.

Figure 29. Aspen with Cornus stolonifera, Rosa and Amelanchier in Plot 43.

and sands underlain by calcareous till or lacustrine clay. Within this category are plot 51 on the Vassar series, Plot 34 on the Moose Lake series, plot 30 on the Birch Point series and plots 46 and 49 on the Baynham series. The tree data which are similar to those of the previous aspen stands are given in Table XX.

TABLE XX

Tree Data for Plots 51, 34, 30, 46 and 49.

Plot	Age (years)	Diameter (inches)	Basal Area (sq. ins.)	Density (Trees/plot)	Height (feet)
51	38	4.9	14.5	210	40 - 45
34	45	6.3	22.1	150	40 - 45
	50	9.5	83.3	11	40 - 50
	40	5.5	21.2	8	40 - 45
30	36	5.4	18.1	188	30 - 45
46	37	5.2	17.3	229	40 - 45
	-	-	-	4	-

Plot	Age (years)	Diameter (inches)	Basal Area (sq. ins.)	Density (trees/plot)	Height (feet)
	-	-	-	4	-
49	43	6.6	34.2	229	40 - 45

The stands may be of pure aspen or may have the occasional birch and jack pine as in 34 and 46. In the table data for the jack pine and birch are given after the aspen in that order.

The species list resembles the previous one except for the presence here of a few species associated with jack pine. Vaccinium angustifolium is very abundant in four out of five plots and Gaultheria procumbens and Antennaria spp. are found in several plots. The complete species list with frequency and cover/abundance data is given in Table XXI. Vegetation on the Birch Point and Baynham series is shown in Figures 30 and 31.

TABLE XXI

Frequency and Cover/Abundance Data for

Plots 51, 34, 30, 46 and 49

	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A
Plot No.	51		34		30		46		49	
Amelanchier sp.	4	+	28	1	64	2	32	1	36	1
Rosa acicularis	60	2			80	3	32	1	84	3
Prunus virginiana	4	+	16	+	12	+	20	1	8	+
Prunus pensylvanica			16	+					20	1
Corylus cornuta	100	4	4	+	96	5	8	+	4	+
Cornus stolonifera							28	1	12	+
Alnus rugosa			60	2						
Salix spp.			28	1			24	1	32	1
Viburnum trilobum	4	+								
Viburnum rafinesquianum	4	+								
Shepherdia canadensis									4	+

	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A
Plot No.	51		34		30		46		49	
Rubus idaeus	4	+			52	2	80	3	28	1
Diervilla lonicera	92	4	96	4			100	4	42	2
Vaccinium angustifolium			56	2	8	+	80	4	60	2
Vaccinium myrtilloides									16	+
Symphoricarpos albus					72	2			24	1
Spirnea alba							4	+		
Pteridium aquilinum	4	+	72	3	92	4			92	4
Aralia nudicaulis	56	2			4	+	60		44	1
Apocynum androsaemifolium			20	1	20	1	4	+	4	+
Galium septentrionale	8	+			24	1			80	2
Streptopus roseus	48	2								
Lathyrus venosus					32	1			52	1
Vicia americana					8	+			4	+
Campanula rotundifolia	8	+								
Melampyrum lineare			20	1					4	+
Clintonia borealis	48	2								
Potamites palmatus	42	2								
Potamites vittifolius					12	+				
Sanicula marilandica	4	+			4	+				
Botrychium virginianum	8	+			4	+				
Aster ciliolatus	88	3	16	+	88	3	88	3		
Aster umbellatus	8	+								
Actaea rubra	4	+								
Anemone canadensis	8	+								
Aquilegia canadensis	4	+					8	+		
Hieracium umbellatum			4	+						

	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A
Plot No.	51		34		30		46		49	
Epilobium angustifolium			20	1	8	+	56	2	16	+
Trifolium sp.									4	+
Thalictrum venulosum					88	2				
Crysopsis asperifolia	76	3	76	3	100	4	52	3	100	4
Agrostis stolonifera var. major	80	3								
Carex spp.					100	4				
Rubus pubescens	4	+	44	1	52	2			24	1
Gaultheria procumbens			72	2	52	2			24	1
Fragaria virginiana	44	2	88	2	100	3	96	3	92	2
Linnaea borealis			4	+					44	2
Maianthemum canadense	72	2	76	2	100	2	56	2	84	2
Galium triflorum							4	+		
Anemone quinquefolia			20	1	24	1				
Cornus canadensis	4	+	8	+					40	2
Antennaria spp.			4	+					4	+
Asarum canadensis	28	1								
Trientalis borealis	12	+					4	+		
Pyrola asarifolia			12	+	16	+			12	+
Pyrola sp.	20	1			4	+				
Eurhynchium and Brachythecium spp.			20	1					12	+

The next group of aspen dominated stands are plots 54, 20, and 32 on the imperfectly drained Lovecand (54) and Wintergreen series (20, 32). The occasional balsam poplar and balsam fir (Abies balsamea) is present on these sites.

Figure 30. Aspen with Corylus cornuta and Pteridium aquilinum on the Birch Point series.

Figure 31. Aspen with Cornus stolonifera and Prunus pensylvanica on the Bayshaw series.

The tree data is given in Table XXII.

TABLE XXII

Tree Data for Plots 54, 20 and 32

Plot	Age (years)	Diameter (inches)	Basal Area (sq. ins.)	Density (Trees/plot)	Height (feet)
54	37	7.0	33.2	75	40 - 45
	45	7.0	28.3	11	40 - 45
	"	"	"	11	40 - 45
20	27	5.5	10.8	63	30 - 40
	-	-	49.0	15	30 - 40
32	59	6.5	28.3	90	40 - 50
	54	7.3	50.3	56	40 - 50

The second row of figures in plot 54 are data for balsam fir and the second row of figures in plot 20 and 32 and third in 54 are balsam poplar data. The species list is rather like that of the imperfectly drained Piney series. Pteridium and Corylus, however, are absent on the plots here.

In all three plots Alnus rugosa forms a dense shrub layer, 10 to 15 feet in height. Table XXIII given the complete species list with quantitative data. Figure 32 shows Cornus stolonifera and Alnus rugosa on the Wintergreen series.

Figure 32. Cornus stolonifera and Alnus rugosa in Plot 32.

TABLE XXXII

Frequency and Cover/Abundance Data for

Plots 54, 20 and 32

Plot No.	54		20		32	
	F	C/A	F	C/A	F	C/A
Rosa acicularis	12	+	72	3	40	2
Cornus stolonifera	16	+	60	2	88	4
Alnus rugosa	100	5	60	2	100	4
Amelanchier sp.					4	+
Prunus virginiana			4	+	36	1
Salix spp.	4	+	12	+	4	+
Fraxinus nigra	4	+				
Viburnum trilobum					8	+
Viburnum rafinesequianum					24	1
Shepherdia canadensis					8	+
Rubus idaeus	24	1	100	4	36	1
Symphoricarpos albus					8	+
Ribes hirtellum	4	+	44	2	36	1
Ribes triste	12	+				
Lonicera oblongifolia					68	2
Aralia nudicaulis	36	1	56	2	76	2
Petasites palmatus	70	2	44	2		
Petasites vitifolius			28	1	36	1
Botrychium virginianum			8	+	4	+
Aster ciliolatus	24	1			56	2
Apocynum androsaemifolium			8	+		
Galium septentrionale					8	+

Plot No.	54		20		32	
	F	C/A	F	C/A	F	C/A
Anemone canadensis			24	1		
Streptopus roseus			4	+		
Actaea rubra			4	+		
Sanicula marilandica			4	+		
Equisetum hyemale					20	1
Solidago gigantea var. leiophylla	8	+	64	2	84	3
Stachys palustris			16	+		
Mentha arvensis	20	1				
Campanula rotundifolia	4	+				
Cystopteris fragilis	8	+				
Vicia americana			8	+		
Epilobium angustifolium			16	+		
Lonicera dioica			8	+		
Aquilegia canadensis					12	+
Eupatorium maculatum var. bruneri					4	+
Smilacina stellata					4	+
Geum rivale	4	+				
Dryopteris spinulosa	32	1				
Equisetum arvense	8	+	12	+	8	+
Poa palustris			42	2		
Crysopsis asperifolia	12	+				
Agropyron trachycaulum var. glaucum			40	1	20	1
Agrostis scabra	20	1				
Bromus ciliatus	84	4			20	1
Fragaria virginiana	52	2	56	2	100	2
Maianthemum canadense	4	+	44	1	72	2
Rubus pubescens	88	2			36	1
Linnaea borealis					32	1
Galium triflorum	16	+			32	1
Anemone quinquefolia			8	+	8	+
Cornus canadensis			32	1	68	2
Mitella nuda			8	+		
Asarum canadensis					36	1

Plot No.	54		20		32	
	F	C/A	F	C/A	F	C/A
Viola adunca	8	+	4	+	4	+
Coptis trifolia var. groenlandica	4	+				
Epigaea repens	4	+				
Agrostis stolonifera var. compacta	20	1				
Eurhyncium sp. and Brachythecium sp.			20	1	4	+
Mnium hornum			4	+	4	+
Climacium dendroides	8	+				
Cynoglossum boreale					4	+
Trientalis borealis	12	+	36	1		

The last two plots to be considered within the aspen dominated stands are on the Woodridge series. Some balsam poplar is present in plot 10 and some jack pine in plot 50. The tree data are given in Table XXIV.

TABLE XXIV

Tree Data for Plots 10 and 50 on Woodridge Series.

Plot.	Age (years)	Diameter (inches)	Basal Area (sq. ins.)	Density (Trees/plot)	Height (feet)
10					
Aspen	34	3.5	17.3	150	30 - 45
Balsam poplar			44.2	30	40 - 45
50					
Aspen	39	6.0	19.2	71	40 - 45
Jack pine	48	9.3	77.0	34	45 - 50

The species list resembles that of the plots on the Vassar, Moose Lake and Baynham series. An abundance of Vaccinium angustifolium distinguishes them from the Garrick and Piney series. Diervilla lonicera, however, does not occur in these two plots. The species list with quantitative data is given in Table XXV. Figure 33 shows the vegetation in plot 10.

Figure 33. Aspen and Balsam Poplar with dense shrub layer of Rosa, Symphoricarpos and Prunus virginiana.

