CERTAIN ECOLOGICAL ASPECTS OF SELECTED BOGS IN NEWFOUNDLAND

FREDERICK C. POLLETT

CERTAIN ECOLOGICAL ASPECTS OF

SELECTED BOGS IN NEWFOUNDLAND

by

© Frederick C. Pollett, B.A., B.Sc.

A Thesis

submitted in partial fulfillment
of the requirements for the degree of
Master of Science
Memorial University of Newfoundland

March, 1967

"Rich is the country which has within
its limits untaxed natural assets of
such dimensions as those Newfoundland
has in her bogs."

Løddesøl (1955)

ABSTRACT

Six areas of Newfoundland were selected for the purpose of investigating the various bog types on the island. These study regions extended from the Avalon Peninsula (Region I) west to St. George's (Region V) and north to Daniel's Harbour (Region VI). A total of 178 peat deposits were studied, which included bogs, fens, and to a lesser extent, marsh accumulations.

The rate and type of accumulation of these deposits is controlled by physiographic factors, such as climate and geology. Pleistocene glaciation has played an important role by the formation of depressions and by damming water, thus creating an environment favourable for bogland development. Fire has resulted in paludification which encouraged the expansion of bogs over relatively dry ground. It was found that climate is the predominant factor controlling the growth and expansion of bogs in Newfoundland. Blanket bogs are most common in Newfoundland, eapecially in the coastal areas, and predominate in all but Terra Nova (Region IV). In Region IV raised bogs are more prevalent than blanket bogs; in Region I raised boga are found but only in localized depressions surrounded by forested slopes. In some areas there are larger bogs formed by the combination of raised centers coalesced by blanket bog. Paludification in all regions result in blanket bog expansion. Wesleyville (Region III) has the largest blanket bogs, in any of the study regions, covering many square miles spreading over bare granite bedrock within the past forty years.

From the study of peat cores, cross-sections were compiled showing the types of peat in some Newfoundland bogs. Bog development is preceded by a growth of fen species, gradually dominated by Cyperaceae and then by the Sphagnum species. Surfaces of both blanket and raised bogs have similar species with sedges Scirpus spp. and Carex spp. more abundant in blanket bogs; Scirpus cespitosus, Sphagnum spp. and ericaceous shrubs dominate the raised bog surface. Raised bogs generally have a good regeneration complex with Sphagnum cuspidatum in flashets, Sphagnum magellanicum the dominating mat component and Sphagnum rubellum, Sphagnum fuscum, Sphagnum flavicomans and Sphagnum imbricatum the hummock-forming species. Ericaceous shrubs, lichens and bryophytes (other than Sphagnum) are commonly found occupying drier surfaces. Other species such as Myrica gale, Menyanthes trifoliata and Carex spp. are principally found in minerotrophic sites such as soaks, drainage channels or bog borders.

The surface features, types of peat, their origin and development; the affects of physiographic processes and fire on bog formation and expansion are discussed.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

I would first like to acknowledge the aid and cooperation received from the Heads and staff of both the Mineral Resources Division of the Department of Mines and the Biology Department of Memorial University.

I am particularly indebted to Dr. W. O. Pruitt, Jr., Associate Professor at Memorial University, for his supervision and suggestions. I gratefully acknowledge Dr. A. W. H. Damman, Research Officer, Federal Department of Forestry, St. John's, Newfoundland, for his time and advice as well as identification of many bog plants. Sincere thanks are given to Dr. F. A. Aldrich, Head (pro tempore), Department of Biology, Memorial University, for his aid during my years with the Department, and for his comments on the style of the text. Thanks are also offered to Dr. T. W. McKenney, Assistant Professor, Memorial University, for reading parts of the first draft.

I am indebted to Mr. L. Moores, photographer, for his cooperation in the field and time spent on the many figures in the text, and also to Miss L. Sullivan for the typing of the final draft of my thesis. This work could not have been done without the help of my field assistants and persons who accommodated us in various towns about the island.

This research was conducted through the Biology Department of Memorial University of Newfoundland under a graduate fellowship.

INTRODUCTION

Gerard Boate in 1652 classified several types of Irish bogs; in 1685 William King described their development, emphasizing the changes in peat communities which accompanied peat accumulation (Gorham 1957). Since then the study of bogland has been undertaken by many investigators, especially in northern Europe, in such places as the British Isles, Germany and the Scandanavian countries. The emphasis of these studies was on the economic importance of bogs in agriculture, horticulture and reforestation. Such economic investigations have contributed much to the knowledge of ecology of bog types and their substrata.

It has been estimated by Healy (1963) that there are approximately 7,800 square miles of bog in Newfoundland comprising about 17% of the total land area. In some areas of the island individual bogs are a maximum of eight miles long; discontinuous bogs, which are relatively common, sometimes exceed this length. Even though such a large proportion of the island is bog there has been comparatively little work one on any aspect other than agricultural reclamation.

In North America the peat resources of various states have been assessed and valuable ecological data are found in such published work as: Dachknowski-Stokes (1912, 1941), Auer (1930), Waksman (1942), Leverin (1946) and Rigg (1958). In Newfoundland, however, there is no complete report on peat resources. I am presently working on such a publication.

In 1955, the Newfoundland Government invited Dr. A. Løddesøl, a director of the Norwegian Bog Association, to study the potentiality of resources lying dormant in bogs on the island. This survey lead to further investigation and in 1956, a section on agricultural reclamation was included in the report of the Newfoundland Royal Commission on Agriculture. Also, the Mineral Resources Division of the Department of Mines, Agriculture and Resources conducted peat moss surveys by Gillespie (1954), Lear (1960), Day and McKillop (1962) and Pollett (1964, 1965). Other than this there has been little done on a classification or a study of bog and peat types. In agriculture, the Federal Experimental Farm at Mount Pearl has study plots at Colinet bogs and the Provincial Government, under the direction of J. V. Healy, is experimenting with bog surfaces in various parts of the island. The reforestation of bogs has not been stressed; however, the Federal Forestry Research Branch hopes to begin this aspect of study this year.

The work discussed here began in a survey conducted by the author. The purpose of this work is to provide a background for the bog investigator. This is attempted by giving the types of bog found in six study regions, and by discussing the physiographic processes involved in their formation. A glossary of terms is included in the appendices to facilitate others working in this field. Because of the sheer amount of bogs in Newfoundland such a study is pertinent and should provide useful information both in future economic and academic research.

Extensive bog growth in Newfoundland is a factor of climate, soils and bedrock geology. It is mainly a feature of areas with poor drainage, thus giving rise to waterlogged soils which, according to Pearsall (1938), restricts the circulation of air and severely depletes the store of oxygen. Waksman (1925) stated that the peat-forming plants find these conditions favorable; especially when the high humidity of the air prevents evaporation and the temperature is low. Under such conditions decomposition processes are slow and the partially-decomposed plant residues give rise to peat. Waksman stated further that the decay of cellulose and hemicelluloses may be particularly slow in the case of Sphagnum, which grows abundantly in acid sites where nutrients, such as phosphorus and lime are scarce.

An attempt is made to correlate various environmental factors with bog development and to relate such development to physical factors such as convexity, depth and surface topography. Emphasis is placed on blanket bogs and raised bogs and the types of peat found throughout each.

STUDY REGIONS:

Newfoundland is situated between 46°35' and 51°39' North Latitude and 52°36' to 59°25' West Longitude. It is approximately 42,700 square miles in area of which an estimated 7,800 square miles are bog, fen, or marsh. (See Glossary)

Six study regions (Figure 1) were investigated with the purpose of comparing bog types, to demonstrate both similarities and differences. The selection of regional boundaries was made on the basis of variations in climate and vegetation and to a lesser degree according to topography, geology, and the effects of man.

Region I - Avalon Peninsula

This is the largest single area and includes all of the Avalon Peninsula and the isthmus between Placentia and Trinity bays. A total of one hundred bog areas was visited. These bogs underlie a substantial part of the region. The largest bogs are located near Sunnyside, Whitbourne and Branch. Figure 19 shows the location of the bogs within the region, each numbered for easy reference.

Region II - Bonavista

This region includes the northeastern tip of the Bonavista Peninsula. Emphasis is placed on bogs numbered 106 to 109 between Catalina and Bonavista. These bogs, comprising about 1,000 acres, are known collectively as Flower's Marsh.

Region III - Wesleyville

This region is located in northeastern Newfoundland extending from Valleyfield to Lumsden. Because of the lateness in the season and the expanse of bog, only 350 acres were surveyed in detail.

Region IV - Terra Nova

This large region includes the area from Hare Bay on the coast

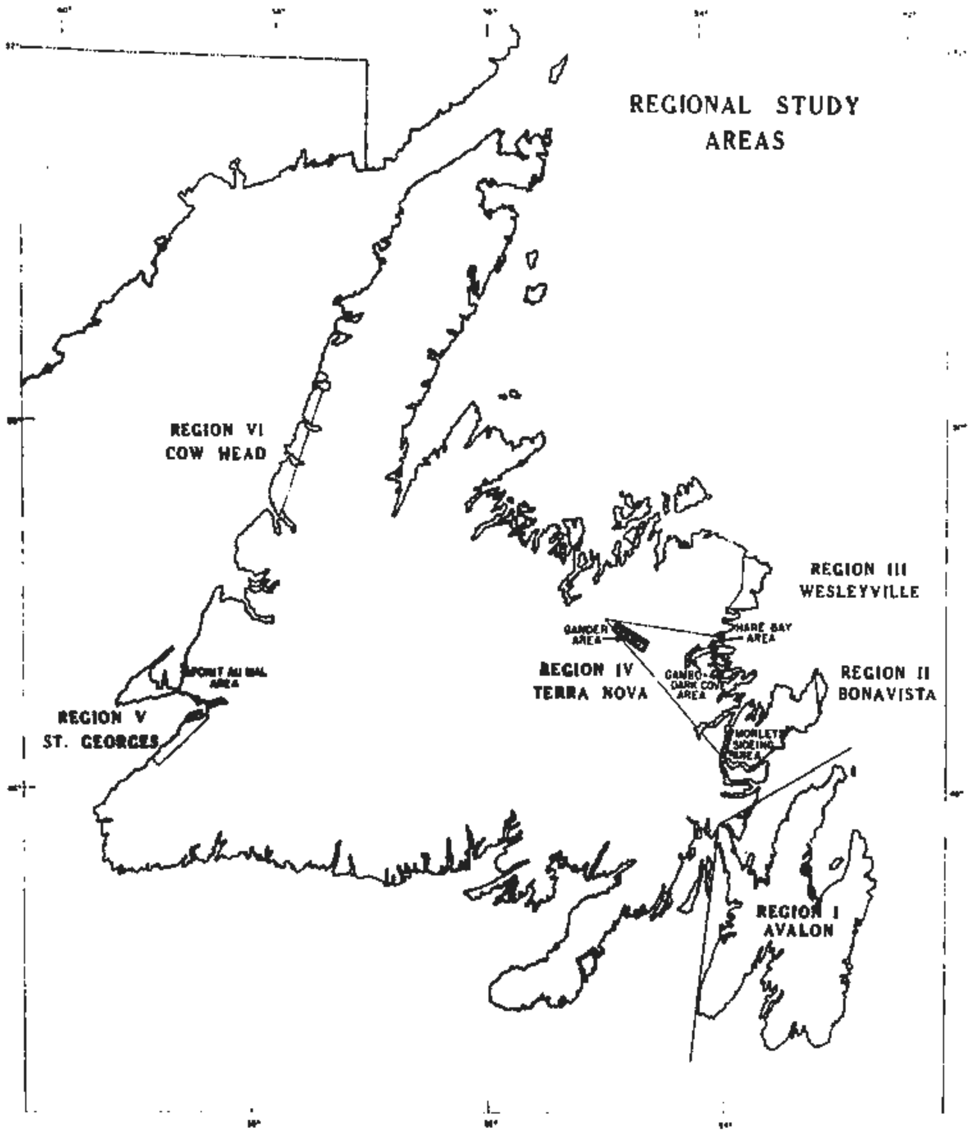

FIGURE 1. Map of Newfoundland showing the six
study regions.

to Gander inland. It is subdivided into four areas, Gander, Gambo-Dark Cove, Hare Bay and Morley's Siding. These are all similar in both vegetation and climate. This study region is less influenced by the sea and has a greater degree of continentality than the other regions.

Region V - St. George's

This region includes a number of coastal bogs extending from St. George's to Heatherton and other inland bogs accessible from the Trans-Canada Highway. A secondary small bog near Point au Mal is also included. Because of its proximity to the Table Mountains this bog was chosen for the purpose of studying the effects of drainage.

Region VI - Cow Head

This region is the most northerly one on the island and includes the bogland situated on the coastal plain between Baker's Brook to the south and Bellburns to the north. The study here was of short duration and consisted only of a reconnaissance of the area. A later visit allowed me to conduct a reconnaissance of bogland extending as far north as St. Anthony.

METHODS AND TECHNIQUES

A. Choice of Bog Areas:

A number of factors determined the bog areas which were to be surveyed. The emphasis is placed on areas which are presently accessible by road or by sea. Because of Newfoundland's geographical location the factor of transportation is foremost in determining the economic potential of any peat deposit. In all but Region I the bog areas examined exceeded 100 acres.

B. Selection of Bogs Investigated:

A complete series of topographic sheets of all accessible areas were obtained and from this bogs were identified. Aerial photographs were then examined under a stereoscope and physical features identifying zones of true organic terrain were sought. According to Graham and Tibbetts (1961, 1965) these features can be recognized easily. The bogs all occur in local depressions with their boundaries sharply delineated on the photographs by an abrupt change from a dark to a lighter grey. The bog area is usually outlined by a rim of spruce growth. Further, if a bog is too shallow it can be distinguished by a gradual merging of shading and textural contrast between organic and mineral soils.

Other factors of economic importance are drainage and accessibility. Surface growth presents little difficulty with most of the bogs having open surfaces. From the use of aerial photos the size, accessibility, density of growth, topography and drainage patterns can be measured.

C. Survey Techniques:

(i) Grid System:

A five-hundred-foot grid was made the standard control for all bogs which were surveyed in detail. Initially the bogs were examined cursorily to determine the depth and degree of humification of the peat. Soundings were taken at random and if the Sphagnum moss H 1-3 exceeded four feet in thickness a grid was established.

A base line was laid down along the long axis of the bog with offsets every five hundred feet extending from either side of the base line and continuing to the boundaries of the bog. These lines were chained with numbered pegs at regular intervals of five hundred feet. This type of grid involved the use of transit, chain and stadia rod and was designed according to methods used by Ziegler, 1946, and Tomter, 1963. For the purpose of a bog survey this method was slow and involved several men.

The method used in 1964 was faster and involved fewer men. This method required only the establishment of a base line with offsets temporarily set by compass and pace. At first a transit was used, but later a brunton compass and tripod replaced it, resulting in greater speed. Numbered pegs were placed along the base line at regular five-hundred-foot intervals. In order to survey temporary offset lines, a brunton sighting was taken along the base line, then a right angle was turned and a line was paced on the bearing with stations every five hundred feet. This method, however, was not as accurate as the transit-laid grid and was not used in the following season.

The third method adopted incorporated both speed and accuracy and involved only three men. Each bog was selected on an aerial photograph and the photo was then projected onto tracing paper by means of a Saltzman projector. The enlarged image was set at the required scale and the outline of the bog and check points such as ponds, streams, trees and shrub were drawn. An underlay 1" grid was then placed beneath the tracing and the grid was drawn directly on the outline. This tracing with grid and check points could be taken into the field and the stations established from sight with the aid of pace and compass technique. Information, also, can be written directly on the tracing. This third method, because of its efficiency and accuracy could be utilized for a majority of the bog areas studied.

(ii) Elevations:

The purpose of obtaining elevations was to provide data for mapping of surface contours and drainage patterns. Readings were taken by means of transit and stadia rod in the first grid method, with shots at every station plus extra readings in irregular zones such as depressions or rises. This method was slow. A second method using a hand level and levelling rod was faster and more flexible because there was no heavy equipment involved. One drawback was that accurate readings could not be obtained at distances greater than 250' and bright sun made readings difficult.