TABLE XXV

Frequency and Cover/Abundance Data for Plots on Woodridge Series

Plot No.	10		50	
	F	C/A	F	C/A
Rosa acicularis	92	4	68	2
Amelanchier sp.	32	1	28	1
Prunus virginiana	48	2	4	+
Cornus stolonifera	12	+	4	+
Corylus cornuta	12	+	4	+
Salix sp.	4	+	36	1
Alnus rugosa			24	1
Rubus idaeus	76	3	48	2
Vaccinium angustifolium	32	1	84	3
Symphoricarpos albus	100	3		
Lonicera oblongifolia			12	+
Vaccinium myrtilloides			4	+
Spiraea alba			40	1
Pteridium aquilinum	40	2	100	4

Plot No.	10		50	
	F	C/A	F	C/A
Aralia nudicaulis	76	3		
Galium septentrionale	92	2	48	1
Apocynum androsaemifolium			8	+
Lithospermum canescens			4	+
Lathyrus venosus	70	3	36	1
Vicia americana	8	+		
Melampyrum lineare			24	1
Actaea rubra	4	+		
Aster ciliolatus			40	1
Aster laevis			4	+
Rhus radicans	4	+		
Schizachne purpurascens	100	3		
Oryzopsis asperifolia			56	2
Thalictrum venulosum	48	2		
Epilobium angustifolium			20	1
Equisetum hyemale			16	+
Maianthemum canadense	92	2	76	2
Fragaria virginiana	60	2	80	3
Rubus pubescens			16	1
Pyrola secunda	4	+		
Viola adunca	4	+	20	1
Smilacina stellata	4	+		
Anemone quinquefolia	48	1	4	+
Pyrola sp.			16	+
Eurhynchium sp.			4	+

From the preceding account it is evident that aspen stands are widespread in southeastern Manitoba on a variety of soil types, from well drained to imperfectly drained soils and from sandy soils to clay soils. Aspen is rarely found, however, on excessively drained sites such as the soils of the Sandilands series. This may be due to the greater availability of jack pine cones on these sites or the substratum may be too dry for the establishment

of aspen seedlings.

Aspen is also found in a wide range of habitats in northern Lower Michigan where it is recognised as the most important secondary association (Gates 1930). Here the aspen becomes established after fire on each of three dominant soil types. When the aspen association occurs on sandy upland soils it is dominated by Populus grandidentata, on clayey upland soils by Prunus pensylvanica, and on lowland soils by Populus tremuloides. Although specimens of Populus grandidentata have been reported for Kandiland none was seen during the course of the summer.

ASPEN/BALSAM POPLAR STANDS

Aspen and balsam poplar are codominant in plots 6 and 47 on the Lonesand series, in 16 on the Malonton series, in 40 on the Carrick series and in 38 on the alluvium of the Rat River. The occasional birch is present on the Lonesand series and Manitoba Maple (Acer negundo) on the alluvium. The tree data is given in Table XXVI. The first row of figures in each plot is aspen data and the second, balsam poplar data.

TABLE XXVI

Tree Data for Aspen/Balsam Poplar Stands

Plot	Age (years)	Diameter (inches)	Basal Area (sq. ins.)	Density (Trees/plot)	Height (feet)
6	30	4.0	31.2	30	40 - 50
	68	8.5	91.6	45	45 - 55
47	47	6.3	22.9	75	40 - 45
	42	7.8	29.1	66	40 - 45
16	54	7.7	50.3	49	50 - 60
	49	8.2	100.3	49	50 - 60
40	35	6.0	27.3	61	30 - 45
	46	9.0	59.4	60	40 - 45

Plot	Age (years)	Diameter (inches)	Basal Area (sq. ins.)	Density (Trees/Plot)	Height (feet)
38	54	6.5	34.2	53	30 - 50
	51	6.5	30.2	49	40 - 50

The balsam poplar are usually taller than the aspen and larger in diameter. The species composition which is somewhat similar to that of the aspen stands on the Piney series is given in Table XXVII. Figure 34 shows the dense undergrowth on the Lonesand series.

Figure 34. Dense Shrub Stratum of Cornus stolonifera and Alnus rugosa in Plot 47 on the Lonesand series.

TABLE XVII

Frequency and Cover/Abundance Data for Aspen/Balsam Poplar Plots

Plot No.	6		47		16		40		38	
	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A
Cornus stolonifera	60	2	68	2	56	2	16	+	80	3
Rosa acicularis	48	2	96	4	44	2	32	1	44	2
Amelanchier sp.	16	+	12	+	12	+	40	1	8	+
Prunus virginiana	12	+	44	2	60	2	24	1		
Corylus cornuta	24	+	4	+	4	+	68	3		

Plot No.	6		47		16		40		38	
	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A
Alnus rugosa	8	+	68	2			28	1	60	2
Salix spp.	4	+	4	+	4	+			16	+
Fraxinus nigra	8	+			76	3				
Spiraea alba					52	2			8	+
Rubus idaeus	48	2	60	2			4	+	44	1
Ribes hirtellum	40	1	20	1	64	2	4	+	36	1
Ribes triste			8	+	4	+			32	1
Lonicera oblongifolia			8	+			4	+	4	+
Vaccinium angustifolium							4	+		
Vaccinium myrtilloides	4	+								
Symphoricarpos albus							4	+		
Diervilla lonicera							28	1		
Aralia nudicaulis			68	2	84	3	72	2		
Galium septentrionale	52	2	72	2	84	2	60	2	36	2
Anemone canadensis	24	1			32	1				
Streptopus roseus							44	2	8	+
Smilacina stellata	40	1			68	2				
Lathyrus venosus	4	+								
Vicia americana			4	+					8	+
Clintonia borealis	4	+					52	2		
Actaea rubra	4	+			4	+			20	1
Potentilla palmatus	52	2	72	2	60	2	36	1	12	+
Potentilla vitifolius	28	1	36	1						
Equisetum hyemale	40	1								
Botrychium virginianum					8	+	20	1	4	+
Aster ciliolatus					56	2			20	+
Aster lateriflorus									8	+
Rhus radicans							20	1	12	+
Thalictrum venulosum	28	1			56	2			20	1
Geum rivale	12	+			4	+			4	+
Trifolium sp.	12	+								
Zizia aptera	4	+								
Circium sp.	8	+			16	+				

Plot No.	6		47		16		40		38	
	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A
Aster puniceus			4	+					36	1
Steironema ciliatum			40	2	8	+	4	+		
Sanicula marilandica			12	+	60	2	16	+	4	+
Heracleum lanatum					24	1				
Lonicera dioica	20	1			8	+	4	+		
Trillium cernuum					16	+				
Anemone riparia									12	+
Rudbeckia laciniata									12	+
Lycopus americanus									4	+
Pteridium aquilinum							40	2		
Aster umbellatus							4	+		
Epilobium angustifolium							4	+		
Equisetum pratense									4	+
Aquilegia brevistyla									4	+
Geum aleppicum var. strictum									4	+
Crysopsis asperifolia	12	+	52	2			96	3		
Bromus ciliatus									32	1
Muhlenbergia mexicana									16	+
Agropyron trachycaulum var. glaucum									16	+
Shizachne purpurascens	80	3								
Luzula acuminata	16	+								
Carex spp.	28	1	16	+	44	2	4	+		
Fragaria virginiana	92	2	100	2	92	2	84	2	36	1
Maianthemum canadense	76	2	84	2			48	1		
Galium triflorum	56	2	28	1	72	2	4	+		
Rubus pubescens	48	2	72	2			52	2		
Cornus canadensis	32	1			60	2			48	2
Trientalis borealis	12	+								
Linnaea borealis	20	1								
Antennaria spp.	4	+								
Pyrola asarifolia			4	+			24	1		
Anemone quinquefolia	24	1	8	+	28	1	20	1		
Betula nana	20	1	12	+	20	2				

Plot No.	6		47		16		40		38	
	F	C/A	F	C/A	F	C/A	F	C/A	F	C/A
Lycopodium obscurum	8	+								
Equisetum scirpoides			12	+						
Asarum canadensis	52	2			58	2				
Eurhynchium and Brachy-thecium spp.	36	1	8	+	44	2				
Mnium spp.					24	1				
Climacium dendroides	4	+								

BIRCH STANDS

Stands dominated by birch are not so common as aspen dominated stands in southeastern Manitoba. They are often found on sandy slopes along the margins of bogs or around a lake such as at Moose Lake. Gates (1930) states that the moist winds in the vicinity of lakes during dry summer spells helps to prevent the too severe over-heating of the tree trunk, which it cannot withstand, having a nearly waterproof bark.

Birch is dominant in plots 9 and 52 on the Moose Lake series and in plot 31 on the Carrick series.

Plot 9 which was the only pure stand examined is located on a fine sandy slope north of the Marchand Ranger Station. The average age of the trees measured is forty-two years with a mean diameter of 4.3 inches. The basal area is 34.2 square inches and the number of trees in the plot is estimated at 255. The trees range in height from thirty to forty feet. Associated with the birch is a tall, very dense shrub layer of Corylus cornuta. In the short shrub stratum Mierville lonicera and Symphoricarpos albus are present in abundance with some Vaccinium angustifolium, Aralia nudicaulis, Smilacina stellata, Maianthemum canadense, Anemone quinquefolia and Pyrola asarifolia are frequent herbs. Oryzopsis asperifolia was the only grass found in the plot. There is

little moss present. Figure 35 shows the vegetation in plot 9. The species list with quantitative data is given in Table XXVIII.

Figure 35. Birch with dense shrub stratum of Corylus cornuta.

TABLE XXVIII

Frequency and Cover/Abundance Data for Birch Plots

Plot No.	9		52		31		24	
	F	C/A	F	C/A	F	C/A	F	C/A
Corylus cornuta	88	5	12	+	96	5	96	5
Amelanchier sp.	12	+	8	+	68	2	4	+
Rosa acicularis	24	1	4	+	64	2	60	2
Prunus virginiana	4	+	4	+	44	2	36	1
Prunus pensylvanica	4	+					4	+
Cornus stolonifera							4	+
Viburnum rafinesquianum					12	+	40	1
Shepherdia canadensis					8	+		
Symphoricarpos albus	60	2			52	2	24	1
Vaccinium angustifolium	24	1	56	2	24	1	12	+

Plot No.	9		52		31		24	
	F	C/A	F	C/A	F	C/A	F	C/A
Vaccinium myrtilloides			12	+				
Diervilla lonicera	72	3	100	4			95	4
Rubus idaeus			4	+	64	2	88	3
Ledum groenlandicum			24	1				
Pteridium aquilinium	8	+			16	+	80	4
Aralia nudicaulis	64	2			8	+	96	2
Apocynum androsaemifolium					20	1	12	+
Galium septentrionale					24	1		
Prenanthes alba	4	+						
Lathyrus venosus	12	+			8	+		
Clintonia borealis	8	+	4	+				
Actaea rubra			4	+				
Potentilla palmatus	8	+			32	1		
Potentilla vitifolius	4	+						
Sanicula marilandica	8	+	4	+	4	+	16	+
Aster ciliolatus								
Rhus radicans	8	+			4	+		
Habenia deflexa					8	+		
Smilacina stellata	68	2						
Oryzopsis asperifolia	64	2	60	3	64	2	100	4
Fragaria virginiana	20	1	48	2	80	2	68	2
Maianthemum canadense	100	2	72	2	84	2	100	2
Rubus pubescens	8	+	49	2	64	2		
Cornus canadensis	4	+	92	2	52	2	16	+
Galium triflorum					8	+		
Trientalis borealis			4	+				
Chimaphila umbellata	4	+	28	1				
Anemone quinquefolia	60	2	24	1	36	1		
Linnaea borealis	4	+	60	2	52	2		
Pyrola asarifolia	40	1			12	+	4	+
Lycopodium annotinum			16	+				
Pyrola sp.			4	+				
Equisetum scirpioides			16	+				
Lycopodium complanatum			4	+				

Plot No.	9		52		31		24	
	F	C/A	F	C/A	F	C/A	F	C/A
Pyrola secunda					8	+		
Eurhynchium and Brachythecium spp.			32	2	12	+	60	2
Mnium sp.							8	+
Pleurozium schreberi	4	+	4	+			4	+
Peltigera canina							12	+

The birch in plot 52 is obviously a secondary growth. The oldest trees present are the red and jack pines. They were also the largest specimens of those species encountered in the south-east during the course of the survey. The tree data are given in Table XXIX.

TABLE XXIX

Tree Data for Plot 52

	Age (years)	Diameter (inches)	Basal Area (sq. ins.)	Density (Trees/plot)	Height (feet)
Birch	55	8.7	27.3	112	40 - 50
Aspen	60	8.7	38.5	38	40 - 50
Red pine	72	15.6	227.0	35	50 - 75
Jack pine	74	13.5	68.2	8	50 - 70

The tall shrub layer is very sparse in this plot but there is a dense short shrub layer of Diervilla lonicera and Vaccinium angustifolium. Some short Ledum groenlandicum is also present. The taller herbs are also rather sparse but Oryzopsis asperifolia is abundant. Cornus canadensis, Maianthemum canadense and Linnaea borealis are very frequent on the ground. The complete species list is given in Table XXVIII.

In plot 31 there are frequent aspen intermixed with the birch. The tree data are given in Table XXX. The species list which is similar to that

of other plots on the Carrick series is given in Table XXVIII.

TABLE XXX

Tree Data for Plot 31

	Age (years)	Diameter (inches)	Basal Area (sq. ins.)	Density (Trees/plot)	Height (feet)
Birch	-	-	11.3	158	30 - 40
Aspen	43	5.5	13.9	80	30 - 40

BIRCH/ASPEN STAND

Birch is codominant with aspen in plot 24. The surrounding areas support jack pine with some red pine and one or two of these trees occur within the limits of the plot. The tree data are given in Table XXXI.

TABLE XXXI

Tree Data for Plot 24.

	Age (years)	Diameter (inches)	Basal Area (sq. ins.)	Density (Trees/plot)	Height (feet)
Birch	47	5.5	24.6	79	40 - 60
Aspen	65	9.0	36.3	68	40 - 60

The species list which is similar to that of the other plots on the Carrick series is given in Table XXVIII.

CHAPTER IV

SOIL/VEGETATION RELATIONSHIPS

Broad Classification of the Vegetation in terms of Soil

Because of different fire histories it is difficult to classify the vegetation of southeastern Manitoba solely on a floristic basis. The soil, which appears to be the chief factor influencing the distribution of vegetation here, is therefore taken into account in an attempt to establish a very broad classification of forest vegetation. The vegetation can best be described by arranging the soils into the three broad groups previously recognized:

1. The podzol and grey wooded soils developed on sandy morainic till, duned sand, and glacial sandy outwash.
2. The bisequa grey wooded soils and grey wooded soils on glacial outwash, aeolian and lacustrine deposits over calcareous boulder till.
3. The grey wooded soils and degraded blacks on calcareous boulder till or calcareous boulder till with thin mantle of lacustrine sand or clay.

These groups can be subdivided according to drainage.

A simplified table (Table XXXII) has been drawn up to show the floristic composition of the vegetation on these three major groups. (The series have been organised into drainage classes within each major group). Frequency values being the most objective figures are used in the table. They have

been averaged for each soil series. The number of plots in each series and the number of plots in which a species occurs within each series are indicated in the table. The species list has been reduced for practicable purposes.

Group 1

Within the first group there are the excessively to well drained sites and the imperfectly drained sites. In the former category are the plots on the Sandilands, Woodridge, Birds Hill and Pine Ridge series. With the exception of two sites, 10 and 50, on the Woodridge series, all plots support stands of jack pine with minor vegetation of similar floristic composition. As might be expected the dunes and beach ridges support rather shorter trees and a shorter, sparser shrub stratum than the level to slightly depressed sites.

In general the dry sands and gravels of this group support a shrub stratum of Amelanchier sp., Rosa acicularis, Prunus virginiana, Prunus pumila, Prunus pensylvanica and Symphoricarpos albus. Juniperus communis, Coeanothus ovatus and Pteridium aquilinum are present locally. The ericaceous dwarf shrubs Vaccinium angustifolium, Arctostaphylos uva-ursi and Gaultheria procumbens are abundant. The commonest herbs on these sites are Maianthemum canadense, Galium septentrionale, Anemone quinquefolia, Aster laevis, Lithospermum canescens, Solomonyrum linearo and Apocynum androsaemifolium. Cryzopsis asperifolia, C. pungens and Andropogon scoparius are the common grasses. A ground cover of mosses and lichens dominated by Pleurozium schreberi and Cladonia is generally found on these sites.

Plots 10 and 50 differ from the others in several respects and bear close resemblance to those on the imperfectly drained Ironwood and Wintergreen series. Plot 10 supports a stand of aspen and balsam poplar and plot 50 a stand of aspen and jack pine. These plots also share several species in common with the imper-

fectly drained sites such as Cornus stolonifera, Rubus idaeus and Lonicera oblongifolia which are not found on the freely drained sands. Conversely species characteristic of the dry sands such as Arctostaphylos uva-ursi are absent here. Originally the soils of these two plots were recognized as separate series but were later included in the Woodridge series because of the lack of a clear distinction between the two. In this case it appears that a difference in moisture regime is being reflected more strongly in vegetation cover than in profile morphology.

The imperfectly drained soils include the Lonesand, Sirko and Wintergreen series. The dominant trees are Populus tremuloides and Populus balsamifera. Short shrubby Fraxinus nigra is occasionally found on such sites. The floristic composition of the minor vegetation is quite consistent in all plots and is quite distinct from that on the freely drained sands. The Prunus sp. and Symphoricarpos are significantly less abundant while Cornus stolonifera and Alnus rugosa which are not or seldom present on the dry sands are very frequent here. Other frequent shrubs not present on the dry sites are Rubus idaeus, Rubus pubescens, Ribes hirtellum and Ribes triste. The ericaceous dwarf shrubs are very occasional on such soils. The commonest herbs are Fragaria virginiana, Aralia nudicaulis, Maianthemum canadense, Galium asrtentrionale, Cornus canadensis and Aster ciliolatus. The two species of Gramineae are the most abundant grasses. No well defined moss layer is present.

Group 2.

This group comprises the Vassar, Moose Lake, Baynham, Birch Point and Hungarian series. All the plots here are on well drained sites except for one on the Hungarian series, a gleyed grey wooded soil. The dominant trees vary from plot to plot. Jack pine may form pure stands on such sites but is

usually associated with aspen or birch either of which is often dominant. The composition of the subordinate vegetation is quite consistent and appears to be intermediate between that of the freely drained and imperfectly drained sands. Diervilla lonicera which is very abundant on soils of this group was not found in the previous one. Corylus cornuta is more abundant in the shrub layer. Pteridium aquilinum, Prunus virginiana, Maranthemum canadense, Cornus canadensis, Aster laevis and Oryzopsis are dominant in the ground vegetation. The dominant mosses are species of Eurhynchium and Brachythecium. The only imperfectly drained plot, 55, has no shrub or tall herb layer. The species which are present occur in the other plots in this group.

Group 3

The soils of the third group consist of the Carrick, Piney, Brokenhead, Pine Valley and Acland series. The dominant trees on these soils are hardwoods, mainly Populus tremuloides. The vegetation on the well to moderately well drained series is not strikingly different from that on the imperfectly drained series. Cornus stolonifera, Viburnum trilobum, Viburnum lentago and Asarum canadense grow more abundantly on the imperfectly drained soils but otherwise little distinction can be made. Corylus cornuta is the dominant shrub while the widespread Prunus virginiana, Rosa acicularis and Amelanchier sp. are abundant. Cornus stolonifera is frequent particularly on the imperfectly drained soils such as the Piney series. Rubus idaeus is common on most series in this group. Prunus virginiana, Maianthemum canadense, Galium asentrionale and Cornus canadensis are the most frequent herbs. Oryzopsis asperifolia is also common. There is no well defined moss layer. The mosses which are present are found mainly on fallen trees.