To overcome these difficulties and to retain accuracy, a levelling rod was designed. This rod, 12' long and 5" wide, was made from light-weight plywood and marked at one foot intervals. Each of the top six intervals was a different color. This color pattern was repeated toward the bottom. At the mid-point a hinge and bolt was inserted to allow the rod to be folded and facilitate carrying it. This device proved successful and readings could be taken rapidly and at greater distances.

(iii) Sampling:

The Swedish sampler (Figure 2) was used in preference to the Davis sampler, because of the former's sturdiness, cylinder type core and the small auger at the bottom. The cylinder and handle are made of thick-walled stainless steel as a protection against rusting. The extension rods are graduated into meters and each is one meter long. The small auger penetrates the substratum and, is capable of removing a sample.

Above the auger is the cylinder which is 0.5 m. (19 inches long) and has a sliding cover controlled by turning the handle. The core is 2.0 cm. (0.8 inches) in diameter. The handle is detachable to allow the addition of the one-metre (38.37 inches) extension rod so that a sample can be obtained from the required depth.

Figures 2 to 7, show the subsequent steps in operating the sampler. After a station is chosen the sampler is first pushed to a depth of two feet. The cylinder must be closed before inserting the sampler into the bog. Through a series of clockwise turns it fills with the desired core. Next a counter-clockwise turn will close the cylinder which is then pulled to surface and opened. The peat sample is then studied *in situ* and a portion is squeezed in the hand to determine humification, vegetal content and structure of the peat. The remainder of the wet sample is placed in plastic bags which are tied, tagged and stored in a cool dry place.

This procedure is followed to sample the complete sequence from surface to bottom at each station. There are times when the cylinder will contain only water with fragments of *Sphagnum* and sedge. This may be for two reasons; firstly green or non-humified *Sphagnum* moss will not sample easily because of the plant structure. This can be overcome by turning the rod many more times than normally. Secondly, in some areas, such as under a quaking bog surface there are water pockets which are water with plant material in suspension.

Figure 2. Swedish sampler showing cylinder, handle, and extension rod. Photo taken on Elliston Bog (108).

Figure 3. Close-up of the open cylinder; note the small auger at the tip of the rod.

Figure 4. The sampler is first turned clockwise opening the cylinder.

Figure 5. Sampler is turned counterclockwise closing the cylinder. It is then pulled to the surface.

Figure 6. Sampler filled with peat moss.

Figure 7. Peat moss is taken into the hand and squeezed to determine the degree of humification (Table 1.)

D. Plant Collections:

The vegetation was sampled on four bogs in various regions to give an indication of plant association on Newfoundland bogs. Emphasis was placed on the Sphagnaceae. This collection was carried out by two methods: first by means of a transect along the base line, and second, by quadrats (Braun and Blanquet 1932; Becking 1957).

It is not my purpose to give a detailed account of the flora for each bog area, but to give an indication of the plants which make up the vegetation and influence the bog succession. The type of vegetation on various typical bog areas is important, however, and has been studied in some cases by means of the Radforth Classification System (Macfarlane, 1958; Radforth, 1953; Legget, 1961).

The plants were identified from Andrews 1913, Roland 1945, Fernald 1950, Petrides 1958 and Szezawinski 1962. Of these the work by Andrews proved to be most valuable in the identification of the Sphagnaceae. The herbaria of the Department of Forestry and Memorial University proved to be valuable references for verification of identification.

E. Classification of Vegetation Cover:

Radforth's (1956) classification of cover based on air form patterns were first used but later abandoned because of the difficulty of application. Radforth believed that a classification of cover based on species distribution may lead to confusion because of many species extending into various micro-environments. He asserted that cover assessed on a structural basis characterizes environment. In a limited study as undertaken here emphasis is placed on the dominant species of the cover rather than the structure of the vegetation. Almost all the bogs investigated are dominated by either sedge or sphagnum with variable proportions of other oxphylous plants. Radforth's method is of value in denoting differences in terrain as reflected by the surfaces of bog and bogland. This classification is given by Legget (1961) and Horwood and Radforth (1964) with reference to cross-Canada application. Allington (1961) classified bogs according to their physiographic characteristics with categories established from differing textures of the surfaces as they appeared on the aerial photographs. The use of aerial photography in investigations of organic terrain is invaluable and should be utilized to a greater extent.

F. Classification of Peat Types:

The co-division scale of humification set down by Lennart Von Post (1927) is used extensively in any description of peat types. This scale (Tables 1 and 2) covers the range from unconverted to completely converted peat. Texture of the substratum is described according to Radforth's classification of subsurface consitution (Macfarlane,1959). The type of peat or peat moss is named with relation to its constitutions and degree of decomposition. Appendix II on bog profiles contains a description of these types. Løddesøl, 1955), has set down the humification scale as follows.

<u>Von Post Scale:</u>

H 1: Completely unconverted and mud-free peat which when pressed in the hand gives off clear water only.

H 2: Practically completely uncoverted and mudfree peat which when pressed in the hand gives off almost clear, colourless water.

H 3: Little-converted or very slightly muddy peat which when pressed in the hand gives off markedly muddy water, but no peat substance passes through the fingers. The press residue is not thick.

H 4: Badly-converted or somewhat muddy peat which when pressed in the hand gives off markedly muddy water. The press residue is somewhat thick.

H 5: Fairly converted or rather muddy peat. Growth structure quite evident but somewhat obliterated. When pressed some peat substance passes through the fingers, but mostly very muddy water. The press residue very thick.

H 6: Fairly converted or rather muddy peat with indistinct growth structure. When pressed, at most 1/3rd of the peat substance passes through the fingers. The remainder extremely thick, but with more obvious growth structure than in the case of unpressed peat.

H 7: Fairly well converted or markedly muddy peat but the growth structure can be seen, however. When pressed, about half the peat substance passes through the fingers. If water is also given off this has the nature of porridge.

H 8: Well converted or very muddy peat with very indistinct growth structure. When pressed, about 2/3rds of the peat substance passes through the fingers and at times a somewhat porridge-like liquid. The remainder consists mainly of more resistant fibres and roots.

H 9: Practically completely converted or almost mudlike peat in which almost no growth structure is evident. Almost all the peat substance passes through the fingers as a homogenous porridge when pressed.

H 10: Completely converted or absolutely muddy peat where no growth structure can be seen. The entire peat substance passes through the fingers when pressed.

Graham and Tibbetts (1965) discuss a new technique put down by Goezke (1963). This evaluation is based on the "r-value" introduced by von Keppler (1920). This is defined as that percentage of weight of the peat substance (moisture and ash free) which is not dissolved by 80 per cent sulphuric acid. The more humified a peat sample is the more resistant it will prove against the acid attack. This procedure is outlined in Graham and Tibbetts (1965) and is expressed by the following formula:

$$r = \frac{(I - II) \cdot 100}{E \cdot \frac{(I - w = a)}{100}}$$

where

I = weight of residue after drying
II = weight of residue after burning
E = weight of air dried sample
w = moisture content of air dried sample
a = ash content of air dried sample

Table 2 illustrates how classification by the r-value is being used by the Peat Institute in Hanover for peat evaluation in comparison to the von Post scale.

Table 1. Method for field determination of humification of raw peat samples (from von Post and Granlund, 1925).

Humification scale	Evidence of degree of decomposition	Plant structure	Mud present	Water passing	Upon squeezing through fingers: Amt. of peat substance passing	Upon squeezing through fingers: Residue
1	Nil	- -	Nil	Yes. Clear and colourless	- -	- -
2	Almost nil	- -	Nil	Yes. Clear but yellow brown	- -	- -
3	Very little	- -	Little	Yes, distinctly turbid	- -	Not pulpy
4	Little	- -	Some	Very turbid	- -	Somewhat pulpy
5	Fairly evident	Barely recognizable	Moderate amount	Very turbid	Some	Very pulpy
6	Fairly evident	Indistinct less in residue	Moderate amount	- -	One-third	Very pulpy, shows plant structure more than unsqueezed turf
7	Strong	Fairly recognizable	Much	Yes, gruelly & dark in colour	One-half	- -
8	Strong	Very indistinct	Much	Yes or no. If it does, gruelly	Two-thirds	Consists of more resistant roots, fibres, etc., in main.

Table 1 - Continued

9	Almost fully decomposed	Almost unrecognizable	Very much	- -	Almost all as a uniform paste	- -
10	Completely decomposed	Entirely without plant structure	Entirely muddy	No free water	All	- -

Table 2. Correlation of the von Post Scale with the von Keppler "r-values". (After Graham and Tibbetts 1965).

H v. Post	Designation	r-value % (equalized)
1 - 3	Slightly humified sphagnum peat (white peat, light colour).	20 - 38
4 - 5	Slightly humified sphagnum peat (white peat, medium colour).	38 - 48
5 - 6	Rather strongly humified sphagnum peat (also called brown peat).	48 - 54
6 - 7	Strongly humified sphagnum peat (black peat).	54 - 63
8 - 10	Very strongly humified sphagnum peat (black peat).	63

G. Analyses of Peat Samples:

Several quantitive analyses were made on peat moss samples. The detailed procedures are described by Leverin (1964) and Graham and Tibbetts (1961) and outlined by Bannatyne (1964).

From these procedures the moisture content, absorptive value, ash content and pH were determined. Determination for nitrogen was modified, however, to give greater accuracy. This method closely resembles that outlined by Scott (1942) and Graham and Tibbetts (1961).

(i) Digestion procedure:

The one-gram portion of a dry, pulverized and well-mixed sample is placed in a 500 ml. Kjeldahl flask. Approximately 0.6 gm. of mercury and 10 gm. of potassium sulphate are added followed by 30 mls. of sulphuric acid with specific gravity 1.84. The flask is heated over a low flame until frothing ceases, after which the heat is raised and the solution brought to a brisk boil. Boiling is continued for an additional two hours after the solution becomes colourless. At this time digestion is completed.

(ii) Distillation Procedure:

The digested solution is diluted with 200 mls. of distilled water and approximately 2 gms. of granulated zinc added to prevent bumping. Then 25 mls. of potassium sulphate are added to fix the mercury followed by addition of concentrated sodium hydroxide in sufficient quantity to render the solution distinctly alkaline. Litmus paper is added to the solution to indicate the desired state. The flask is then connected to a distillation apparatus and the distillate is collected. To this distillate are added 10 mls. of approximately N/10 H_2SO_4. Calculations are then carried out by a standard formula.

Physiographic Processes Involved in Bogland Formation

A. Geology of Newfoundland:

The island of Newfoundland has been described as a slightly tilted plateau, as reflected in the generally decreasing elevation of its prominent topography features in an easterly direction.

Newfoundland forms the most northerly part of the Appalachian Mountain system and may be divided, on the basis of age and structural development, into three distinct belts; (1) the western Precambrian rocks and Lower Paleozoic deposits, (2) the central Paleozoic belt and (3) the eastern Precambrian rocks and Lower Paleozoic deposits (Williams, 1964).

The Long Range Mountains complex of schists and gneisses which form the core of the western belt, has been shown to be a Grenville inlier (Clifford and Baird, 1962). The Paleozoic rocks consist of two contrasting Cambrian-Ordovician sequences: a shelf facies comprising a carbonate sequence, and a clastic sequence, with associated volcanics and mafic to ultramafic intrusions. Each of these sequences is thousands of feet thick.

The central belt consists mainly of eugeosynclinal volcanics and sediments which are Ordovician and Silurian in age. In general, volcanic rocks predominate in its western part while sediments predominate in the east. Devonian granitic intrusives underlie extensive areas in the belt, and there are two relatively narrow zones of ultramafic intrusive rocks near its margins.

Basic to acidic volcanics and predominantly clastic sediments, of probable Proteozoic age, underlie most of the eastern belt. Isolated patches of Cambrian and Lower Ordovician sediments are preserved in down-faulted segments and synclinal troughs throughout the belt.

Late Paleozoic rocks occur only in the St. George's Bay and the Grand Lake-White Bay areas which are underlain by Carboniferous strata. These rocks are postorogenic, sedimentary deposits which include extensive evaporite sequences in the St. George's Bay area.

The rocks of the Island were deformed mainly during the Taconic and Acadian orogenies. The northeasterly trend, typical of the Appalachians, is very evident, particularly where the coastline is highly indented as a result of the characteristic fold pattern.

B. Soils:

The existing soils in Newfoundland have formed since the retreat of the last glaciation which, according to Olson and Broecher (1958), terminated on the Island about 7,400 years ago. The soils are thin and young because of the short time involved in their development and because of Newfoundland's climatic conditions. Many areas are underlain by a mixture of hard rocks resistant to disintegration and decomposition. The soils on ice-scoured surfaces vary from one to fifteen inches in depth (Newfoundland, 1956). There is, moreover, a direct relationship between the depth and quality of the soil, as well as the type of rock involved.

The Royal Commission report (Newfoundland, 1956) shows that the combined factors of humid climate and boreal vegetation have resulted in a podzolization of the soil in most cases. Most of the soluable mineral elements and organic matter have been removed from the topsoil and deposited in the subsoil. As a result, the topsoils tend to be ashen grey while the accumulation of iron salts and organic compounds has made the subsoils a yellowish brown. This leaching, together with the lack of limestone in the underlying rock, has produced a condition of strong acidity in the soil. Fernald (1918) has described the silicous and acidic rocks in Newfoundland and divides the Island into four regions.

Region I.	The calcareous western region north of Bay St. George, including the Northern Peninsula.
Region II.	The acid central region.
Region III.	The acid southeastern region.
Region IV.	The acid southwestern region.

The limestones, marbles, dolomites, traps and serpentines as well as calcareous slates and related clastics of western Newfoundland contribute to the formation of calcareous soil there. The eastern ridges of the Long Range are chiefly granite and pass into a great central lowland, or low tableland, of dominantly acid-rocks which extend to the Exploits Valley. The southeastern section, including the adjacent Avalon Peninsula, has rocks which are acidic or highly silicous. Fernald (1918) said that soil requirements are important factors in plant distribution on the island. He concluded that soil is more fundamental in determining this plant distribution than are considerable differences in temperature and humidity.

C. Glaciation:

Four glacial advances and retreats are believed to have occurred during Pleistocene time and each cycle is estimated to have lasted approximately 100,000 years (Flint, 1940). Olson and Broecker (1958) obtained a radiocarbon age of 7,400 ± 15 years on carbonaceous material taken from the base of Bay Bulls Bog (70). This may be interpreted as an approximate measure of the time since this last retreat.

Glacial maps after Flint (1940, 1952) show Newfoundland completely covered in the last advance by part of the Labrador Ice Sheet. Jeness (1960, 1963) gives evidence based on glacial striae which support the theory of a separate ice cap for Newfoundland. It is evident that the ice spread in all directions from a central zone, perhaps near Red Indian Lake. Similar evidence, as shown in Figure 8, supports the belief that a subsidiary ice cap occupied the Avalon Peninsula during some phase of the glaciation. This view is held by MacClintock and Twenhofel (1940), Riley (1962) and Jenness (1960, 1963). However, Henderson (1959) believes that this was part of an ice cap which spread across Placentia Bay.

Following the last glacial retreat, isostatic readjustment began with a gradual uplift of the land. Some areas, such as the Exploits Valley where the river channel extends out into the sea, are still far below pre-glacial elevations. Flint (1940) states that uplift during the Quaternary affected certain sections more than others. This is evident in the coastline in the vicinity of St. George's. Also, the

Figure 8. An outline of the Avalon Peninsula, showing the orientation of glacial striations (after Jenness, 1963).

coastline along the Northern Peninsula has been uplifted only about 80 feet as compared to an uplift of more than 100 feet near St. George's.

Prior to glaciation Newfoundland underwent an uplift of more than 1,000 feet with a tableland resulting. Towards the end of the Tertiary this was well elevated. The coastal areas were characterized by steep gulleys and young streams, whereas inland areas were relatively level. Then during glaciation the ice followed the pre-existing valleys to the sea, modifying existing formations and reshuffling and gouging deposits of till, glacial drift, and peat. The following uplift resulted in a rise toward the west and south, with certain areas, especially the northeastern and eastern, far below former level. The indented coastline with fiords and inlets are an indication of this.