TABLE XXXII

Floristic Composition of Vegetation on Three Major Soil Groups

Groups	1							2					3				
Drainage Classes	A				C			B				C	B	C			
Series	S[10]	F[5]	BM[2]	FR[1]	L[4]	Sk[1]	Wi[2]	F[3]	ML[4]	BP[1]	BA[2]	R	C[6]	F[5]	A[1]	BM[1]	PV[2]
Amelanchier sp.	38[9]*	65[3]	74[2]	4[1]	14[2]		2[1]	45[3]	13[4]	64[1]	34[2]		34[6]	17[5]	90[1]	68[1]	24[1]
Rosa acicularis	39[9]	64[3]	84[2]	48[1]	41[4]	24[1]	56[2]	63[3]	21[3]	80[1]	58[2]	4[1]	49[6]	50[5]	65[1]	68[1]	66[2]
Prunus virginiana	27[9]	36[3]	20[2]	16[1]	28[2]		20[2]	4[2]	6[3]	12[1]	14[2]		33[6]	24[5]	30[1]	20[1]	31[2]
Prunus pensylvanica	15[4]	4[1]	8[1]		1[1]			12[2]	5[2]		10[1]		5[4]	2[1]			
Prunus pumila	21[9]	4[1]	34[1]	36[1]	1[1]				2[1]								
Symphoricarpos albus	11[6]	72[3]	86[2]	36[1]		20[1]	4[1]	5[1]	20[2]	72[1]	12[1]		38[6]	14[4]	5[1]	12[1]	4[1]
Cornus stolonifera					36[3]	88[1]	74[2]				20[2]		7[5]	41[4]	60[1]	56[1]	53[2]
Corylus cornuta	2[2]		10[1]		7[2]			49[3]	26[3]	96[1]	6[2]		66[6]	82[5]		92[1]	44[1]
Alnus rugosa					52[4]	60[1]	80[2]		60[2]				5[1]	1[2]			28[1]
Salix spp.			2[1]		3[3]	24[1]	8[2]	4[1]	2[1]		28[2]		9[1]	8[3]	8[1]	12[1]	12[2]
Fraxinus nigra					3[2]									1[1]		4[1]	
Viburnum trilobum							4[1]	1[1]		8[1]				10[4]	5[1]		25[2]
V. lentago														3[2]			20[1]
V. rufinesquianum							12[1]	1[1]		8[1]			13[4]	8[2]	20[1]	40[1]	2[1]
Juniperus communis	2[1]	20[2]															
Ceanothus cyatus	1[1]	16[2]	24[2]		8[1]												

Groups	1							2					3				
Brainerd Classes	A				C			B				C	B	C			
Series	S^{10}	F^{3}	HF^{2}	PH^{1}	L^{4}	SL^{1}	HL^{2}	F^{3}	SL^{4}	HF^{1}	PA^{2}	H	O^{6}	P^{5}	A^{1}	HP^{1}	PV^{2}
Rubus idaeus					48^{4}	92^{1}	18^{1}		10^{2}	52^{1}	54^{2}		44^{6}	34^{3}	10^{1}		40^{2}
Ribes hirtellum					16^{3}	48^{1}	18^{1}						1^{1}	15^{3}	5^{1}		24^{1}
Ribes triste					5^{2}	44^{1}							1^{1}	1^{1}			2^{1}
Lonicera oblongifolia					1^{1}	4^{1}	34^{1}							2^{1}	5^{1}		13^{1}
Diervilla lonicera								93^{3}	95^{4}		71^{2}	4^{1}	21^{2}	15^{2}	60^{1}	24^{1}	
Vaccinium angustifolium	81^{10}	85^{3}	58^{2}	84^{1}	5^{1}			61^{2}	54^{4}	8^{1}	70^{2}		8^{4}				
Apocynum androsaemifolium	13^{8}	8^{1}	12^{1}	12^{1}	3^{1}		4^{1}	3^{1}	10^{2}	20^{1}	4^{2}		7^{4}	7^{3}	15^{1}		
Pteridium aquilinum	25^{5}				4^{1}			56^{3}	22^{3}	92^{1}	46^{1}		56^{5}	8^{2}		8^{1}	
Lithospermum canescens	18^{8}	26^{3}	20^{2}	16^{1}	1^{1}	4^{1}											
Aster laevis	14^{5}	42^{2}		68^{1}													
Anemone patens	44^{3}	29^{3}	8^{1}														
Solidago hispida	13^{9}	12^{3}		4^{1}													
Campanula rotundifolia	10^{7}	10^{3}	10^{2}	8^{1}	2^{2}			4^{2}					1^{1}				
Galium septentrionale	24^{5}	100^{3}	90^{2}	8^{1}	38^{3}	32^{1}	4^{1}	2^{1}	1^{1}	8^{1}	40^{1}		49^{5}	61^{4}		100^{1}	70^{2}
Lathyrus venosus	12^{3}	19^{2}	26^{1}		1^{1}			9^{1}		32^{1}	26^{1}		11^{2}	10^{3}			2^{1}
Vicia americana	1^{2}	22^{2}	26^{1}		1^{1}					8^{1}	2^{1}		7^{2}	6^{3}			2^{1}

Groups	1							2					3				
Drainage Classes	A				C			B				C	B	C			
Series	S	W	BW	FW	L	SK	WI	F	ML	BP	BA	H	C	P	A	BR	FV
Melampyrum lineare	23^{5}	1^{1}	2^{1}	20^{1}	18^{1}			5^{1}	7^{2}		2^{1}		1^{1}				
Aralia nudicaulis					37^{3}	16^{1}	66^{2}	38^{2}	17^{3}	4^{1}	52^{2}	4^{1}	41^{6}	56^{4}	85^{1}	96^{1}	18^{1}
Potasites palmatus					49^{3}		22^{1}	14^{1}	2^{1}			64^{1}	11^{2}	34^{3}		76^{1}	46^{2}
Aster ciliolatus					20^{2}	12^{1}	28^{1}	37^{3}	22^{3}	68^{1}	44^{1}	4^{1}	9^{1}	49^{4}	70^{1}		
Sanicula marilandica					3^{1}	32^{1}	2^{1}	1^{1}	3^{2}	4^{1}			20^{5}	30^{4}	8^{1}		26^{2}
Clintonia borealis					1^{1}			38^{2}	4^{3}	4^{1}			10^{2}				
Botrychium virginianum						18^{1}	6^{2}	2^{1}		4^{1}		4^{1}	3^{1}	6^{3}	25^{1}		6^{2}
Rhus radicans			26^{1}			24^{1}			2^{1}				17^{4}	11^{2}		8^{1}	
Smilacina stellata	1^{1}				10^{1}									58^{2}			
Oryzopsis asperifolia	74^{9}	87^{3}	66^{2}	16^{1}	37^{3}			92^{3}	76^{4}	100^{1}	75^{2}	24^{1}	82^{6}	55^{4}	60^{1}	80^{1}	
Andropogon gerardi	17^{4}	39^{3}	46^{1}	92^{1}	4^{1}								3^{1}	2^{0}			
Arctostaphylos uva-ursi	53^{9}	95^{3}	90^{2}	72^{1}													
Linnaea borealis	8^{3}	19^{2}			5^{1}		16^{1}	35^{2}	37^{4}		22^{1}	24^{1}	9^{1}	3^{1}			
Gaultheria procumbens	55^{9}	33^{2}	26^{1}	100^{1}	1^{1}			19^{1}	20^{2}				1^{1}				
Anemone quinquefolia	49^{7}	83^{3}			8^{2}		8^{2}	5^{1}	28^{3}	24^{1}		4^{1}	9^{3}	22^{5}		24^{1}	33^{2}
Painthemum canadense	59^{9}	80^{3}	8^{1}	56^{1}	46^{4}	12^{1}	58^{2}	63^{3}	85^{4}	100^{1}	70^{2}	16^{1}	81^{6}	75^{5}	70^{1}	100^{1}	49^{2}

Groups	1							2					3				
Drainage Classes	A				C			B				C	B	C			
Series	S	W	BH	PR	L	SK	Wi	P	BP	BE	BA	H	C	P	A	BR	PV
	10^{*}	3	2	1	4	1	2	3	4	1	2	1	6	5	1	1	2
Antennaria spp.	19^{8}	40^{3}	46^{2}	32^{1}	4^{2}				1^{1}		2^{1}						
Fragaria virginiana	10^{3}	28^{3}	60^{2}		82^{4}	84^{1}	78^{2}	36^{3}	53^{4}	100^{1}	94^{2}	32^{1}	87^{6}	98^{5}	100^{1}	100^{1}	90^{2}
Rubus pubescens					34^{2}	84^{1}	18^{1}	37^{3}	25^{3}	52^{1}	12^{1}	100^{1}	19^{2}	29^{2}	80^{1}		23^{1}
Cornus canadensis					34^{4}		34^{1}	23^{3}	26^{3}		26^{2}	56^{1}	21^{4}	45^{5}	46^{1}	100^{1}	8^{1}
Galium triflorum					25^{3}		8^{1}	5^{1}	7^{1}		2^{1}	20^{1}	10^{3}	31^{5}	16^{1}	12^{1}	46
Asarum canadense					13^{1}		18^{1}	9^{1}				32^{1}	1^{1}	36^{4}	6^{1}		16^{1}
Mitella nuda					15^{3}		4^{1}					40^{1}		12^{2}	12^{1}		
Cladonia spp.	30^{7}	41^{3}	34^{2}	100^{1}													
Pleurozium schreberi	47^{8}	57^{3}	56^{2}	56^{1}	2^{1}			13^{1}	6^{3}								
Eurhynchium and Brachythecium spp.			26^{1}		7^{3}	20^{1}	5^{2}	26^{1}	$=1^{3}$		16^{2}	8^{1}	14^{2}	20^{3}		32^{1}	45^{2}

Drainage Classes:

A - Excessively to well drained

B - Well to moderately well drained

C - Imperfectly drained.

Soil Series:

S - Sandilands

W - Woodridge

BH - Birds Hill

PR - Pine Ridge

L - Lorenzand

SK - Sirko

Wi - Wintergreen

V - Vasser

ML - Moose Lake

BP - Birch Point

BA - Baynham

H - Hungerian

C - Carrick

P - Piney

A - Acland

BR - Brokenhead

PV - Pine Valley

* The number represents the average frequency and the superscript refers to the number of plots in which the species occurs.

Indicator Species

It is evident from the preceding discussion that plant species differ in their tolerance of the various soil types. Those species which have a limited tolerance are said to have a high indicator value and, conversely, those which are tolerant of a wide range of conditions are of little use as indicators.

Examples of widespread species in this latter category are Rosa acicularis, Maianthemum canadense, Galium septentrionale, Amelanchier spp. and Anemone quinquefolia. The first three species are mentioned by Rowe (1956) as having little indicator value as far as moisture is concerned in the southern boreal forest. Maianthemum also has a scattered representation on the members of a podsol catena studied by Wilde and Leaf (1955) in Wisconsin.

A table (Table XXXIII) has been drawn up to illustrate the range of soils on which some examples of indicator species are found. Some species, the better indicators, are confined to only one type of soil while others are present on several soil types but differ in frequency from soil to soil. Frequencies are represented in the table by the lengths of the blocks. The soils are arranged along a moisture gradient.

Arctostaphylos uva-ursi, Solidago hispida, Anemone patens, Aster laevis, Juniperus communis and the lichen, Cladonia are good indicators of excessively and well drained sands.

Prunus pumila, Antennaria spp., and the moss Pleurozium schreberi occur over a range of moisture conditions but only on the soils of the first and second groups. This suggests that heavier textured, high lime soils such as those of the third group are unfavourable to the growth of these species. All three species grow most abundantly, however, on the excessively to well drained soils of the first group and when present in quantity are indicative of

such sites.

When it grows abundantly Cornus stolonifera is a valuable indicator of imperfectly or poorly drained soils. Viburnum trilobum also shows a tendency to grow on such soils. The small herb, Mitella nuda, is found only on imperfectly and poorly drained soils.