D. Geology, Soils, and Glaciation (Regional Study):

(i) Region I: Avalon Peninsula:

Precambrian rocks, both sedimentary and volcanic, make up most of the Avalon Peninsula. These rocks are a mixture of hard volcanics with siliceous slates, sandstones and quartz conglomerates, all of which are resistant to erosion. Such rock types do not produce soil and soils of the Peninsula are composed mainly of rock flour, partially decayed foreign material, and a residium of the organic soils (Newfoundland, 1956). The better quality soils are restricted mainly to basins of Cambrian and Ordovician sediments, as for example, Manuels, where Cambrian rocks underlie a small band along the coast.

The Avalon Isthmus is characterized by numerous exposures of bedrock and "barrens" having a thin soil cover and sparse vegetation. The interior is covered largely by end moraine, much of which could be classified as barren, and supports a vegetation dominated by low-growing shrubs. The soils are mainly coarse-textured podzols that have developed on bouldery, unsorted, glacial materials. End moraine is also found in the larger valleys. Ground moraine covers much of the Avalon and is most extensive in the south and southwest, and may be continuous or discontinuous at depths form five to twenty feet. In many places ground moraine is covered by ablation moraine. Outwash and kame deposits are common with end moraine, but there are few eskers. Where there are eskers they are generally short and discontinuous (Henderson, 1959). There was no large scale damming of water by the retreating ice except for the area south of Whitbourne where moraines did influence the drainage pattern.

(ii) Region II: Bonavista:

The Bonavista bogs are underlain by Precambrian coarse clastics, red and green sandstones and siltstones with interbedded volcanics (Christie, 1950; Jenness, 1963). The bog area is located near a syncline and it appears that there is an anticline immediately to the east. This anticline has its axial plane orientated northward. Uplift in the area, as taken from Jenness' isobase map (1960), is approximately forty to fifty feet; evidence for this is based on the upper level of outwash deltas.

Ground moraines form a continuous or discontinuous cover and are concentrated in the valleys. There are no known eskers, kames, or outwash sands. Highway cuts in the area reveal a sandy till, presumably derived from underlying sandy rocks of the Musgravetown Group (Jenness, 1963). Indicator boulders are a distinctive feature, and there are frequent outcrops which disrupt drainage, thereby encouraging bog formation.

(iii) Region III: Wesleyville:

This study area is underlain,entirely, by the Devonian Ackley batholith, which is a coarse-grained porphyritic biotite granite. It has a distinctive elongated body orientated approximately N 30°E (Jenness, 1963). The rock is Middle Ordovician and appears to be post-tectonic. This granite is resistant to weathering and the many outcrops are practically bare of soil.

The Wesleyville region has been denuded by multiple fires and the result is an area of granite outcrop and boulder fields, with a few pockets of gravelly till and large expanses of bogland.

(iv) Region IV: Terra Nova:

The Gander area, which includes Bonanza Bogs (140, 141) and Gander Bog (139), is underlain by rock of the Middle Ordovician, consisting mainly of greywacke and argillaceous sandstones regionally metamorphosed to chloritic rock (Jenness, 1963). The Gambo-Dark Cove area is underlain by Devonian granites which are part of the Ackley batholith. The Hare Bay area is underlain chiefly by Precambrian schists which have been granitized, and by a granitized equivalent of Palaeozoic greywacke and argillacous sandstone. The Morley's

Siding area is underlain by Cambrian and Ordovician black shales and slate, with some older red, green and purple shales (Rose, 1948; Jenness, 1960, 1963).

The Glacial drift forms an almost continuous localized moraine in which the composition is controlled by the bedrock. Where there is underlying shale or slate, the moraine is rich in clay. An example of this may be seen in the area about Morley's Siding. In areas underlain by sandstone the moraine is generally of a gravelly texture. Rates of soil formation vary, with slates and shales providing the basis for a faster soil formation than sandstone and other hard rocks. The soil is relatively thick compared to Regions I, II and III and supports a substantial vegetation cover.

The region is characterized by deposits of outwash sand and gravel which occur in many valleys or at their mouths. These outwash deposits generally terminate in sandy deltaic deposits which may be more than ten feet above sea level (Jenness, 1963). Jenness (1963) also mapped twenty-five eskers and a few kames in the region.

(v) Region V: St. George's:

The west coast region is gently rolling, drift-covered lowland underlain by Carboniferous clastics and evaporites including minor limestones. According to Riley (1962) the rock is Mississippian in age and is made up of siltstones, gypsum, and anhydrite as well as red and grey sandstone. The Pennsylvanian is represented by a sequence of continental clastics with relatively minor coal measures. The Mississippian clastics, and possibly the evaporites, are the rocks most closely associated with bogland development.

Twenhofel (1940) describes three episodes in this area during the Wisconsin glaciation.

(i) ST. GEORGE'S RIVER DRIFT:
This is the oldest deposit and consists of till, plain gravel and kame gravel.

(ii) ST. GEORGE'S BAY DELTA STAGE:
This follows the first episode. It consists of glacio-marine deposits of silt and silty clay.

(iii) ROBINSON'S HEAD DRIFT:
This third episode is an upper suite of glacial deposits of till, plain gravel, and kame gravel.

The soil is a podzol and is acid because of the nature of the underlying bedrock; the climate, and vegetation. These acid soild support the growth of Sphagnaceous bogs, but are influenced in some measure by drainage from calcareous soils on the coast. Figure 9 shows a cross-section of surficial deposits which underlie the coast area on which many of the west coast bogs have formed.

The Point au Mal area is underlain principally by red, green and black shales which were originally mapped as Ordovician (Humber Arm Group), but which actually may be earlier Palaeozoic. The bog is formed on a very fine blue silt, probably of the St. George's Bay glacial deposits.

(vi) Region VI: Cow Head:
This study region is underlain by rocks of the Humber Arm Group. It is composed mainly of fine grained clastics, basalt, carbonate rocks and limestone breccias.

The surface geology of this area is dominated by postglacially uplifted marine sediments in the form of raised beaches and bars.

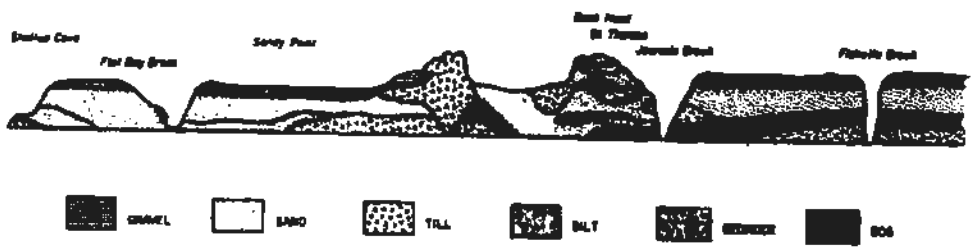

Figure 9. A cross section of glacial depositions between Shallop Cove and Fishel's River. (Modified from MacClintock and Twenhofel, 1940).

The end and lateral moraines, however, are still under water. The soils are mainly coarse textured podzols developed on flat to sloping beachlands. The glacial deposits are wave-worked in some areas and consist of sands and well-rounded gravels. (Newfoundland, 1956).

E. Climate

(i) Climatic Influences

The ocean is the dominating factor controlling Newfoundland climate, with the cold Labrador current exerting the greatest single influence (Hare, 1952; Lindroth, 1963). According to Lindroth the topographic diversity is another important influence. The Long Range Mountains have the greatest precipitation while shielding the lower regions from cold southeasterly air currently. Damman (1965) states that the distribution of certain plant species is evidence for an American continental influence; and reflects the prevailing southwesterly and westerly winds. Chamaedaphne calyculata (L.) Moench is common throughout Newfoundland and yet is continental or sub-continental in Europe. Therefore, Damman places the island within a sub-oceanic rather than a hyperoceanic climate.

Sea ice (Figures 10, 11) has a direct effect on temperature. Once consolidated near the coast, the ice cools the air above it almost as does a continental land mass. These ice floes retard spring and shorten the vegetative or growing season. Figure 12 shows the length, in days, of the vegetative season, based on the number of days when the air temperature is above 43°F (Hare, 1952). This temperature is the "threshold temperature" and is necessary for growth of the vegetation.

(ii) Seasonal Temperatures

Winter temperatures are partially controlled by the sea; a much milder climate prevails in areas not influenced by the pack ice, such as the southern and southeastern regions of the island. The January mean temperatures (Figure 13) verify this. Argentia has a mean of 27.6°F and Cape Race 27.2°F (Table 3). However, the interior and the northern coasts are much colder and have a greater thermal continentality of climate (Lindroth, 1963). The January means drop to 16.9°F at Buchans and 15.2°F at St. Anthony. The winter temperatures are not constant near the coast and the day-to-day variability is an important factor influencing microclimate. Spring is late because of the pack ice and is characterized by fluctuating temperatures near the freezing point. Not until mid-May does the temperature rise consistantly above freezing and spring merges into summer which is brief but warm. The mean July temperature is 55°F near the coast (Figure 14) and 61°F inland. Southern and southeastern Newfoundland are cooled by frequent fog and by prevailing southwesterly winds over the Labrador current.

The autumn is accompanied by characteristic declining temperatures with a more rapid fall in the north. Thus, a north to south gradient is established which ends the anomalous distribution typical of summer (Hare, 1952). Frost is not infrequent in September, and persistent frost begins in early November on the Northern Peninsula. The remainder of the island, except for the Avalon Peninsula, has persistent frost in late November. On the Avalon persistent frost does not usually occur until the first week in December.

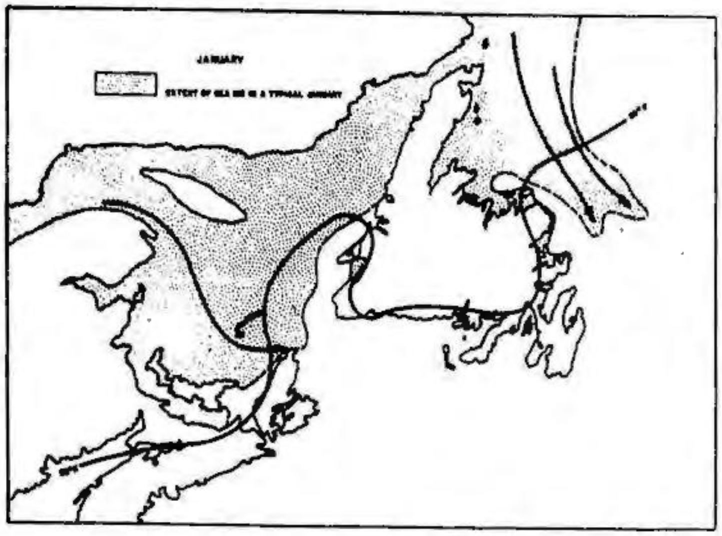

Figure 10. Map showing the extent of sea ice in a typical January. The arrows indicate the direction of the ice advance. (After Ice Atlas of the Northern Hemisphere - after Hare, 1952).

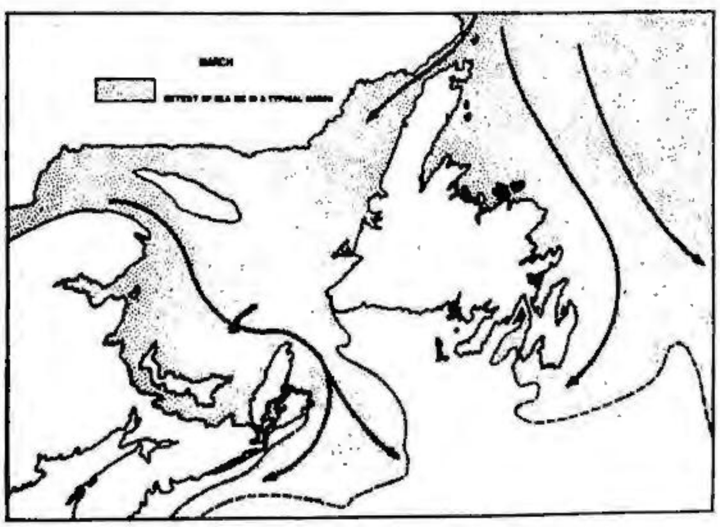

Figure 11. Map showing the extent of sea ice in a typical March. (After Hare, 1952). The main pack ice drift is shown by the arrows.

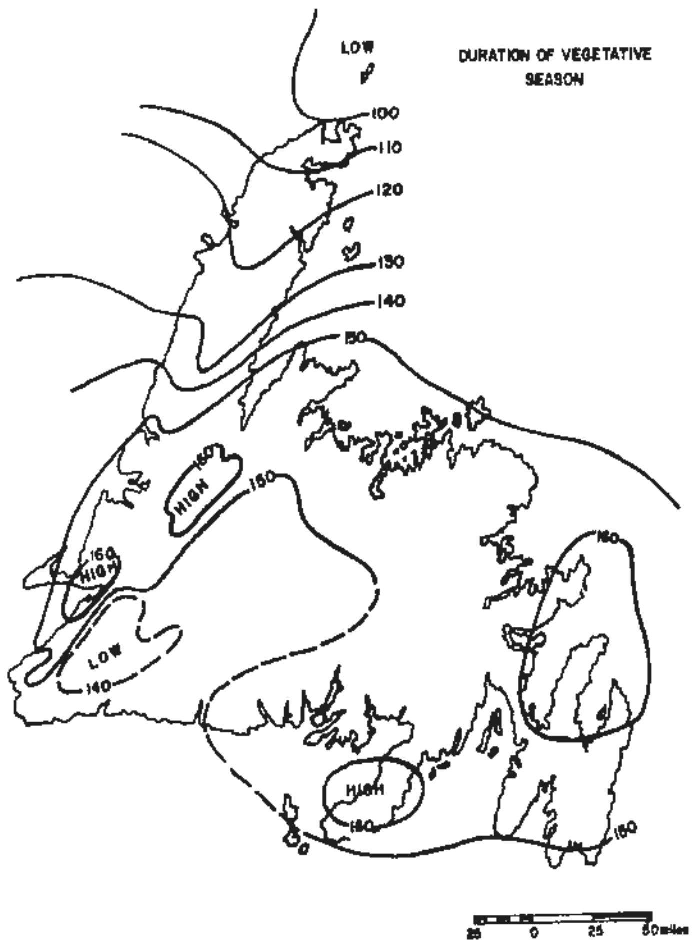

Figure 12. Map of Newfoundland showing the duration of the vegetative season; in day, (after Hare, 1952).

Figure 13. Map showing the mean air temperature in Newfoundland for January; given in degrees F.

Figure 14. Mean air temperature in Newfoundland for July; given in degrees F.

(iii) Regional Temperatures:

a) Region I - Avalon Peninsula

The Avalon has mild winters and cool summers with a vegetative season of approximately 155 days. The following table gives the mean air temperatures for stations located on the Avalon Peninsula.

Table 3. Mean Air Temperatures of selected meteorlogical stations in Region I; Avalon Peninsula (D.O.T., 1959). Given in degrees F.

Station	January	July	Year
Argentia	27.6	56.7	41.9
Cape Race	27.2	53.5	39.8
Colinet	26.0	57.6	41.1
Torbay (A)	24.3	59.7	40.5

The thermal continentality is not great and the temperatures are indicative of a maritime climate which may be termed oceanic.

b) Region II - Bonavista:

Bonavista has a July mean of $58^{o}F$ and a January mean of $25.3^{o}F$. This is similar to temperature conditions on the Avalon Peninsula. The influence of pack ice is not as great as is experienced in Region III and does not affect the temperature appreciably.

c) Region III - Wesleyville:

There are no weather stations within the study area. Twillingate and Fogo, however, are nearby and give an indication of temperature normals for Region III.

Table 4. Mean air temperatures in degrees F, of meteorological stations near Region III. (D.O.T., 1959-1965).

Station	January	July	Year
Fogo	20	60	39
Twillingate	22.4	60.7	39.8

These temperatures are comparable to inland areas. The temperature range is greater, whereas the yearly mean is lower. These differences may be a result of the factor of typical ice conditions which could cause a degree of continentality in the climate.

d) Region IV - Terra Nova:

Meteorological stations are located at Gander, Glenwood and nearby at Grand Falls. The normal means are similar to those in Table 3.