Diervilla lonicera is found only on the sands underlain by clay or till and on the calcareous till and clay soils. Alone it is of little use as an indicator but in conjunction with jack pine, as in plots 37 and 44, it often proves useful in detecting a bisequa profile in complex areas of minimal podzols and bisequa grey wooded soils. The clay B horizon of the bisequa profile clearly has an effect on the composition of the minor vegetation. The growth of such species as Diervilla is probably favoured by the higher fertility and moisture content in these soils as compared with the minimal podzols.

Rubus pubescens and Cornus canadensis occur along with Diervilla on the more fertile soils but are also found on the imperfectly drained sterile sands of group 1. This wide range rather limits their use as indicators except within a podzol catena. Cornus canadensis was found to be rigorously confined to the sandy gley podzol, the imperfectly drained member of the podzol catena, in the study by Wilde and Leaf (1955).

It should be mentioned that there are drawbacks in deducing soil type from vegetation cover, particularly in southeastern Manitoba, as the effects of burning and felling may be such as to produce a plant community not truly indicative of environmental conditions. In any area small pockets subject to different soil conditions to those generally prevailing may occur.

No definite rules, therefore, are laid down for the interpretation of vegetation. However, bearing the obvious pitfalls in mind, it is believed possible

to obtain general indications of soil type from a careful examination of the vegetation once the soil-vegetation relationships have been established.

TABLE XXIII

Range of Soils on which some "Indicator" Species are Found

Soils	1	2	3	1	3	1
Drainage	A	B	B	C	C	D
Arctostaphylos uva-ursi						
Cladonia spp.						
Aster laevis						
Solidago hispida						
Anemone patens						
Juniperus communis						
Prunus pumila						
Pleurozium schreberi						
Antennaria spp.						
Cornus stolonifera						
Viburnum trilobum						
Mitella nuda						
Diervilla lonicera						

NOTE: See following page for Legend.

SOILS

1. Podzol and grey wooded soils on sandy morainic till, duned sand and glacial sandy outwash.
2. Bisequn grey wooded and grey wooded soils on glacial outwash and aeolian and lacustrine deposits over calcareous boulder till.
3. Grey wooded soils and degraded blacks on calcareous boulder till or calcareous boulder till with thin mantle of lacustrine sand or clay.

DRAINAGE

A. - Excessively to well drained.
B. - Well to moderately well drained.
C. - Imperfectly drained.
D. - Poorly drained.

AVERAGE FREQUENCY

76 - 100%

51 - 75%

26 - 50%

6 - 25%

1 - 5%

CHAPTER V

Conclusions.

A primary survey of forest vegetation in southeastern Manitoba indicates that the forest types are associated with definite pedological and physiographical features. The dry sand and gravel ridges, and sandy outwash plains support stands of Pinus banksiana.

On the imperfectly drained sands in depressions, Populus tremuloides and Populus balsamifera are found mixed with the Pinus banksiana or, as in many cases, appear to have completely replaced it. Alnus rugosa and Salix spp. are frequent members of the shrub stratum on such sites. Pinus banksiana may also be dominant on the medium to fine lacustrine sediments and sands underlain by clay or calcareous till but is usually found associated with Populus tremuloides or Betula papyrifera either of which may be dominant. The jack pine stands on these soils are quite distinct from those on the first group of soils in the composition of the minor vegetation. The presence of Diervilla lonicera, for example, with jack pine is a good indication of a bisequa profile.

The well to moderately well drained calcareous boulder till and clay soils support hardwood stands dominated by Populus tremuloides or, less commonly, Betula papyrifera. Populus balsamifera and Salix spp. are more frequently mixed with the aspen or birch on the imperfectly drained boulder till and clay soils. These aspen stands can usually be distinguished from those on the fine sandy soils by the absence of typically jack pine species such as Vaccinium angustifolium.

The large expanses of organic deposits in the low-lying areas support a dense forest cover of Picea mariana with some Larix laricina and Thuja occiden-

taiga on the drier parts, and a fen type of vegetation on the wetter parts. As these areas have not been examined, an ecological investigation would yield interesting information and make the survey of vegetation in southeastern Manitoba more complete.

Several other tree species are found in the south-east but only to a limited extent. Pinus resinosa, which is found on the same soils as Pinus banksiana, grows naturally in the vicinity of Piney, South Junction, Whitemouth Lake and Moose Lake. Pinus strobus is less widespread, occurring mainly in the Moose Lake area. Fraxinus nigra, Acer spicatum, Acer negundo and Ulmus americana are found occasionally on imperfectly drained soils. The two latter species are frequently found on the alluvial soils of the area. Abies balsamea occurs in two of the stands examined, one on the imperfectly drained Lonesand series and the other on the imperfectly drained Hungarian series. However, it does not appear to be confined to only these soils. A further investigation of the balsam fir stands in the area would give more information on the range of soil types suitable for growth. Picea glauca and Quercus macrocarpa have a scattered representation on a variety of soils in the area.

Forest succession in the south-east depends to some extent on soil type. Aspen or in some cases birch is the first tree to colonise a burned area except on the excessively drained sites where jack pine is usually the pioneer tree. On the sandy soils aspen is generally succeeded by jack pine. In one plot there is some evidence of balsam fir replacing hardwoods on an imperfectly drained fine sandy soil. Hardwood stands are dominant everywhere on the highly calcareous boulder till and clay soils and the stands examined on these soils show little sign of being replaced by conifers. There is an indication from early literature that red and white pines were more widespread about 100 years ago but it is doubtful whether they were ever dominant. The red pine probably occurred along

with jack pine on the sandy soils where now there is jack pine only and the white pine on the heavy soils where now there are hardwood stands.

Because of recurrent fires and logging the minor vegetation, rather than tree species in southeastern Manitoba, reflects changes in soil type. From the primary survey it is evident that several species have a limited range of tolerance and can be selected as possible indicators of certain soil types. An intensive survey with detailed quantitative data could determine the range of these species and their reliability as indicators.

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APPENDIX

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APPENDIX

Nomenclature Used in Profile Descriptions

The horizon nomenclature used throughout is that adopted by the National Soil Survey Committee in March 1960 (Personal Communication. Manitoba Soil Survey).

Organic horizons	L	Organic matter, undecomposed
	F	Organic matter, partially decomposed
	H	Organic matter, well decomposed
Horizons of eluviation	Ah	Surface mineral horizon with a relatively high content of organic matter.
	Aeh, Ahe	Transitions to Ae
	Ae	Leached horizon
	AeB	Transition to B horizon
Horizons of illuviation	Bf	Maximum accumulation of iron
	Bt	Maximum accumulation of clay
	C	Parent Material
	k	Accumulated calcium carbonate layer
	g	Gleyed layer in imperfectly or poorly drained soils.

Sandilands Series — Location: East centre of S.E. quarter of 12 - 5 - 9 EPM

L - F Horizon — Leaf litter (1/4" - 0); strongly acid in reaction.

Ah Horizon	Greyish brown when dry to very dark greyish brown when wet (10 YR 5/2 - 3/2*) fine sand (0 - 2"); weakly developed fine crumb structure; very friable when moist, soft when dry; medium acid in reaction; grades into an Ae Ah horizon with a clear smooth boundary.
Ae Ah Horizon	Pale brown when dry to dark yellowish brown when moist (10YR 6/3 - 4/4) fine sand (2" - 5.5"); structureless; loose when moist, loose when dry; medium acid in reaction; grades into an Ae horizon with a gradual smooth boundary.
Ae Horizon	Very pale brown when dry to yellowish brown when moist (10 YR 7/4 - 5/6) fine sand (5.5" - 13"); structureless; loose when moist, loose when dry; medium acid in reaction; grades into a Bf horizon with a gradual smooth boundary.
Bf Horizon	Yellow when dry to brownish yellow when moist (10YR 7/6 - 6/6) pebbly sand (13" - 19"); structureless; loose when moist, loose when dry; slightly acid in reaction; grades into a BfC horizon with a clear smooth boundary.
BfC Horizon	Very pale brown when dry to yellow when moist (10YR 7/4 - 7/6) fine sand (19" - 26"); structureless; loose when moist, loose when dry; slightly acid in reaction; grades into a C1 horizon with a clear smooth boundary.
C1 Horizon	Very pale brown when dry to pale brown when moist (10YR 7/3 - 6/3) fine sand (26" - 46"); structureless; loose when moist, loose when dry; slightly acid in reaction; grades into a C2 horizon

* Colour code number as taken from "Munsell Colour Chart".

C2 Horizon — Fine sand (46" - +); gravel at 54"; alkaline in reaction; effervescees.

NOTE: — The upper horizons in the solum of this soil were considered as Ah and Aeäh horizons due to the slight enrichment of these layers by humus from the grass and herb roots. This profile is weakly developed for the Sandilands series since most have a slightly more prominent Ae and Bf horizons.

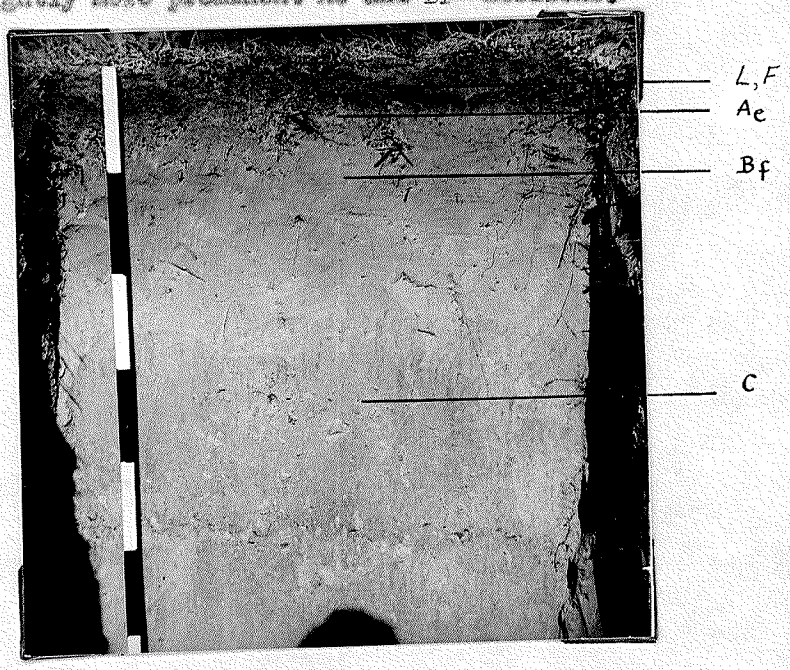


Figure 36. Sandilands Profile

Sandilands Series — Dumed Phase.