Table 5. Mean air temperatures, in degrees F, from selected meteorological stations in and near Region IV.

Station	January	July	Year
Gander	20.8	62.3	39.7
Glenwood	20.8	61.5	39.6
Grand Falls	18.2	62.9	39.5

This region has the highest summer means (Figure 14) but a lower annual mean than all other regions except Region VI.

e) Region V - St. George's:

St. George's is the only recording station located in the study region, however, Stephenville and St. Andrew's have been included because of their proximity.

Table 6. Mean air temperature, in degrees F, from selected meteorological stations in or near Region V.

Station	January	July	Year
St. George's	21.0	60.0	41.0
Stephenville	23.0	61.5	41.2
St. Andrew's	24.6	59.3	40.9

f) Region VI - Cow Head:

The temperature from Bonne Bay north to Bellburns is based on data from Daniel's Harbour. The mean temperature is 18.3°F in January and 57.5°F in July. The winters are colder than the remainder of the island and the summers very cool. This can be verified from a comparison of means listed in Tables 3-6.

(iv) Precipitation:

Precipitation is high in Newfoundland; the southern and south-eastern section along with the higher western positions receiving the greater amounts (Figure 15). There is a range of more than thirty inches. Mount Pearl Experimental Farm has a normal of 63.79 inches compared with 32.75 inches at St. Anthony. Apart from its abundance, the precipitation in most regions is evenly distributed throughout the year.

The water loss, annually, by soil evaporation and transpiration under optimal soil and moisture conditions is known as the potential evapotranspiration (PE) (Thornthwaite, 1948). This represents the water need of an area. The mean annual PE, as shown in Figure 16, varies from a high of 20 inches in the Deer Lake area to 18-19 inches over the greater part of the island, with a low of 16 inches near the tip of the Northern Peninsula (Hare, 1952; Damman, unpublished map). Figure 17 shows the water surpluses for Newfoundland. The water surplus is found by subtracting the PE in a given area from the mean annual precipitation in that same area. This surplus is the amount of water which is available for runoff.

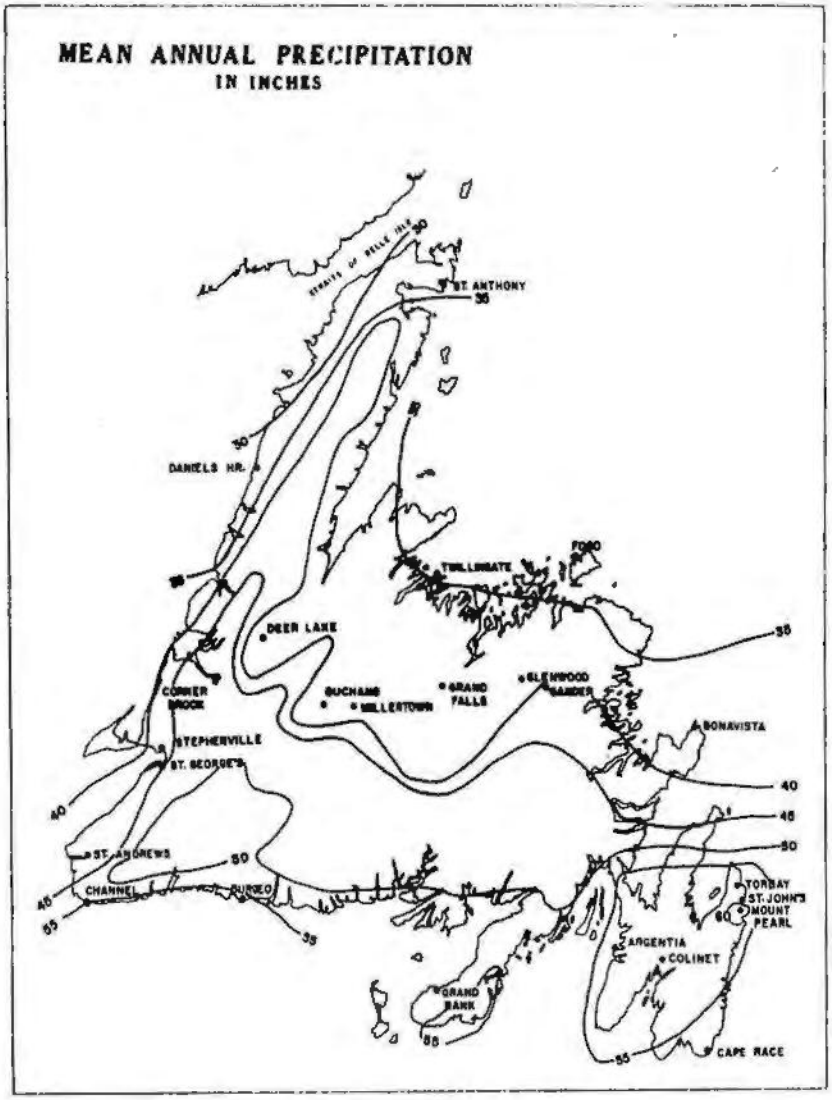

Figure 15. Map of Newfoundland showing the mean annual precipitation; given in inches. Location of meteorological stations is included.

Figure 16. The mean annual potential evapotranspiration for Newfoundland (according to Thornthwaite).

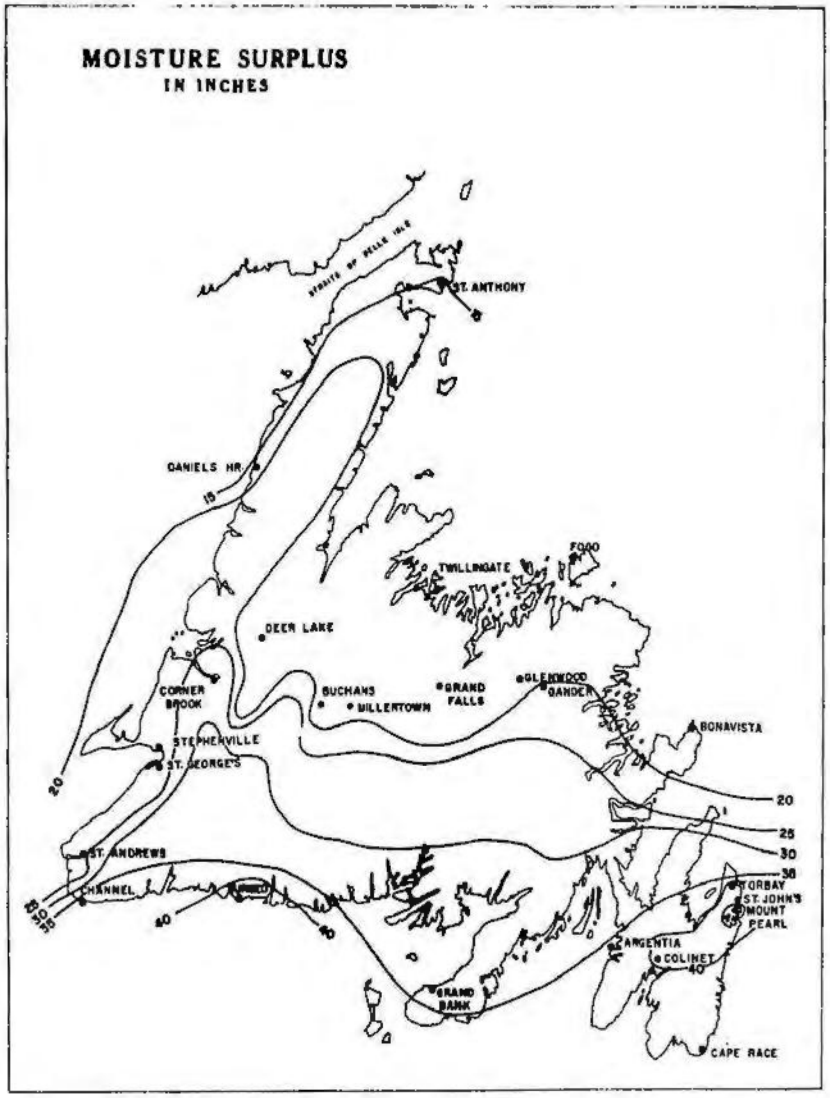

Figure 17. Map showing the mean annual water surplus for Newfoundland; given in inches.

(v) Regional Precipitation:

Table 7. Regional breakdown of the precipitation budget for selected stations in Newfoundland

Region	Station	Mean Annual Precipitation (in inches)	Potential Evapotranspiration (in inches)	Water Surplus (in inches)
Region I	Torbay (A)	60.98	19	42
	St. John's	53.18	19	34
	Mount Pearl	63.79	19	45
	Colinet	57.84	19	39
	Cape Race	53.98	18	36
Region II	Bonavista	39.64	19	20
Region III	Fogo	34.12	18	16
	Twillingate	36.45	18	18
Region IV	Gander	40.35	19	21
	Glenwood	37.89	19	19
	Grand Falls	35.99	19	17
Region V	Stephenville	40.62	19	22
	St. George's	43.10	19	24
	St. Andrew's	42.66	19	24
Region VI	Daniel's Harbour	32.77	17	16

In Region I, Torbay Airport and Mount Pearl have normal precipitation values over 60 inches (Table 7) whereas St. John's records a mean of 53 inches. This difference is a factor of topography. St. John's is situated in a valley and the land rises to the north and southwest, resulting in greater precipitation in these higher areas. Region II may have a normal much similar to Region IV, but there are not sufficient data to establish a definite norm.

(vi) Wind:

The wind, because of its frequency and speed, is an important climatic factor in Newfoundland. The normal means are higher than those on the adjacent mainland. Tables 8 and 9 summarize the available data on the wind (Department of Transport, 1959).

Table 8. Mean wind speeds (MPH) from selected meteorological stations in all but Region II.

Region	Station	January	July	Annual
I	Cape Race	20.2	13.3	17.2
	St. John's	18.3	13.8	15.7
II	–	–	–	–
III	Fogo	17.1	9.1	13.4
IV	Gander	16.5	11.5	14.0
V	St. Andrew's	14.9	7.6	10.6
VI	Daniel's Hr.	16.7	9.6	13.1

The Avalon has the highest means; this, together with open barren terrain contributes to more rapid evaporation. The wind also cools by wind chill even when air temperatures are relatively high. According to Damman (1965) the prevailing southwesterly and westerly winds influence the climate. In Table 9, the southwesterly and westerly winds have the highest frequencies in all stations but one, St. Andrew's.

Table 9. Percentage of frequency of winds from selected stations in all regions throughout Newfoundland

Region	Station	N.	NE.	E.	SE.	S.	SW.	W.	NW.
I	Cape Race	7	15	7	5	6	21	18	10
	St. John's	11	6	6	9	12	21	26	8
II	-	-	-	-	-	-	-	-	-
III	Fogo	7	10	7	14	4	27	16	13
IV	Gander	10	5	6	10	11	21	21	14
V	St. Andrew's	4	17	6	13	16	13	6	21
VI	Daniel's Hr.	7	10	5	14	5	34	9	13

(vii) Classification of Newfoundland Climate :

Newfoundland, according to Koppen's classification lies in the microthermal D province within the sub-Arctic sub-province Dfc. The upper portion of the Northern Peninsula is near the ET or tundra climate.

Thornthwaite's classification based on moisture index places the island in a perhumid to humid climate within the following range.

	Climatic Type	Moisture Index
A	Perhumid	100 and above
B_4	Humid	80 to 100
B_3	Humid	60 to 80

These three types are at the top of the moisture scale (Thornthwaite, 1948). Thornthwaite also classifies climate based on potential evapotranspiration. Newfoundland would lie mostly in the warm microthermal province C_2^{1}.

A portion of the Northern Peninsula has a cool microthermal climate C^1 which is immediately below Tundra on the scale.

F. Vegetation:

Vegetation types are the result of edaphic, climatic and other environmental factors acting on particular sites. Besides being an indicator of site conditions the vegetation reflects the nature of the materials in the substrata which supports it. Newfoundland lies in the eastern extremity of a continuous belt of boreal coniferous forest characterized by black spruce Picea mariana (Mill.) BSP and balsam fir Abies balsamea (L.) Mill. Other conifers, white spruce, Picea glauca (Moench) Voss, and larch Larix laricina (Du Roi) K. Koch, are also common. There is also an admixture of broadleaved species; white birch, Betula papyrifera Marsh and poplars, Populus tremuloides Michx. being most common.

According to Rowe (1959) the forests of eastern Newfoundland have been badly decimated by fires and cultural practices. The prevailing character of the vegetation is, then, patchy dense-growing coniferous forest interrupted by extensive barrens. Abies balsamea dominates on good sites whereas Picea mariana occupies the poor sites and also the burned-over areas. On the wetter lowlands bogland prevails with some stunted Larix laricina associated with Picea mariana. This bogland is predominately of the blanket bog type. Regions I, II, and III are included in Rowe's description of eastern Newfoundland.

Region IV has forests of balsam fir with extensive fire stands of black spruce. According to Damman (1964) balsam fir occupies all undisturbed sites except the extremely dry or wet ones which are occupied by black spruce or alder swamps. The hardwoods, white birch, poplar and pin cherry, Prunus pennsylvanica L., are of fire origin.

The bogs in this region are localized in depressions and generally are not spread over wide areas. Raised bogs are common. Many of these have concentric domed surfaces , and principally oligotropic and ombrotrophic. Dwarf-shrub bogs are present as are mesotrophic bogs, the latter being less common. Fens are not uncommon with the mesotrophic fen (poor fen) being more common than the eutrophic fen.

Region V comprises a coastal strip within the Corner Brook section of Rowe's classification. This section is characterized by good forest stands. The flora also has more species in comparison to the remainder of the island. Besides the conifers and previously mentioned hardwood, there is white pine, Pinus strobus L., black ash, Fraxinus nigra Marsh, balsam poplar, Populus balsamifera L., and yellow birch, Betula lutea Michx. The presence of these species is due mainly to calcareous soils. The bog area, however, is mostly bordering on the coast and overlies a more acidic substrata.

There are two main types of bogs, the dominant being blanket bog and sub-dominant transitional bogs. The blanket bogs vary from very extensive (up to 8 miles long) to small areas in localized depressions.

The Cow Head region (VI) is included in the Northern Peninsula section of Rowe's forest classification. The conifers are dominant, especially near the western coastal areas. Much of the coastal plain is poorly drained and supports extensive development of herbaceous and moss peat. This is mainly blanket bog with a large proportion of mesotrophic bog.

The remainder of the island composes the sparsely forested heath and moss barrens in south and central Newfoundland and the Long Range Mountains. This is a featureless windswept terrain with many rock barrens and lakes. The bogland in these areas is primarily a low blanket peat dominated by sedges.

It should be mentioned that the flora of Newfoundland is complex. Fernald (1918) demonstrates this complexity and states three major elements:

(i) The Arctic-Alpine and Hudsonian

(ii) Tbe Coastal Plain

(iii) Atlantic European

Damman (1965) also shows the unconformity of the flora. He believes the most conspicuous features are the occurrence of species with Arctic affinities, the absence of many temperate-boreal species present on Cape Breton Island and again the Coastal Plain element.

Two other types of organic terrain related to bog origin and formation are the fen and marsh. The fen vegetation has been broken down by Damman (1964) for Newfoundland habitats. The marsh vegetation is rare and will only receive brief mention in the text.

Ecology of Selected Bogs in Each Study Region

A. Region I - Avalon Peninsula

(i) Field Work:

One hundred peat deposits were examined in the Avalon Peninsula region, including the isthmus as well. The bog areas were selected and investigated on the basis of accessibility and size. All areas were first examined in a cursory manner with selected bogs then surveyed in greater detail.

As can be seen from Figure 18, the greatest concentration of bogs are found near Whitbourne. Other areas such as Branch - St. Bride's (Bog 97, 98) and Sunnyside (Bog 1) are also extensive, covering many square miles.

(ii) Topography:

The Avalon Peninsula has many low, rolling hills some forested, others barren. The southern and eastern sections are well forested, in contrast to the central and northern barrens which are covered by moss and ericaceous shrubs. According to Henderson (1959) there is little large scale damming of water, except south of Whitbourne and in this area the bogs form in depressions at the termination of esker formations. Various oxyphylous plants, sedge, Sphagnum (Dill.) L. and ericaceous shrubs cover the flatter areas and thick peat accumulations whereas ericaceous shrubs and sedge cover the better-drained upland slopes. Sedge dominates the poorly drained slopes.

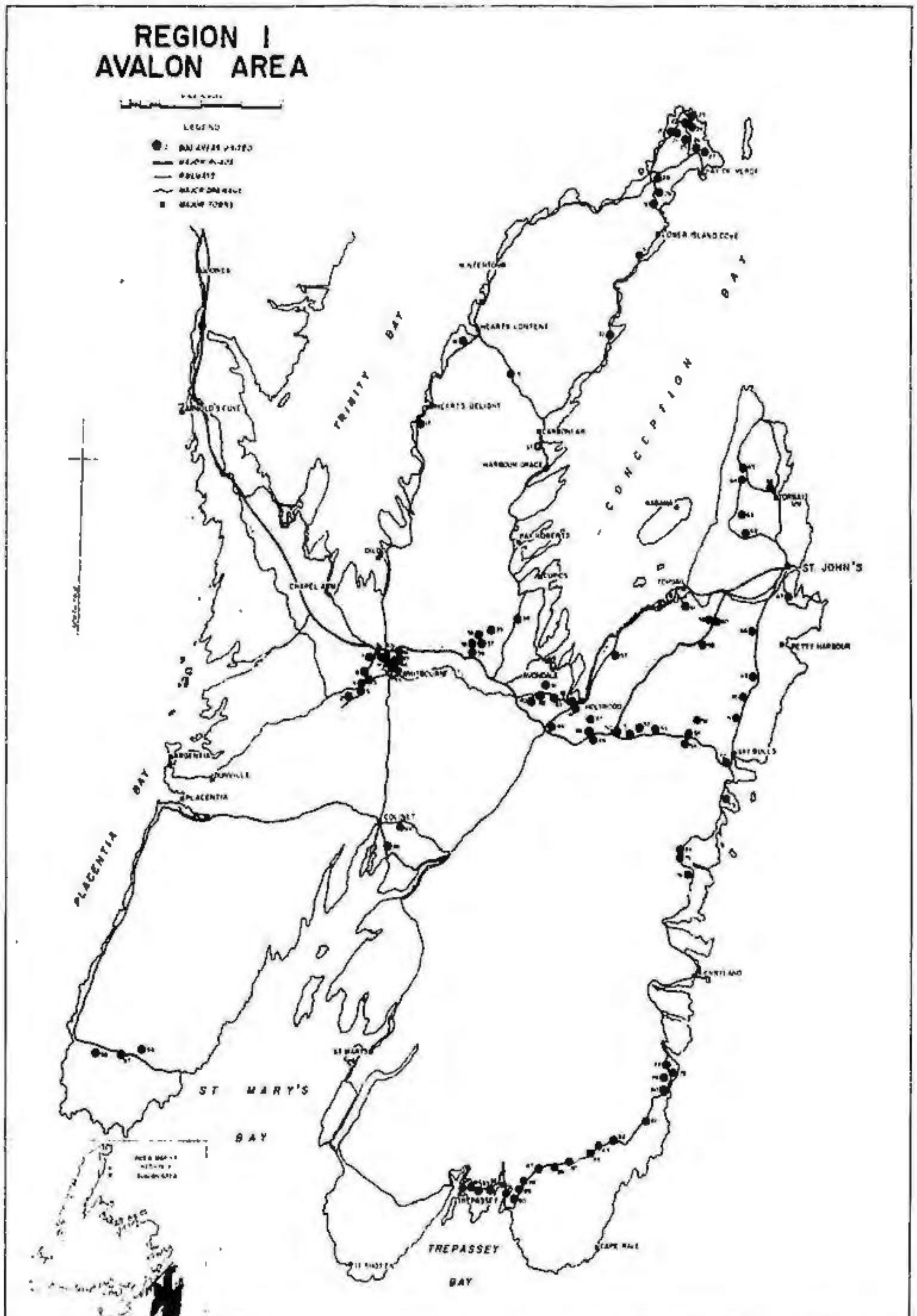

Figure 18. Map of Region I - Avalon Peninsula, showing the location of the bogs studied.

(iii) Climate:

Precipitation (Table 7) is greatest on the Avalon Peninsula with the annual mean varying from 54 to 63 inches. This variation of more than 11 inches is due to topographic influences previously discussed. As a result of this high precipitation there are moisture surpluses of 34 to 45 inches, which, according to Granlund (1932) would tend to favour the development of ombrotrophic blanket bogs with a decline in raised bog formation. This is partially true on the Avalon Peninsula where the dominant bog type is of the blanket bog variety. These blanket bogs, however, are not true ombrotrophic and are influenced in many areas by drainage from mineral soils.

Wind speeds on the Avalon Peninsula have a mean of about 16 mph which is the highest for Newfoundland. This factor, however, does not affect the evaporation to any extent because of the very high atmospheric humidity which acts as a balancing agent. Therefore winds primarily affect plants, which could be uprooted, and bog areas susceptible to erosion.

The bogland vegetation of the Avalon Peninsula is influenced, then, by heavy rainfall, high moisture surplus, high atmospheric humidity, very strong winds and cool temperatures.

(iv) Geology:

As previously mentioned, soils are thin on the Avalon Peninsula and the bogs are underlain by podzols formed from sedimentary and volcanic Precambrian rock. These rock types are dominantly acidic and can support the initial growth necessary for bog development and expansion. In many areas the bog expands over well-drained till as seen in Figure 19. Here Scirpus cespitosus L., Eriophorum spp and ericaceous shrubs such as Kalmia augustifolia L., Kalmia polifolia Wang., Vaccinium augustifolium Ait., Ledum groenlandicum Retz., and Chamaedaphne calyculata (L.,) Moench are dominant. This is a dry minerotrophic site and these species grow directly on the podzols. The texture of the soil is that of a coarse till with a low accumulation of fines (Figure 20).

(v) Surface Features:

Because of the size of Region I there is a great diversity in surface features with both sedge and Sphagnum bogs. The most common bogs are Scirpus bogs which are common in the barren areas. The Sunnyside bog is a good example of Scirpus blanket bog. This is shallow; averaging about 3 feet in depth and well humified (H 6). Many of the blanket bogs on the Avalon Peninsula are Scirpus - Sphagnum, both being co-dominants. The highmoors and true ombrotrophic blanket bogs vary with Sphagnum - Scirpus, Sphagnum - Ericaceae - Scirpus being the most common combinations. Figure 21 shows the surface of a Sphagnum - Scirpus - Ericaceae bog which is oligotrophic and ombrotrophic. Figure 22 shows a dwarf-shrub bog dominated by a Sphagnum - Ericaceae type vegetation. Hochmoors or raised bogs are not extensive, mainly because of high precipitation, unfavourable topography and man's cultural habit of burning the land.

As we have seen, Scirpus cespitosus is the main component of many bogs and fens. This species grows in tufts (Figure 23)

Figure 19. Sedge and ericaceous shrubs on mineral soil near edge of Cochrane Pond Bog.

Figure 20. Hole in glacial till, 18 inches in diameter. (Cochrane Pond Bog)

Figure 21. Central portion of Bauline Bog showing surface of raised bog sloping toward hill.

Figure 22. Small raised bog near Cochrane Pond.

Figure 23. *Scirpus cespitosus* on raised bog near Whitbourne.

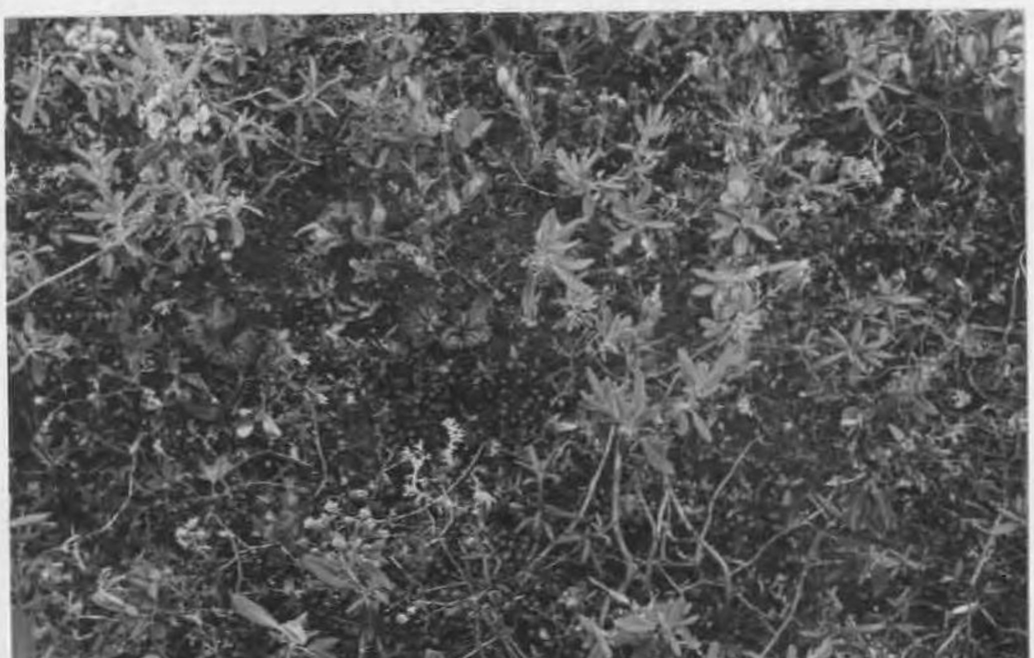

Figure 24. Shrub vegetation from raised bog near Whitbourne.

and the other oxphylous plants grow between these tufts (Figure 24). On Sphagnum bogs the ericaceous shrubs Kalmia spp., Ledum groenlandicum, Vaccinium augustifolium and Andromeda glaucophylla Link. are commonly between the tufts with Empetrum nigrum L. and Cladonia alpestris (L.) Rabenh. These grow in the Sphagnum mat which is composed of Sphagnum fuscum (Schimp.) H. Klinggr., Sphagnum imbricatum Hornsch, Sphagnum flavicomans, and Sphagnum rubellum Wils. in hummocks with Sphagnum magellanicum Brid. most commonly found in the lower mat.

These small raised bogs on the Avalon Peninsula do not have an active regeneration complex. Also the pond development is not similar to typical raised bogs in that there are few bogs with concentric circles of ponds from the centre.

Mesotrophic bog vegetation is common on the Avalon Peninsula with such characteristic species as Scirpus spp., Carex exilis Dewey, Carex oligosperma Michx., Rhynchospora alba (L.,) Vahl., with shrubs Myrica gale L. and Menyanthes trifolia L. Sphagnum recurvum Beavr. and more aquatic species Sphagnum compactum DC. Sphagnum dusenii C. Jens. and Sphagnum pylaesii Brid. are the most frequent of the Sphagnaceae occurring in this habitat.

Figures 25 and 26 show a small mesotrophic bog near Bauline. The wetter lower portion is dominated by Scirpus cespitosus and Myrica gale which are seen in belts. The higher zone has some Sphagnum fuscum and Sphagnum rubellum which forms small hummocks. About these are mostly sedges, Carex spp. and Scirpus. Then, on the drier section are ericaceous shrubs and Chamaedaphne calyculata.

Figure 25. Lower portion of small mesotrophic bog near Bauline.

Figure 26. Upper portion of small mesotrophic bog near Bauline.

Figure 27. Small pond near Bauline with marsh vegetation near the shore.

Figure 28. Peat profile of Cochrane Pond Bog (58) showing various strata. The lighter layers are the less humified.

Marsh is not common in Newfoundland and the Avalon Peninsula is no exception. One such habitat is near Bauline (Figure 27). Here the marsh, located near the shore, is composed of an aquatic vegetation consisting mainly of Carex spp.

(vi) Subsurface Characteristics:

The surface is sometimes a good indicator of subsurface conditions. The blanket bogs dominated by Scirpus (Table 10) are shallow and well decomposed from top to bottom. Where Sphagnum moss H 2.5-3 is found it is shallow and underlain by humified sedge peat. This is common in bogs on the Avalon Peninsula. These bogs are influenced greatly by minerotrophic conditions and soligenous waters.

Other bog areas such as the true ombrotrophic bogs are dominated by Sphagnum with co-dominants Scirpus and Ericaceae. These bogs are deeper than the minerotrophic blanket bogs. On the Avalon Peninsula these Sphagnum bogs average about 7.5 feet in depth with peat, mostly Sphagnum moss, H 1.5 - 2; the darker layers, in various stages of humification usually increase with depth (Figure 28). There are areas which have layers H 6+ located between two layers H 2.5 - 3.5. These may be the result of former drying, either through fire or climatic means.

As in the other regions the peat has little variation in composition. Auer (1930) has described limnetic deposits underneath the high bogs of southeastern Ontario; Heinselman (1963), Rigg (1940, 1925, 1958) and Rigg and Richardson (1938) illustrate bog profiles, from the northern states, which also have limnetic deposits. The Sphagnum bogs on the Avalon Peninsula as elsewhere have almost no lake deposits, and bottom layers are mainly composed of fen species which are well decomposed (H 6+).

(vii) Discussion:

Both sedge and Sphagnum bogs are widespread on the Avalon Peninsula, principally in the form of blanket peat. True ombrotrophic raised bogs are few and where they are present expansion is limited by topography, climate and fire. The peat is mainly well decomposed in the shallower blanket but has some variation in raised bogs. The decomposition of the peat may be influenced by mineral waters from the excess surface water on the peninsula. Mineral water brings nutrients into the bog and the plant residue has a more accelerated rate of decomposition. When the bog surface has grown such that it is above the mineral water level this influence is less and the peat is less humified. The numerous fires on the Avalon Peninsula will also influence the rates of decomposition; this is discussed further for Region II and III. The upper layers of some raised bogs show advanced stages of decomposition. These layers indicate periods of drying, either climatic or by fire (Waksman, 1932).

Table 10. Depths of peat in certain bogs on the Avalon Peninsula. These bogs are grouped according to their surface cover.

No. of bog	Area (Acres)	No. Soundings	Average Depth	Maximum Depth
A. Surface: Scirpus - Sphagnum				
(1)	436	35	4.7	11
(96 - 98)	679	246	4.9	9
(57)	10	5	4.5	7
(44)	18	14	5.8	13
(54)	12	6	5.4	8
(46)	11	8	4.6	6
B. Surface: Sphagnum - Scirpus - Ericaceae				
(37)	54	27	7.2	16
(14)	16	13	9.1	15
(9)	46	28	7.3	11
(34)	36	25	11.0	18.5
C. Surface: Sphagnum - Ericaceae - Scirpus				
(43)	41	39	8.3	13
(58)	82	116	7.0	20
(42)	7	14	9.6	15.5
(65)	36	16	7.4	14.5

B. Region II - Bonavista:

(i) Field Work:

This work involves the study of sixteen bogs, numbers 101 to 116 on the northeastern section of the Bonavista Peninsula, extending from Little Catalina northward to Bonavista. Four of the largest bogs (106 to 109), totalling about six hundred acres, are collectively known as Flower's Marsh. Figure 29 shows the distribution of the bogs in the area. Flower's Marsh underwent a detailed survey to determine their ecological significance whereas the other twelve bogs were examined cursorily.

Figures 29 and 30 show the position of Flower's Marsh and the major transportation routes. Elliston Bog (108) is located four miles southeast of Bonavista and three and one-half miles west of Elliston. The other bogs (106 and 107) are to the south while 109 is west of bog 108.

(ii) Topography:

The land appears flat, mostly barren, with sedimentary outcrop, bog and shrub covered areas. The land rises to the north reaching a maximum of 450 feet above sea level. Land also rises westward and is characterized by many hills.

The bogs (Figures 34 and 38) appear to be flat, separated by barrens and drainage channels. These bogs do rise, and there is a difference of about forty feet in bog 108 from its border to the highest elevation (Figure 31). This rise is not the result of a thickening peat accumulation but rather due to a sloping substrate as indicated in the profile in Figure 32.