Plot 53. — Location: East centre of S.E. quarter of 25 - 1 - 13 WPM

L Horizon — Jack pine needles and twigs (1" - 1/2").

F Horizon — Very dark grey (10YR 3/1) weakly decomposed litter (1/2" - 0), strongly acid in reaction; grades into an Ae horizon with an abrupt smooth boundary.

Ae Horizon — Grey when dry to dark grey when moist (10 YR 6/1 - 4/1) fine sand (0 - 1"); structureless; loose when moist, loose

loose when dry, strongly acid in reaction; grades into a Bf 1 horizon through an abrupt smooth boundary.

Bf1 Horizon — Pale Brown when dry to brown when moist (10 YR 6/3 - 5/3) fine sand (1" - 3"); structureless; loose when moist, loose when dry; medium acid in reaction; grades into a Bf 2 horizon through a gradual smooth boundary.

Bf2 Horizon — Light yellowish brown when dry to yellowish brown when moist (10 YR 6/4 - 5/4) fine sand (3 - 10"); structureless; loose when moist, loose when dry; strongly acid in reaction, grades into a BfC horizon through a diffuse smooth boundary.

BfC Horizon — Very pale brown when dry to light yellowish brown when moist (10 YR 7/4 - 6/4) fine sand (10" - 15"); structureless loose when moist, loose when dry; medium acid in reaction; grades into a C horizon through a diffuse irregular boundary.

C Horizon — Very pale brown (10 YR 8/4 - 7/4) fine sand (15" +); structureless; loose when moist, loose when dry; medium acid in reaction.

NOTE: The solum is very weakly developed. There is 1/2" to 1" of Ao below the needle litter and a thin gradual fading of colour downward. The upper part of the B horizon seems to have some organic matter addition from shallow roots. Some deep buried organic mineral layers were encounted below 4 feet.

Lonesand series. — Location: Centre of SE 1/4 7-3-17E

F Horizon — Very dark greyish brown (10 YR 3/2) partially decomposed leaf, twig, and root litter (1 1/2 - 1/2), strongly acid in reaction.

H Horizon — Black (10 YR 2/1), mixed well decomposed organic matter and mineral material (1/2 - 0); medium acid in reaction; weakly

mottled with iron concretions; grades into an Aeg horizon through an abrupt smooth boundary.

Aeg Horizon — White when dry to light grey when moist (10 YR 8/2 - 7/2) sand (0 - 4"), structureless; loose when moist, loose when dry; medium acid in reaction, weakly mottled with iron concretions; grades into a Bfg1 horizon through a clear wavy boundary.

Bfg1 Horizon — Pale brown when dry to brown when moist (10 YR 6/3 - 5/3) sand (4 - 6"); structureless; loose when moist, loose when dry; medium acid in reaction, mottled with iron concretions; grades into a Bfg2 horizon with a clear wavy boundary.

Bfg2 Horizon — Reddish yellow when dry to dark brown (7.5 YR 6/6 - 4/4) sand (6 - 14"); structureless; loose when moist, weakly cemented when dry; medium acid in reaction; strongly mottled with iron concretions. Tongues into a Cg horizon through a gradual irregular boundary.

Cg Horizon — Light brown when dry to brown when moist (10 YR 6/4 - 5/4) sand (14" +); structureless; loose when moist, loose when dry; slightly acid in reaction; strongly mottled with reddish yellow when dry to yellowish red when moist (7.5 YR 6/6 - 5/6) iron concretions.

Woodridge series. — Location: 17 - 6 - 10ZW

L-F Horizon — Organic mat of pine needles, bark, grass and herb remains (1" - 0). This horizon grades into an Ash horizon with an abrupt smooth boundary.

Ash Horizon — Dark greyish brown (10 YR 4/2) when dry, sand (0 - 3"); weak fine crumb structure; very friable when moist, soft when dry; medium acid in reaction. Grades into an Ae horizon through a

clear smooth boundary.

Ae Horizon — Pale brown (10 YR 6/3) when dry, sand (3 - 6"); structureless; loose when moist, loose when dry; strongly acid in reaction. Grades into an AeB horizon through a clear smooth boundary.

AeB Horizon — Light yellowish brown (10 YR 6/4) when dry, sand (6 - 9"); structureless, loose when moist, loose when dry; strongly acid in reaction. Grades into a B1 horizon through a gradual smooth boundary.

Bf Horizon — Yellowish brown when dry (10 YR 5/4), sand (9 - 11"); structureless, very friable when moist, weakly cemented when dry; strongly acid in reaction. Grades into a B2 horizon through a gradual smooth boundary.

Bt Horizon — Dark yellowish brown when dry (10 YR 4/4), sand to course sand (11 - 13"); weak fine crumb structure; very friable when moist, weakly cemented when dry; medium acid in reaction. Grades into a Ch horizon with an abrupt smooth boundary.

Ch* Horizon — Dark greyish brown when dry (10 YR 4/2), fine gravel with white pebbles (13 - 14 1/2"); structureless; loose when moist, loose when dry; mildly alkaline in reaction. Grades into a C1 horizon with a gradual smooth boundary.

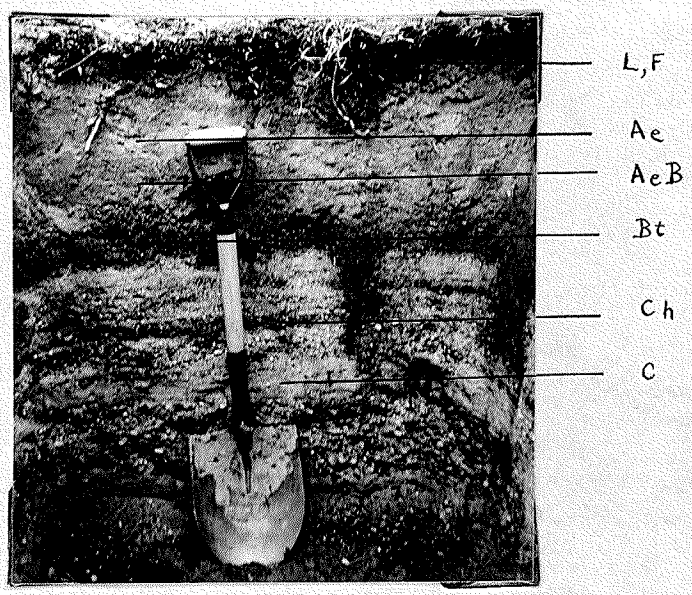
C1 Horizon — Very pale brown when dry (10 YR 7/4), coarse sand to fine gravel (14 1/2 - 19"); structureless; loose when dry, loose when moist; mildly alkaline in reaction, effervesces strongly. Grades into a C2 horizon with a gradual smooth boundary.

* This is a zone of root concentration believed to be brought about by the perching of water in this course layer due to the presence of a finer layer immediately beneath it.

C2 Horizon — Very pale brown when dry (10 YR 7/3), sand to fine gravel (19" +); structureless; loose when dry, loose when moist, mildly alkaline in reaction, effervesces strongly.

NOTE: This profile might be weakly podsolised. Any clay accumulation appears to be in the bottom of the B2 layer.

Figure 37. Woodridge Series



Birds Hill series — Location: East centre of 14-2-9 EPM

F-H Horizon — Very dark greyish brown (10 YR 3/2), partially decomposed leaf mat and charcoal (1" - 0); neutral in reaction. Grades into an Ae horizon with an abrupt smooth boundary.

Ae Horizon — Very pale brown (10 YR 7/3), coarse sand (0 - 4"); structureless;loose when moist, loose when dry; medium acid in reaction. Grades into an Ae Bt horizon with a gradual smooth boundary.

AeBt Horizon — Light yellowish brown (10 YR 6/4), coarse sand (4 - 7"); struc-

structureless; loose when moist, loose when dry; medium acid in reaction. Grades into a Bt horizon with a clear smooth boundary.

Bt Horizon — Dark yellowish brown (10 YR 4/4), coarse sandy loam (7 - 10"), weak fine blocky structure; very friable when moist, slightly hard when dry; contains a strong or cobbly lens; slightly acid in reaction. Grades into a BtG horizon with an abrupt smooth boundary.

BtG Horizon — Pale brown (10 YR 6/3), gravel (10 - 18"); structureless; loose when moist, loose when dry; effervesces; mildly alkaline in reaction. Grades into a C horizon with a clear, smooth boundary.

C Horizon — Light grey (10 YR 7/2), stratified coarse sand and gravel (18" +); structureless; loose when moist, loose when dry; effervesces strongly; mildly alkaline in reaction.

NOTE: — There was less than 1/2" of Ah. The Ae horizon is stained in colour in lower portion with either clay and iron or iron alone. There is a thick BtG horizon which occupies the coarsest layer and is a zone of root concentration. This soil in the Piney map area is probably more strongly leached than much of the Birds Hill soils mapped in other areas. The depth of the Bt horizon appears to depend upon the depth of sand to the first coarse layer.

Mirko Series — Location: North-west corner of 1-3-9 WPM

H Horizon — Black (10 YR 2/2), well decomposed organic matter and charcoal (2" - 0); medium acid in reaction. Grades into an Aeg horizon

with an abrupt smooth boundary.

Aeg Horizon — Pale brown (10 YR 6/3), sand (0 - 2 1/2"); structureless; loose when moist, loose when dry; weakly iron stained; medium acid in reaction. Grades into a Btg horizon with a clear smooth boundary.

Btg Horizon — Yellowish brown (10 YR 5/4), stony coarse sandy loam (2 1/2 - 8"); weak medium crumb structure; very friable when moist, slightly hard when dry; weakly iron stained; effervesces, mildly alkaline in reaction. Grades into a BCg horizon with a gradual irregular boundary.

BCg Horizon — Light yellowish brown (10 YR 6/4), gravel (8 - 13"); structureless; loose when moist, loose when dry; weakly iron stained; effervesces; mildly alkaline in reaction. Grades into a Cg horizon with a gradual smooth boundary.

Cg Horizon — Light grey (10 YR 7/2); stratified sand and gravel (13" +); structureless; loose when moist, loose when dry; weakly iron stained; effervesces; mildly alkaline in reaction.

NOTE: This profile has less than 1/4" of Ah horizon. Sharp break from Aeg to Btg. Btg is irregular due to presence of limestone and granitic cobbles. The limestones are present in the Btg horizon which is alkaline in reaction. BCg horizon appears to be mainly a layer of root concentration. Iron staining is not prominent in this imperfectly drained soil.