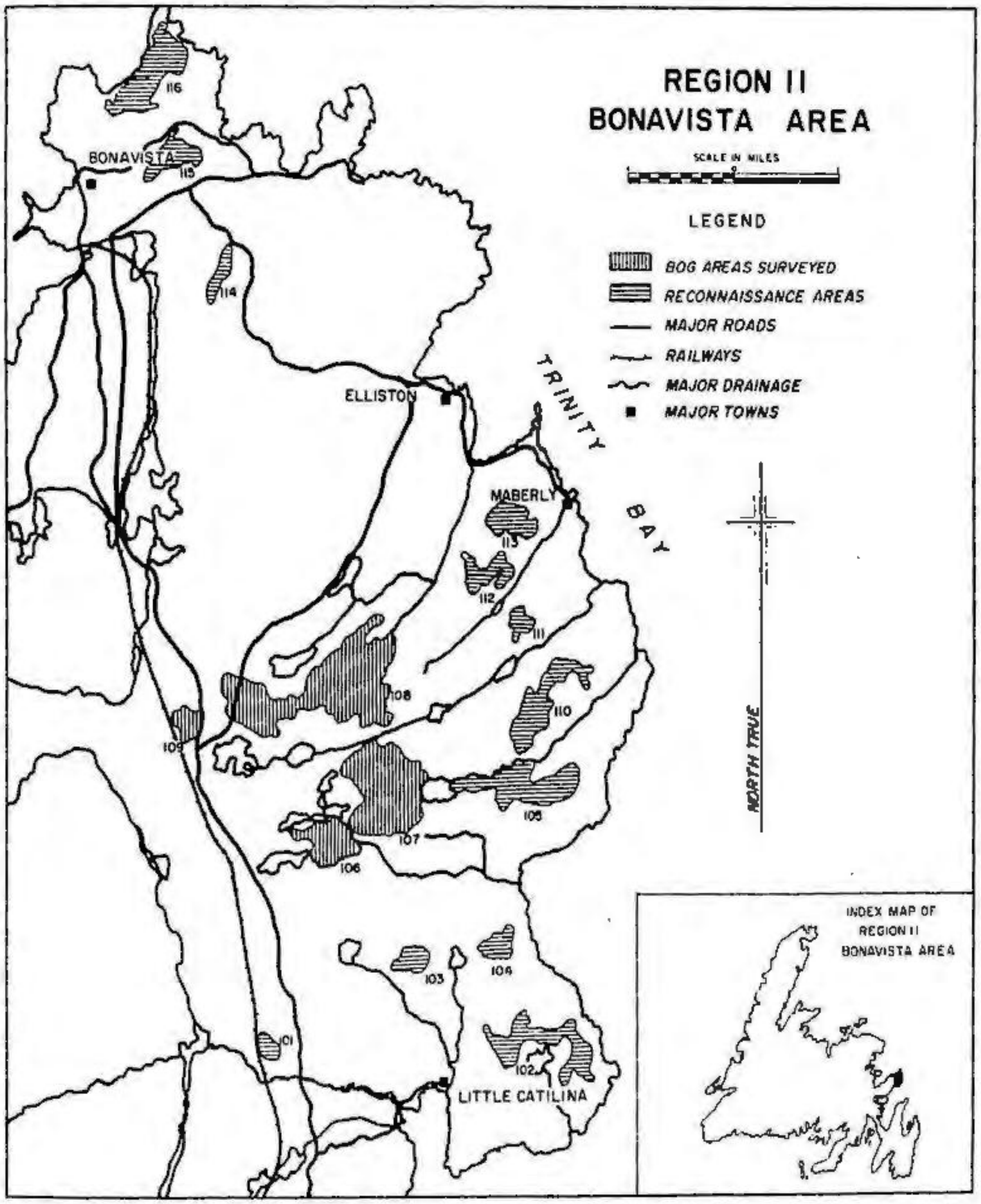

Figure 29. Map of Region II - Bonavista, showing the location of bogs examined. Bogs 106 to 109 were surveyed in detail; the others in a cursory manner.

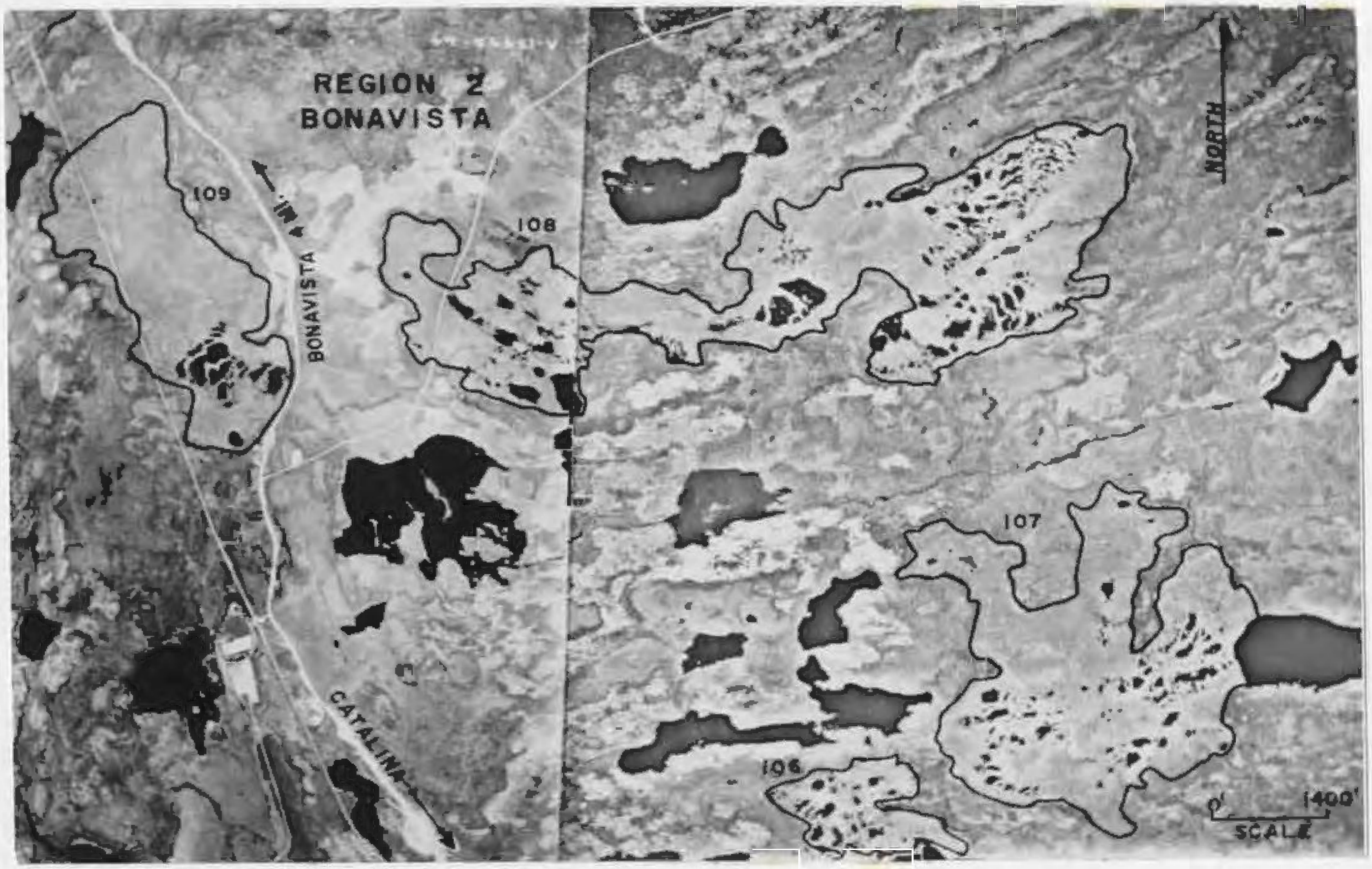

Figure 30. Aerial photo of Flower's Marsh and surrounding area, R.C.A.F. photo A-13445-64. Scale 1" = 2800'

(iii) Climate:

The mean annual rainfall is 39.64 inches with a moisture surplus of 20 inches. It is this surplus which allows the growth of bogs in this area. According to Granlund (1932) raised bogs in Sweden are primarily found in areas with a rainfall between 25 and 40 inches, above which they give way to ombrogenous blanket bogs, which in regions with high humidity can extend over sloping ground.

Through the combination of moisture surplus and high humidity the bogs can grow by paludification (Auer, 1930). This type of growth will result in the pattern shown in Figure 32, which shows the expansion of Elliston Bog (108) over relatively steep slopes.

Temperature also facilitates bog development here with cool summer means of 47.7, 58.0 and 58.0°F for June, July and August respectively. These cool temperatures also lessen the possibility of drying by evaporation. Thus the combination of cool temperatures, high humidity and precipitation coupled with a vegetative season of 160 days favour the development of blanket bogs.

(iv) Geology:

As in most of Newfoundland the soils in this area are thin, mainly formed from the parent bedrock. The soils and rocks are acidic, favouring the growth of oxyphylous plants. In some sections there are pockets of clay which are relatively impervious. The bog areas are underlain by either clay or bedrock. Bedrock in some areas has impeded drainage to the extent that bog development has resulted. Such conditions probably influenced bog growth in the one shown in Figure 33.

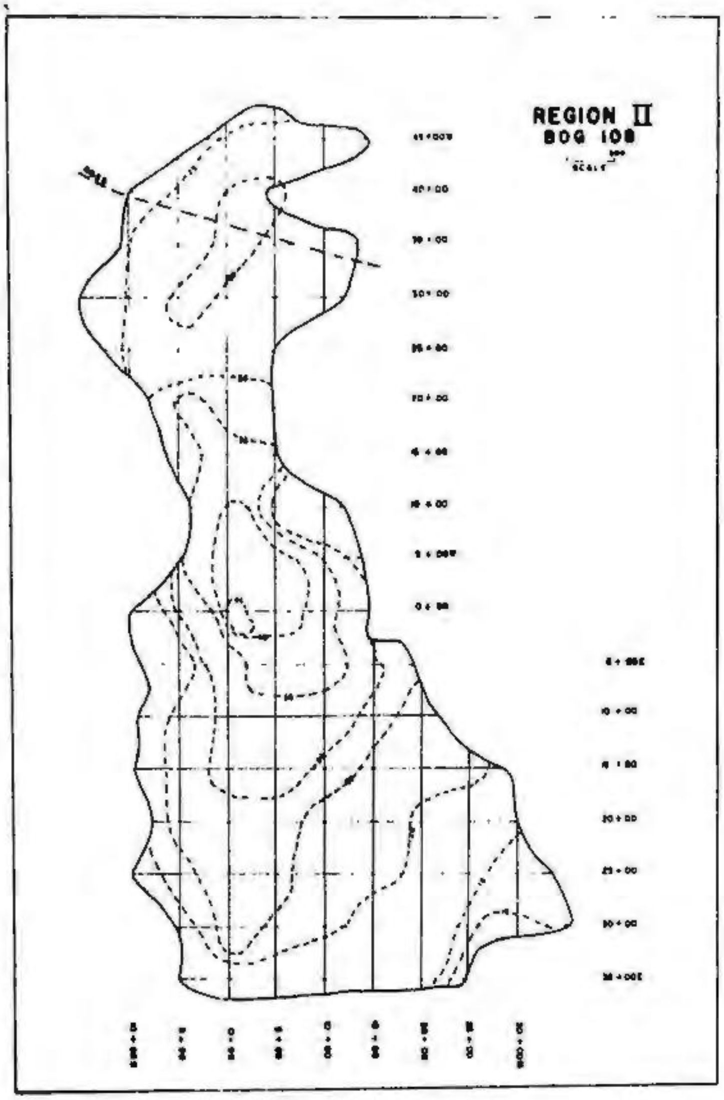

Figure 31. Map of Bog 108 showing sampling stations, coordinates and contours.

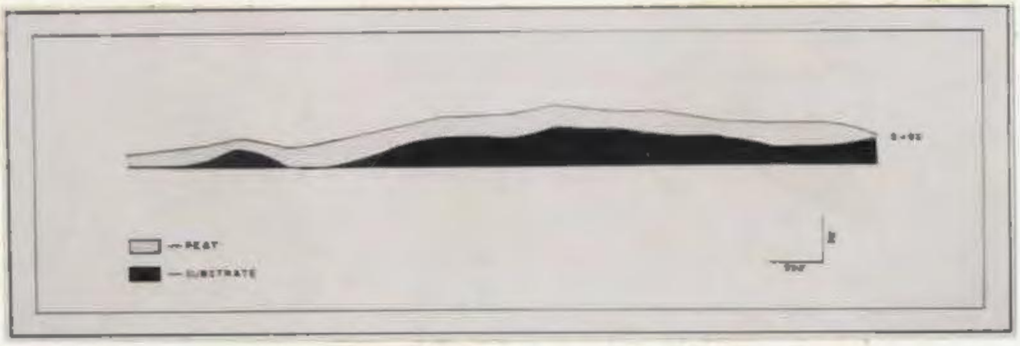

Figure 32. Profile of Elliston Bog (108), showing pattern of growth over substrate.

Figure 33. Sedimentary outcrop with summit above the surface of the bog. This rock has been frost shattered.

Figure 34. Southeastern section of Elliston Bog with barrens in the background. Note the relative flatness of the land.

Figure 35. Northeastern section of Elliston Bog sloping to the north toward drainage area.

Figure 36. Surface vegetation on Elliston Bog with (A) hummock-forming mosses, (B) Empetrum nigrum, (C) Dicranum bergeri, (D) Rubus chamaemorus L. and other oxyphylous plants.

Figure 37. Lichens Cetraria islandica (L.) Ach. and Cladonia spp. on drier surface of small hummock.

Figure 38. Hummocks completely covered by Rhacomitrium lanuginosum. The lighter areas are elevated above the surface of the Sphagnum mat.

Figure 39. Dense growth of Myrica gale about border of bog pond.

(v) Surface Features:

The surface of Elliston Bog (108) was studied in detail and may be considered typical for most of the bog areas within Region II (Figures 34 and 35). This surface is mainly firm and dry as a result of burning. Because of fire the vegetation is not typical for such an oligotrophic ombrogenous bog. Most successful are the rhizome bearing plants such as Empetrum nigrum and Vaccinium oxycoccus, which cover much of the Sphagnum mat. Other ericads are not abundant but rather are restricted, being most common near ponds. Figures 36 and 37 give an indication of this surface vegetation.

There are many large ponds but flashets are not common. The drier areas have hummocks formed by the hummock-forming species Sphagnum fuscum, Sphagnum imbricatum, Sphagnum flavicomans and Sphagnum rubellum. The surfaces of these hummocks are dry and are inhabited by lichens, Cetraria islandica (L.) Ach. and Cladonia sp. Other plants such as the liverwort Ptilidium ciliare (L.) Hampe and mosses Rhacomitrium lanuginosum (Hedw.) Brid., Dicranum bergeri Bland. and Polytricum strictum Turn. are more abundant than is normally the case (Figures 36 and 38).

The borders of the ponds support a substantial growth of dwarf shrubs dominated near the borders by Myrica gale (Figure 39). In the flashets the Sphagnum species are mainly Sphagnum cuspidatum, Sphagnum pulchrum (Lindb.) Warnst., Sphagnum dusenii and Sphagnum torreyanum. Near the edge of the flashets and in the main Sphagnum mat is Sphagnum magellanicum. This distribution is similar to that stated by Gates (1942) and Conway (1949).

The drainage areas are generally shallow and found between the bog proper and the mineral soil. This area supports a vegetation called a marginal fen (Conway, 1949). This is the line of demarcation where minerals are brought to the peat by ground water (Sjors, 1961). This area according to Damman (1964) is sometimes termed a mesotrophic bog rather than a true fen. Figures 40 and 41 show this fen vegetation with such characteristic species as Myrica gale, Carex spp., Juncus sp. and Sphagnum recurvum. Another minerotrophic site is one that occurs near a rock outcrop (Figures 33 and 42) where the bog is quite shallow.

(vi) Subsurface Characteristics:

Of the bogs surveyed almost all had similar types of peat. Immediately below the surface the peat layers are composed principally of Sphagnum moss between H1.5 and H2.5. The texture of this moss can be seen from exposed sections near the highway (Figures 43 and 44). Where fires have been intense the upper peat layers may be black and in an advanced state of decomposition (Figure 45).

In general, the upper layers are mainly cymbifolia peat with large coarse fibers, having a light brown to reddish colour and a fluffy texture. These layers vary in thickness with an average of about four feet. The middle layers from four to seven feet thick vary in texture depending on the amount of sedge peat present. The western portion of Flower's Marsh has almost undecomposed peat (H1-3) down to six feet; the central and eastern portions are patchy with some layers of more muddy (H6+) material and sedge peat. The bottom layers vary little and are fairly well decomposed (H6+) with sedge and muck

Figure 40. Marginal fen in drainage channel at the edge of Sphagnum mat. A narrow water channel with Nuphar microphyllum (Pers.) Fern. separates bog and fen.

Figure 41. A narrow water channel separates bog and fen, Carex spp., Nuphar microphyllum and Myrica gale are characteristic species.

Figure 42. Minerotrophic site near outcrop (lower right corner) good growth of Myrica gale, Eriophorum sp. also present.

Figure 43. Exposed peat at side of Bonavista highway. Eastern edge of Bog 109, depth 5 feet.

Figure 44. Close-up of peat profile, Sphagnum moss H1.5 to H2.5.

Figure 45. Exposed subsurface beneath burned-over surface.

present. There are some stations which yielded only unconverted peat (H1-2) from top to bottom.

(vii) Discussion:

Flower's Marsh and the other bogs of Region II are ombrotrophic blanket bogs, with their dimensions determined by topography. North of Lethbridge and south of Port Union there are no large bogs because of many hills. On the steeper slopes there is forest growth, mainly consisting of Picea marinana, Abies balsamae growth with Kalmia the dominant shrub. The study region, north of Port Union is flatter and has depressions suitable for bogland development. This development could begin with the succession from a fen vegetation to a substantial Sphagnum growth as the site was converted from minerotrophic to ombrotrophic. Some areas had Sphagnum as the initial vegetation as seen from cores which have Sphagnum from the upper layers to the mineral substrate. This may be the result of growth by paludification (Auer, 1930) by which the bog creates its own water table thus enabling its up-slope growth.

There is evidence that the growth of the bog is slowed by fires, which have upset the normal vegetation pattern associated with oligotrophic bog surfaces. Just below the surface the peat is mostly converted and is black in colour, consisting of a fine, dry residue with many ericaceous roots and little Sphagnum moss. Further vertical growth will allow this layer to be below the water table, it will then be a dark muddy layer between layers of a lighter residue which is less decomposed. This may not happen if the bog has reached a state of equilibrium with the surrounding area. This equilibrium is evident on Flower's Marsh. There is a lack of good regeneration complex and from comparisons of my work with Gillespie (1954) and Damman (1956) there is shown relatively little change in the surface vegetation for a period of twelve years.

The bogs in the Bonavista region are ombrotrophic blanket bogs, mostly oligotrophic with marginal fens or mesotrophic bog confined to drainage channels and borders. The vegetation changes near the fens and on bedrock substrate near rock outcrops. This is because of the influence of mineral waters. These bogs originated in depressions and extended over flatter areas and up gentle slopes.

C. Region III - Wesleyville

(i) Field Work:

In all, 575 acres, which includes Templeman Bog (122) and a small area near Brookfield (117) were surveyed in detail (Figure 46). A large bog (118) some 3.5 miles long near Badger's Quay, was examined by running a base line along the long axis through the central portion of the bog.

Templeman Bog (Figure 47) is typical of most of the bog areas in the group and most of the ecological information resulted from a study of this area. Templeman Bog (122) is only a part of a quite large bog area.

Bogs extend for many miles along the coast to Cape Freels but northeastward beyond this point they are more sporadic in their distribution and are shallow. These latter bogs, to Musgrave Harbour, were examined cursorily.

(ii) Topography:

The land, devastated by fire, is rolling plateau covered by a coarse granite till with many boulders. The bogs extend outward from the depressions and onto the slopes. This type of bog is of the blanket variety, both oligotrophic and dwarf shrub. In many cases the bogs extend to the shoreline where marine erosion of peat is taking place (Figure 53). The surface of the bog is approximately forty to seventy feet above sea level.

(iii) Climate:

This region has relatively warm summers and cool winters, with mean temperatures reflecting a degree of continentality similar to the interior of the island. This condition may be influenced by winter and spring ice conditions of the region. Precipitation is 35 inches and there is a moisture surplus of 17 inches per year. The mean annual wind velocity is 13.5 mph. Such a combination of these factors should encourage the development of raised bogs or hochmoores; nevertheless the blanket bog type prevails. The type of bog development characteristic of the region may have been controlled by the effects of fire.

(iv) Geology:

A unique fact concerning the initial growth and expansion is that most of the bog has developed directly on the granite. Cross sections of Templeman Bog (Appendix II) show various outcrops and the growth of bogs about them. The granite is coarse-grained, overlain in places by burned turf and boulder till, with

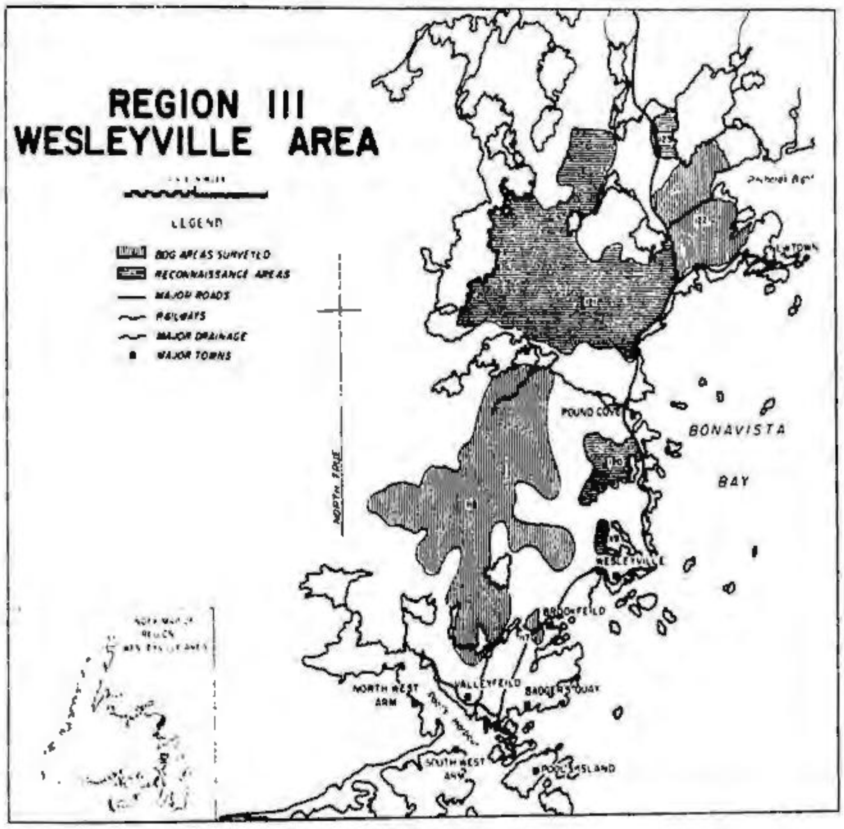

Figure 46. Map of Region III - Wesleyville showing bogs examined.

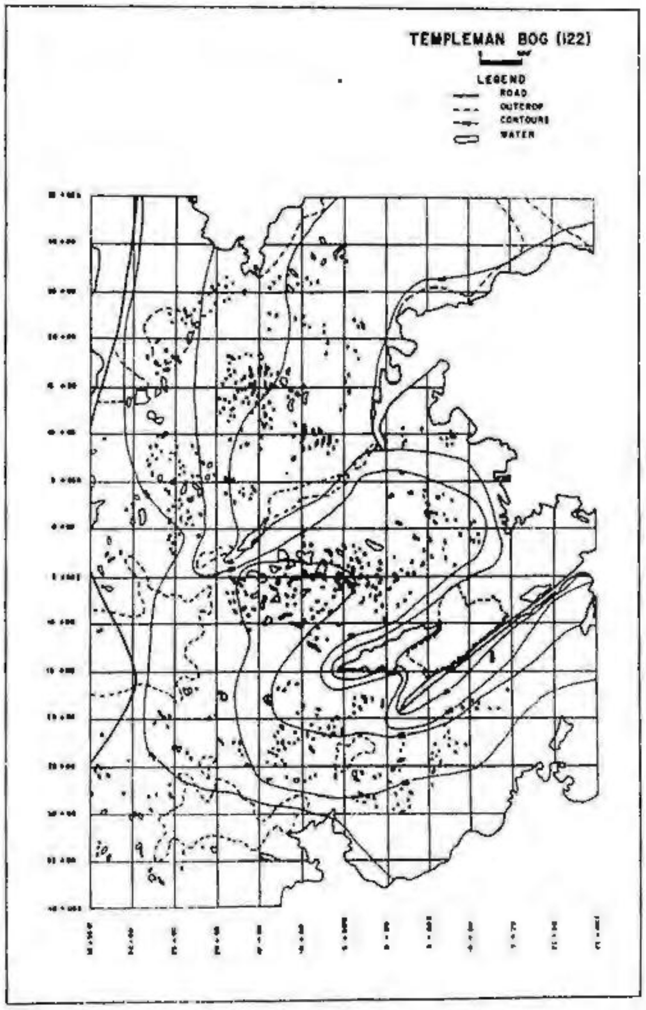

Figure 47. Map of Templeman Bog (122), showing sampling stations, contours, as well as the distribution of outcrop and bog ponds. This map is drawn from aerial photos of the area.

pockets of sandy podzol. According to Millington (1954) and Gorham (1958) granite soils may support thick accumulations of peat. There is little or no soil in the region and the thick and extensive peat accumulations indicate favourable relations between the outcrop and oxyphylous plant growth.

(v) Surface:

These bog areas are mainly wet oligotrophic type with hummocks of Sphagnum spp. and some drier hummocks topped by Cladonia spp. and ericaceous species or by Rhacomitrium lanuginosum. Figure 48 shows a wetter area covered by hydrophilous sphagna; in the background are hummocks topped by Rhacomitrium and Cladonia (Figure 49).

The bogland has been radically affected by fire, and as a result Empetrum nigrum, Empetrum hermaphroditum, Vaccinium oxycoccus and Vaccinium macrocarpon are widespread. Rhacomitrium lanuginosum and Cladonia are sensitive to fire but recover quickly (Pearsall, 1956). Near the edge of the road and in drainage channels Myrica gale and sedges are dominant; in such areas where this association is found the peat is generally shallow and well decomposed. Chamaedaphne calyculata is also common near the edges and in the drier or more minerotrophic zones. The Wesleyville region, unlike Region II, has a substantial growth of Chamaedaphne calyculata, indicating a sub-oceanic environment.

The growth of the bogland and its expansion in the past twenty years has been remarkable. Aerial photos of this region taken in 1947, show numerous small ponds about 10 to 15 feet in diameter. Direct observations in 1965 did not verify this; on the contrary, the number of small ponds are much fewer. Also, examination of the 1947 photos

Figure 48. Surface of oligotrophic bog. (Bog 121)

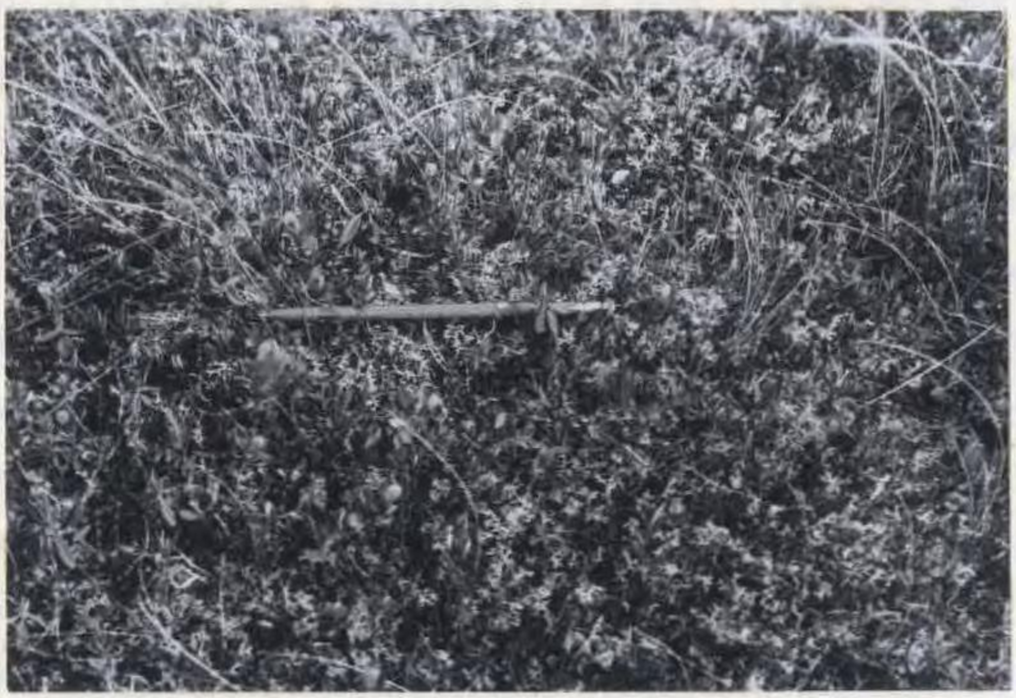

Figure 49. Cladonia spp. topped hummock on Badger's Quay. (Bog 118).

shows outcrop and barren land where there is now considerable peat accumulations. Bog 118 is a good example of this expansion. The cause of this growth is fire; the tree layer is destroyed and the water table rises because of the disruption in the water economy. This rise of ground water then increases paludification in the truest sense (Auer, 1930).

Ericaceous shrubs such as Ledum, Kalmia and Vaccinium comprise the major vegetation of the dwarf shrub bogs found in better drained ombrotrophic sites. These shrubs vary in abundance from the central portion of the bog (Figure 50) in comparision with the growth near the coast (Figure 51).

(vi) Subsurface Characteristics:

The peat deposits in this region are thick with an average depth of 13 feet and a maximum of 28 feet. Templeman Bog itself has an average depth of 13.09 feet. The peat is variable in humification; however, the upper layers are comprised mainly of Sphagnum moss which is fine fibered but with a coarse texture. This may be the result of the accumulation of acutifolia peat such as Sphagnum fuscum. The humification of peat in bog 118 is inconsistant with some stations yielding a core of well converted peat from surface to bottom while a short distance away there may be a deposit of Sphagnum H 1-3. Most cores were consistant although muddy spots in layers were common as a result of drying by fire or climatic conditions. Bog 122 has a uniform transition layer H 3-5 overlying more humified peat. Decayed fen peat, being the pioneer mat, is more common in depressions.

Figure 50. Dwarf shrubs bog near coast (Templeman Bog).

Figure 51. Surface of dwarf shrub bog area near centre of Templeman Bog.

Along the shoreline the bog is being eroded (Figures 52 and 53). The peat is exposed, well drained and compact. Some sections are almost turf-like and have a crumbly texture. Many islands near the coast are peat-covered, the bog lying directly on the bedrock. This peat is mainly covered by Empetrum and Vaccinium and its residue is dry with a fine fiber.

(vii) Discussion:

The Wesleyville region has the most extensive blanket bogs in any of the study areas. These bogs have developed on the bare rock. According to Horwood and Radforth (1964) such an expansion of bog over bedrock is not commonly seen elsewhere in Canada.

This expansion has been accelerated during the past twenty years, however, there is a limit to the mechanism of bog growth. There is a stage when evaporation exceeds the water-retaining capacity of the peat thus creating a drier, more progressive succession. If, through fires, lumbering, or other agencies, the tree layer is destroyed then the dynamics are preserved and the rise of ground water then increases paludification (Auer, 1930).

The bogs in the Wesleyville area are mainly oligotrophic wet ombrotrophic blanket bogs with smaller areas of dwarf shrub and mesotrophic bog. Both fen and marsh habitats are rare.

Figure 52. Erosion channel near coast. Photo taken from the road crossing Templeman Bog.

Figure 53. Wave-eroded peat at eastern edge of Templeman Bog. The surface immediately above is well drained.