Pine Ridge Series — Location: Centre of 17-2-11 EPM

F Horizon — Organic matter layer consisting of partially decomposed needles, twigs, bark and grasses (1" - 0).

Ahe Horizon	Dark yellowish brown (10 YR 4/1) when dry, sand (0 - 1"); structureless; loose when dry, loose when moist; slightly acid in reaction. Grades into an Ae horizon with an abrupt smooth boundary.
Ae Horizon	Light brownish grey (10 YR 6/2) when dry to pale brown when moist (10 YR 6/3), sand (1 - 8"); structureless; loose when dry, loose when moist; medium acid in reaction. Grades into a Bt horizon with a clear smooth boundary.
Bt Horizon	Light yellowish brown (10 YR 6/4) when dry to yellowish brown (10 YR 5/4) when moist, coarse sand (8 - 12"); weak fine crumb structure; firm when moist, soft when dry; strongly acid in reaction. Grades into a B3 horizon with a clear smooth boundary.
B+C Horizon	Brownish yellow (10 YR 6/6) when dry to yellowish brown (10 YR 5/6) when moist, coarse sand to sand (12 - 18"); structureless; loose when moist, loose when dry; medium acid in reaction; grades into a C1 horizon with a gradual irregular boundary.
C1 Horizon	Very pale brown (10 YR 7/3) when dry to pale brown (10 YR 6/3) when moist, sand to coarse sand (18 - 22"); structureless; loose when moist, loose when dry; mildly alkaline in reaction; effervesces. Grades into a C2 horizon with a clear irregular boundary.
C2 Horizon	White when dry (10 YR 8/2) to light grey when moist (10 YR 7/2) sand; structureless; loose when dry loose when moist; mildly alkaline in reaction; effervesces.
NOTE:	Very often the Bt horizon is located in a fine gravel to coarse sandy loam in the profile. The parent material here

appears to be only slightly calcareous.

Wintergreen Series.

This soil exhibits the same general profile characteristics as the Orthic Grey Wooded sub-group but has iron mottling in a major portion of the Ae horizon. The Bt horizon of this soil very often forms in a coarser lens in sand which contains large pebbles of limestone. These pebbles may occur in pockets which gives rise to the formation of a broken Bt horizon.

Raynham Series. Location: Centre of east side of 12-2-11 W4M

F Horizon — Very dark brown (10 YR 2/2) when dry to black (10 YR 2/1) when moist, partially decomposed leaves, twigs, grasses and herbs (1 - 1/2"); neutral in reaction.

H Horizon — Black (10 YR 2/1), well decomposed organic matter mixed with fine sand (1/2 - 0); structureless; loose when dry, loose when moist; medium acid in reaction. Grades into an Ae horizon with an abrupt smooth boundary.

Ae Horizon — Grey (10 YR 5/1) when moist to light grey (10 YR 6/1) when dry, fine sand (0 - 2"); structureless; loose when moist, loose when dry; medium acid in reaction. Grades into a Bf horizon with an abrupt smooth boundary.

Bf Horizon — Very pale brown when dry (10 YR 7/3) to light yellowish brown when moist (10 YR 6/4), fine sand (2 - 5"); weak medium platy structure; very friable when moist, slightly hard when dry; strongly acid in reaction. Grades into an Ae horizon with a clear wavy boundary.

Ae horizon — Light grey when dry (10 YR 7/1) to light grey when moist (10 YR 7/2), fine sand (5 - 7"); weak medium platy structure; very friable when moist, slightly hard when dry; medium acid in reaction. Grades into a Bt horizon with a clear smooth boundary.

Bt Horizon — Dark greyish brown when dry (10 YR 4/2) to dark brown when moist (10 YR 3/3), clay (7 - 12"); strong fine blocky structure; firm when moist, extremely hard when dry; strongly acid in reaction. Grades into a BC horizon with a clear smooth boundary.

B+C Horizon — Light yellowish brown when dry (10 YR 6/4) to dark yellowish brown (10 YR 4/4), sandy clay loam (12 - 16"); weak fine crumb structure; friable when moist slightly hard when dry; neutral in reaction. Grades into a C horizon with a clear wavy boundary.

C Horizon — Very pale brown (10 YR 7/3 to 10 YR 7/4), sandy loam (16"+); moderate fine fragmental pseudo-structure; firm when moist, strongly cemented when dry; moderately alkaline in reaction, effervesces with dilute HCl.

NOTE: This profile does not represent the modal concept of the Bayham series. The sandy mantle is too shallow. Mineralogical analysis seems to indicate that the sandy layer above the Bt horizon was derived from different mineral material than the calcareous till from which the Bt was formed.

This soil is characterised by a podzol sequence of horizons occurring within the Ae horizon overlying a textural B horizon. The remaining portion of the solum has characteristics similar to those of an Orthic Grey Wooded soil developed on calcareous boulder

till or water-worked calcareous boulder till.

The podzol sequence, generally less than 12" thick, consists of a light grey Ae horizon and a yellowish brown to reddish brown Bt horizon. This upper sequum is underlain by and separated from the textural B horizon by a pale brown to yellowish brown Ae horizon. The reaction and base status of the podzol sequum is generally lower than that of the Orthic Grey Wooded Ae horizon.

Frequently iron concretions or mottles are found just above the Bt horizon which has developed from the calcareous boulder till. The siliceous sandy mantle over the calcareous boulder till is generally 16 - 30" thick.

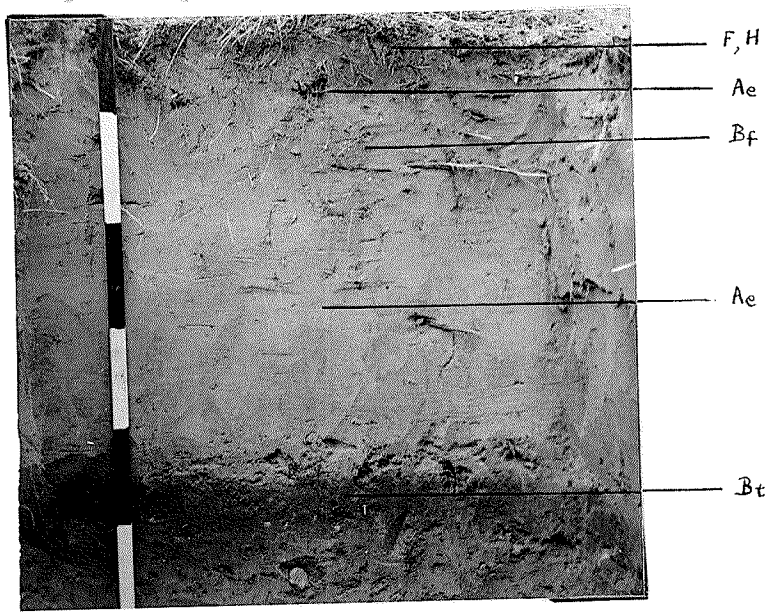


Figure 38. Raynham Series.(The Bf horizon is barely perceptible when dry).

Vassar Series Plot 37. Location: SE corner of 36-1-12 SPM

F Horizon Very dark brown (10 YR 3/2), partially decomposed leaf, twig and root litter (1" - 0); medium acid in reaction; grades into

an Ae horizon with a clear smooth boundary.

Ae Horizon — Light grey to greyish brown (10 YR 7/1 - 5/2), sand (0 -4"); structureless; loose when moist, loose when dry; strongly acid in reaction. Grades into a Bf Ae horizon with a clear smooth boundary.

BfAe Horizon — Brown to dark brown (10 YR 5/3 - 4/3), sand (4 - 8"); weak fine crumb structure; very friable when moist, soft when dry; strongly acid in reaction. Grades into a Bf horizon with a gradual smooth boundary.

Bf Horizon — Light yellowish brown to yellowish brown (10 YR 6/4 - 5/4); sand (8 - 15"); weak fine crumb structure; very friable when moist, soft when dry; strongly acid in reaction. Grades into an Ae horizon with an abrupt wavy boundary.

Ae Horizon — Very pale brown to pale brown (10 YR 7/3 - 6/3); sand (15 -15 1/2"); structureless; loose when moist, loose when dry; medium acid in reaction. Grades into an AeBt horizon with an abrupt wavy boundary.

AeBt Horizon — Brown to dark brown (10 YR 5/3 - 4/3); clay (15 1/2 - 17 1/2"); moderate fine blocky structure; firm when moist, hard when dry; medium acid in reaction. Grades into a Bt horizon with a gradual wavy boundary.

Bt Horizon — Dark brown to very dark brown (10 YR 4/3 - 3/3), clay (17 1/2 - 26"); strong medium to fine blocky structure; very firm when moist, very hard when dry; strongly acid in reaction. Grades into a BtC horizon with gradual wavy boundary.

BtC Horizon — Very pale brown to pale brown (10 YR 7/3 - 6/3) and brown to dark greyish brown (10 YR 5/3 - 4/2); clay (26 - 30"); weak

fine fragmental and weak fine blocky structure; firm when moist, hard when dry; mildly alkaline in reaction; effervesces with dilute HCl. Grades into a C horizon with a gradual irregular boundary.

C Horizon — Light yellowish brown to light brownish grey (2.5 Y 6/3 - 6/2) and light olive brown to greyish brown (2.5 Y 5/3 - 5/2) varved clay and silt loam (30"+); weak fine fragmental pseudo structure; firm to friable when moist, hard to slightly hard when dry, mildly alkaline in reaction, effervesces strongly; iron stained.

NOTE: The podzol sequum which occurs in the Ae horizon of the Grey Wooded soil developed on this material is generally less than 12" thick. However, when the sand mantle is deep (approx 30") the podzol sequum frequently is deeper than 12".

The Aelt horizon is frequently iron stained because of a temporary perched water table above the Bt horizon.

The clay till may be a mixture of slightly calcareous lacustrine clay and water-worked strongly calcareous till.

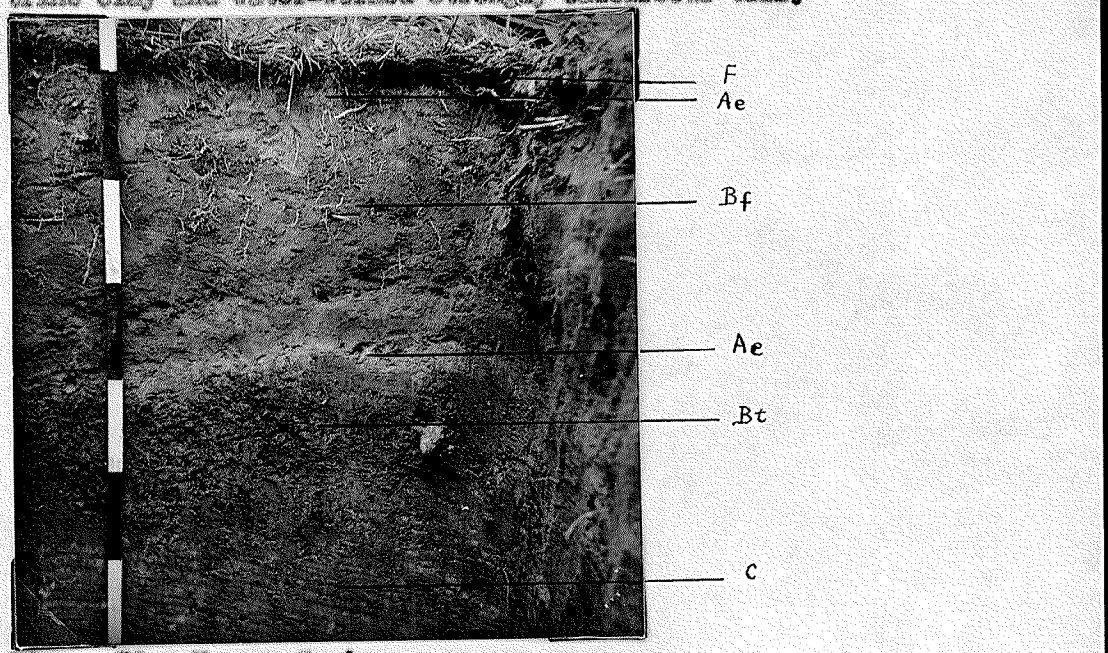


Figure 39. Vassar Series

Moose Lake Series. Location: NE corner of 2-3-16 BPM

L- F Horizon — Black (10 YR 2/2), partially decomposed fibrous mat of deciduous leaves, bark and roots (1" - 0); medium acid in reaction. Grades into an Aeh horizon with an abrupt smooth boundary.

Aeh Horizon — Light brownish grey to greyish brown (10 YR 6/2 - 5/2), fine sand (0 - 1"); structureless; loose when moist, loose when dry; medium acid in reaction. Grades into an Ae horizon with an abrupt smooth boundary.

Ae Horizon — Light grey to light brownish grey (10 YR 7/2 - 6/2), fine sand (1 - 3"); loose when moist, loose when dry; slightly acid in reaction. Grades into a Bf1 horizon with a gradual irregular boundary.

Bf 1 Horizon — Pale brown to brown (10 YR 6/3 - 5/3), fine sand (3 - 6"); structureless; loose when moist, weakly cemented when dry; medium acid in reaction. Grades into a Bf2 horizon with a gradual irregular boundary.

Bf 2 Horizon — Light yellowish brown to yellowish brown (10 YR 6/4 - 5/4); fine sand (6 - 11"); structureless; loose when moist, weakly cemented when dry; medium acid in reaction. Grades into an Ae horizon with a gradual irregular boundary.

Ae Horizon — Light grey to pale brown (10 YR 7/2 - 6/3), fine sand (11 - 17"), stained with very pale brown to light yellowish brown (10 YR 7/4 - 6/4); iron mottles; structureless; loose when moist, loose when dry; medium acid in reaction. Grades into a Bt horizon with an abrupt irregular boundary.

Bt Horizon — Yellowish brown to dark yellowish brown (10 YR 5/4 - 4/4); fine sandy loam to fine sandy clay loam (17 - 19"); weak fine blocky

structure; firm when moist, hard when dry; neutral in reaction. Grades into a BtC horizon with a clear irregular boundary.

BtC Horizon — Pale brown to brown (10 YR 6/3 - 5/3), loamy fine sand (19 - 20"), weak fine crumb structure; very friable when moist, slightly hard when dry; mildly alkaline in reaction. Grades into a Ck horizon with an abrupt irregular boundary.

Ck Horizon — White to light grey (10 YR 8/2 - 7/2), silt loam (20 -29"); weak fine fragmental pseudo structure; friable when moist, strongly cemented when dry; effervesces violently; moderately alkaline in reaction. Grades into a C horizon with a clear irregular boundary.

C Horizon — Light grey to light brownish grey (2.5 Y 7/2 - 6/2), very fine sand (29"+); weak fine fragmental pseudo structure; very friable when moist, weakly cemented when dry; effervesces strongly; moderately alkaline in reaction; weakly iron stained.

NOTE: Podzolization is distinct in this soil. The Bt horizon is variable in thickness and is broken where a limestone boulder above has caused the precipitation of clay. The solum above the Bt is mottled or blotched throughout and in places there is not a distinct Ae (grey wooded). There is a concentration of stones and boulders at about 12" below the surface. There is an apparent strong $CaCO_3$ concentration below the Bt horizon. The parent material was probably stratified.

Birch Point Series.

This soil exhibits the morphological characteristics of an Orthic Grey Wooded soil developed on very fine sand to silty clay loam calcareous sediments. The solum of this series is much deeper on the sandy textured less calcareous material than on the finer

textured more calcareous sediments.

Hungarian Series.

This soil exhibits the morphological characteristics of a gleyed Grey Wooded soil developed on very fine sandy to silty clay loam calcareous sediments. The solum is generally iron stained throughout and is not as strongly developed as in the Birch Point series.

The solum is deeper on the sandy textured less calcareous material than on the finer textured more calcareous sediments.

Carrick Series. Location: South centre of north-west quarter of 2-3-10 EPM

L - F Horizon — Black to very dark brown (10 YR 2/1 - 2/2), partially decomposed leaves, twigs, grasses and herbs (1/2"- 0); neutral in reaction. Grades into an Ae horizon with an abrupt smooth boundary.

Ae Horizon — Light grey to greyish brown (10 YR 7/2 - 5/2), fine sand (0 - 2"); weak medium platy structure; very friable when moist, loose to soft when dry; medium acid in reaction. Grades into a Bf horizon with a clear smooth boundary.

Bf Horizon — Very pale brown to brown (10 YR 7/3 - 5/3), fine sand (2 - 6"); weak medium platy structure; very friable when moist, slightly hard when dry; medium acid in reaction. Grades into a Bt horizon with a clear smooth boundary.

Bt Horizon — Yellowish brown to dark brown (10 YR 5/4 - 4/3), heavy clay loam (6 - 10"); moderate fine subangular blocky structure, firm when moist, very hard when dry; medium acid in reaction. Grades into a B^3 horizon with a clear wavy boundary.

B+C Horizon — Very pale brown to pale brown (10 YR 7/3 to 6/3), clay loam (10 - 12"); weak fine granular structure; firm when moist, hard when dry; mildly alkaline in reaction. Grades into a C horizon with a gradual wavy boundary.

C Horizon — White to light grey (10 YR 8/2 - 7/3), clay loam to silty clay (12"+); strong medium fragmental pseudo structure; firm when moist, strongly cemented when dry; moderately alkaline in reaction; effervesces strongly with dilute HCl.

NOTE: — This profile appears to have developed directly on the calcareous boulder till. The gritty platy structured and soft to slightly hard consistence of the Ae and Bf horizons leave this impression.

The Ae horizon appears to be slightly podzolised as indicated in the above description. The Bf horizon merges with the Bt horizon. Slight podzolisation in the Ae seems to be a common characteristic of the members of the Carrick series.

Piney Series. — Location: South-east corner of 7-3-17 MPR

L Horizon — Very dark brown (10 YR 2/2) leaf litter (2 - 1 1/2");.

H Horizon — Black (10 YR 2/1); well decomposed organic matter (1 1/2" - 0); slightly acid in reaction; mixed with some fine sandy mineral material. Grades into an Aeg horizon with an abrupt smooth boundary.

Aeg Horizon — Light brownish grey when dry (10 YR 6/2) to greyish brown when moist (10 YR 5/2); fine sand (0 - 3"); structureless; loose when moist, loose when dry; contains iron concretions; slightly acid in reaction. Grades into a Btg horizon with a clear wavy boundary.

Btg Horizon — Brown when dry (10 YR 5/3) to dark brown when moist (10 YR 4/3); clay loam (3 - 6"); weak fine blocky structure; firm when moist, slightly hard when dry; stained with iron mottles; contains a gravel and cobble lens; neutral in reaction. Grades into a BCg horizon with a clear wavy boundary.

BCg Horizon — Light brownish grey when dry (2.5 Y 6/2) to greyish brown when moist (2.5 Y 5/2), clay loam (6 - 8"); weak fine crumb structure; firm when moist, slightly hard when dry; stained with iron mottles; effervesces with dilute HCl; mildly alkaline in reaction. Grades into a Cg horizon with a diffuse irregular boundary.

Cg Horizon — Light grey when dry (2.5 Y 7/2) to light brownish grey when moist (2.5 Y 6/2); clay loam (8"+); weak fine fragmental pseudo structure; firm when moist; cemented when dry; contains iron mottles; effervesces violently; moderately alkaline in reaction.

NOTE: The Btg horizon was formed in a gravel, and cobble lens and is not strongly developed. Unlike the Carrick series does not show any signs of weak podzolisation in the Aeg horizon .

Figure 40. Piney Series

Acland Series

This soil is characterised by a thin O horizon a very dark grey to black Ahag horizon with lighter greyish leached spots or bands; a Bg horizon which may be somewhat finer in texture than the A horizon. Iron staining is quite conspicuous in a major portion of the Ahag horizon.

The Ahag horizon may be contained entirely within a shallow deposit of lacustrine sand to clay less than 6" thick.

The Bg horizon may sometimes occur within a coarse lens of gravel or cobbles.

Brokenhead Series.

This soil is morphologically similar to the Orthic Grey Wooded soil on the same parent material as the South Junction series except that iron staining occurs in a major portion of the Aeg horizon and all of the Btg. If a C horizon is present in the clay mantle it is usually calcareous and contains pockets of concretionary calcium carbonate.

The accompanying photograph shows a ditch exposure of the South Junction series which is the well drained member of this catena. The clay shows up as a dark layer.

Figure 41. South Junction Series

Pine Valley Series.

This soil is characterised by a thin organic horizon a very dark grey to black Ahcg horizon with lighter greyish leached spots or bands; a Bg horizon which may be somewhat finer in texture than the A horizon. Calcium carbonate concretions occur in pockets in the C horizon. Iron staining may be difficult to see in this dull olive coloured clay.

This profile type occurs over an unconforming horizon of strongly calcareous boulder till or water-worked boulder till. In the till substrate phase the C horizon may be absent.

In the Piney map area the Pine Valley till substrate phase appears to be the most common type.