D. Region IV - Terra Nova:

(i) Field Work:

Bogs 125 to 141 inclusive make up this region. Within the area there are four sub-divisions comprising those bogs which were surveyed in detail. Other bogs included in the area but outside these four sub-divisions were examined cursorily. Figure 54 shows all these bogs in relation to the surrounding area. Bog 124 is also included but lies south of the region.

In all, about 3,000 acres were surveyed in detail in the following areas.

Morley's Siding Area	480 acres
Gambo - Dark Cove Area	839 acres
Hare Bay Area	450 acres
Gander Area	1,229 acres

There is, in addition, a great concentration of bogland south of Gander Lake, however, because of relative inaccessibility, the area was not examined.

(ii) Topography:

The land varies from a flat rolling plain about 150 feet above sea level, on which the Morley's Siding Bogs are found, to a hilly section in which the bogs are restricted to the valleys such as those in Gambo, Hare Bay and Gander areas. The slopes are generally well forested with black spruce and spruce-fir associations.

Glacial deposits give the land a hill and valley topography, especially in the Gambo-Dark Cove area. In Hare Bay the hills are mainly bedrock. The topography in Region IV does govern the location and dimensions of

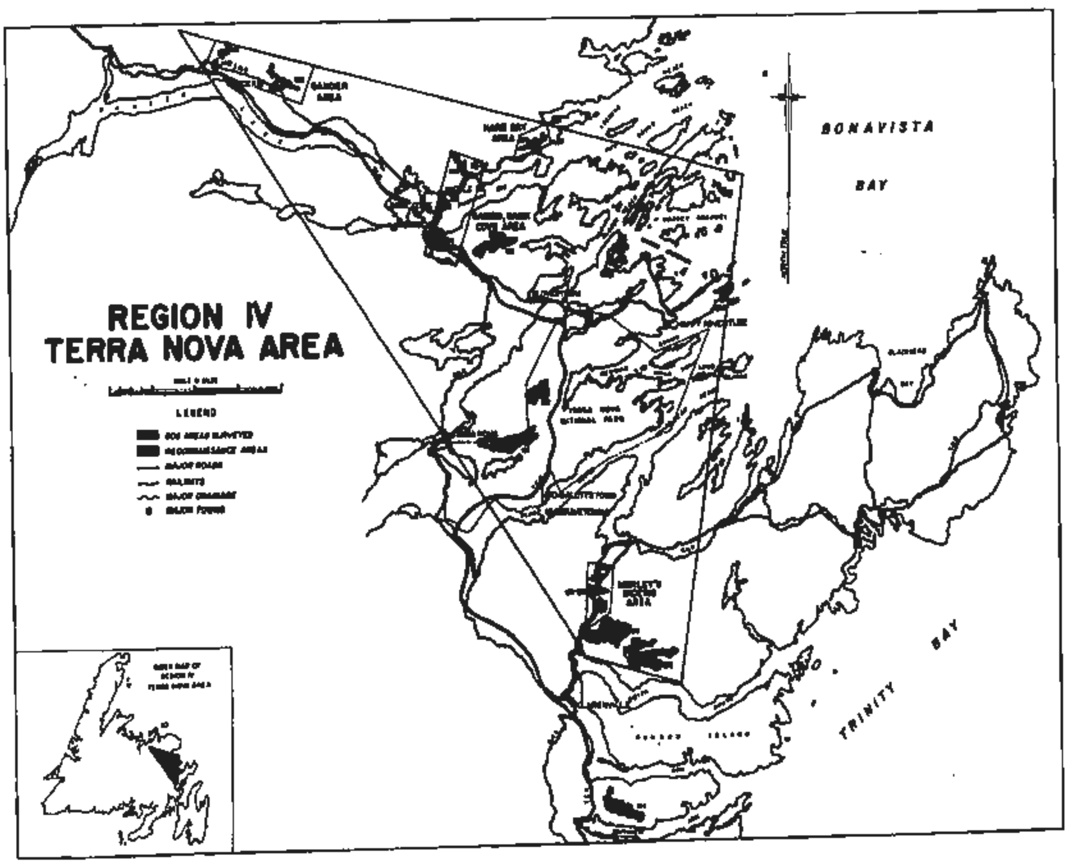

Figure 54. Map of Region IV - Terra Nova, showing the bog areas examined. Four areas were examined in detail, these are Morley's Siding, Gambo-Dark Cove, Hare Bay and Gander.

the bogs by restricting them to lower levels.

(iii) Climate:

The ocean is not the dominant factor controlling climate in this region and the change in vegetation inland is noticeable. The influence may be seen in the surface patterns of the bog types in the area (Figure 55). The raised bog or hochmoor variety is predominant over blanket bogs.

The temperatures reflect the continentality with a degree difference of 40+ between Jsnuary and July means. According to Potzer and Courtemanche (1955) the depths of bogs on the east coast of mainland Canada vary with latitude, decreasing northward from 24 feet at 46°N to 7 feet at 55°N. In Region IV the deepest bogs are found at 49°N. South of this, however, the depth decreases. This can be correlated with temperature and the 60° July isotherm which remains in the central portions of the province with colder temperatures all around the coast. Thus the warmer summers supports a good growth resulting in thicker deposits.

Precipitation in Region IV ranges from 35 to 40 inches. This appears to favour the development of raised bogs. According to Granlund (1932) parts of Sweden with a rainfall of 25 to 40 inches have the best development of raised bogs. Also the Central Plain of Ireland has raised bogs in areas with a rainfall of 30 to 40 inches (Dyal, 1965).

(iv) Geology:

There is considerable variation in the bog substrata in this area. The Morley's Siding bogs are located on a clay-rich deposit which is grey to red in colour and is dominantly fine-grained. This substratum holds the water in relatively flat areas and fosters the development of a fen or mesotrophic bog on which ombrogenous bogs may develop, either as blanket or raised types. Gambo - Dark Cove area has variable substrata; Gambo Bog (134) is situated on an outwash plain and may have originated from small shallow kettle holes in which fen development began. Dark Cove Bog A (135) is on a deltaic sandy deposit and may have formed with a slight uplift of the land and damming of water. Figures 55 and 56 show this bog and its relation to Freshwater Bay.

Hare Bay Bog (138) is underlain by coarse gravel and granite outcrop. This granitized rock may have supported the fen vegetation on which the bog developed. Gander Bog (139) is underlain by a medium grained gravel and Bonanza Bogs (140, 141) by a finer sandy deposit. Rigg (1925) states that bogs on the North Pacific Coast are found on similar substrata. In Alaska the bogs are mainly found on bare rock and Seattle bogs are in depressions on glacial till, some on sand, clay, outwash gravel and rock. All these substrata are acidic and support the growth of acidphilous plants.

(v) Surface Features:

Region IV has an increase in the proportion of raised bogs. These bogs are smaller in area than many of the blanket bogs and have a characteristic pond development in which the ponds are grouped in concentric circles out from the raised centers (Figure 57). This is common in the Scandanavian bogs and to some degree in the British

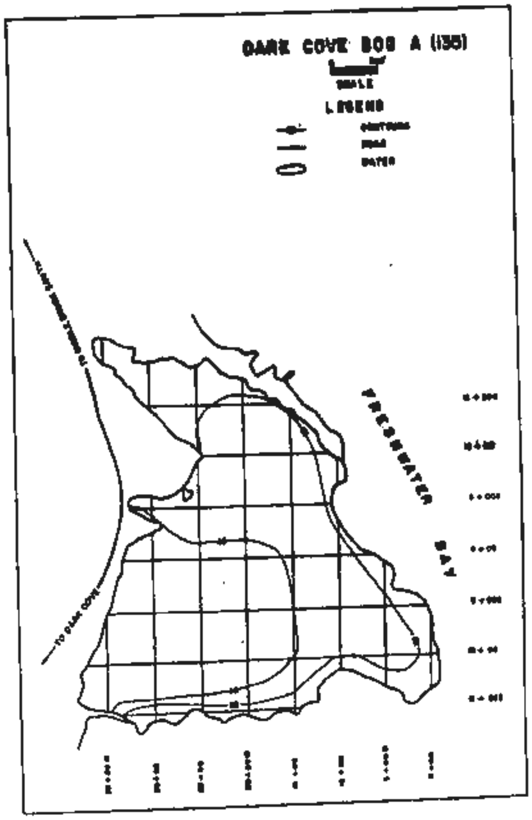

Figure 55. Map of Dark Cove Bog (135) showing the elevation of the bog surface above sea level. Coordinates and sampling stations are also given.

Figure 56. Aerial photo of Dark Cove Bog (135) showing the relationship of the bog surface to Freshwater Bay. The bog lies on a sandy delta.

Figure 57. Aerial photo of Morley's Siding Bogs. Bogs A and C show the concentric pattern of ponds found on raised bogs. (Scale 1" = 2,500').

Isles (Ratcliffe and Walker, 1958). Morley's Siding Bog C (127) in Figure 57, shows this development in four areas. On other bogs such as the Bonanza Bogs (140, 141) (Figures 58, 59 and 60) these ponds or flarks have filled in, however, the pattern is still detectable; the new *Sphagnum* growth in these ponds being lighter than the remaining surface. Gander Bog (139) (Figure 61) is larger than other bogs in the Gander area because of the coalesence of a number of smaller raised bogs through paludification. These raised centers, separated by lower bog surfaces or drainage channels, can be seen on the bog in Figure 62.

Gambo Bog (134) (Figures 63and 64) differs from others in the area in that it has this concentric pattern but is not convex. This may be similar to planmosse (Sjors, 1961) which is common in Fennoscandia. Hare Bay Bog (138) seen in Figure 65, is a blanket bog interrupted by drainage channels, outcrop and islands of forest growth. The bog is oligotrophic ombrogenous and may have developed by processes similar to those active in the formation of bogs in the Bonavista or Wesleyville regions.

The raised bogs of Region IV support a substantial growth of *Sphagnum*; however, there are some areas in these bogs where mineral water has deterred the accumulation of *Sphagnum* moss. Such minerotrophic sites are termed soaks (See Glossary of Terminology). Soaks were found in many of the bogs investigated, for example in Bog 127 (Figure 65) a soak is located between two centers which are five to ten feet higher than the site. These soaks have some characteristic mesotrophic bog species such as *Myrica gale*, *Carex* spp. and in the drier portions

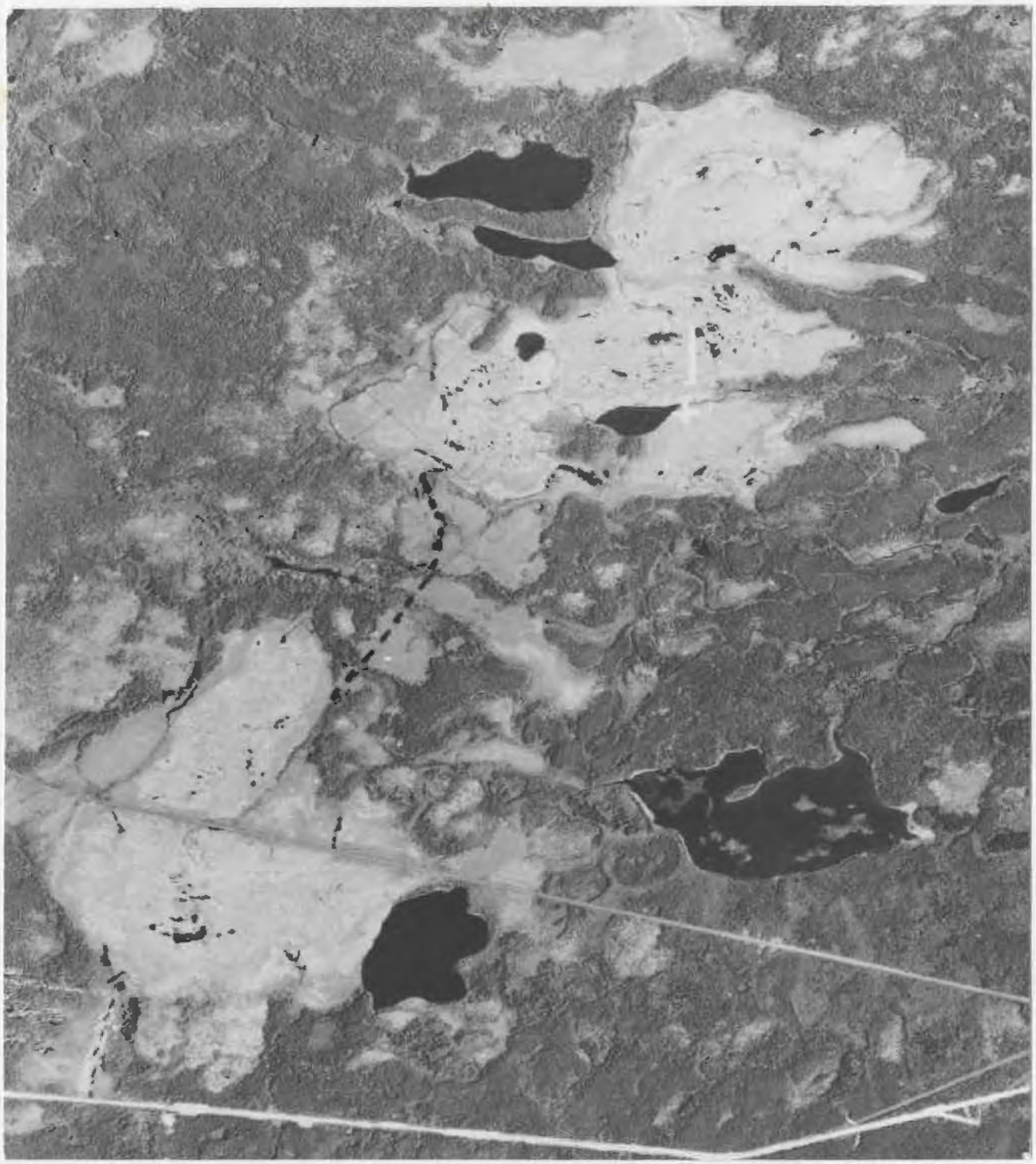

Figure 58. Aerial photo of Bonanza Bogs (140, 141); this shows two raised bogs with numerous filled ponds indicating the concentric pattern. Scale 1" = 2,000'.

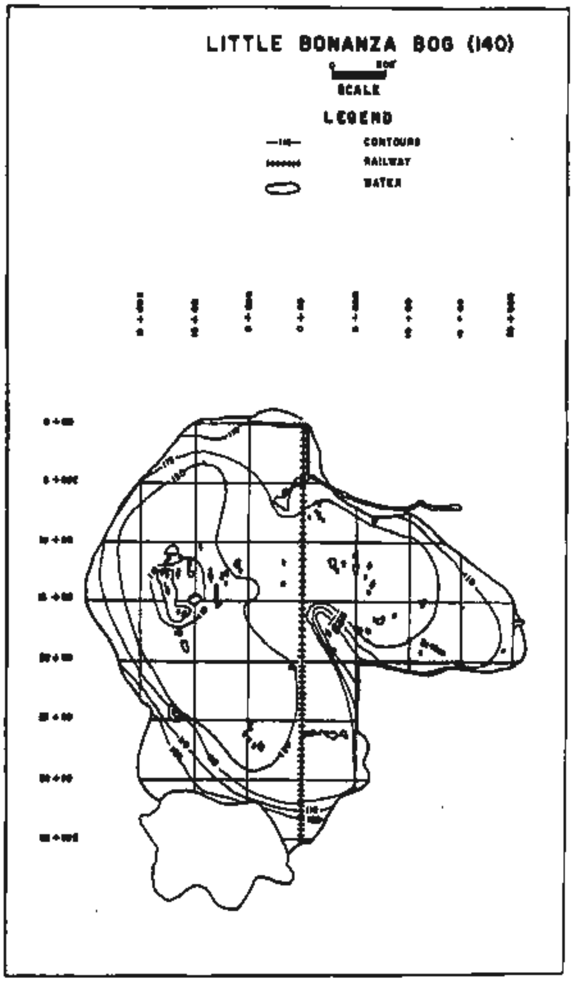

Figure 59. Little Bonanza Bog showing the contours, sampling stations and coordinates. The contour lines indicate that this is a typical raised bog, having a raised center.

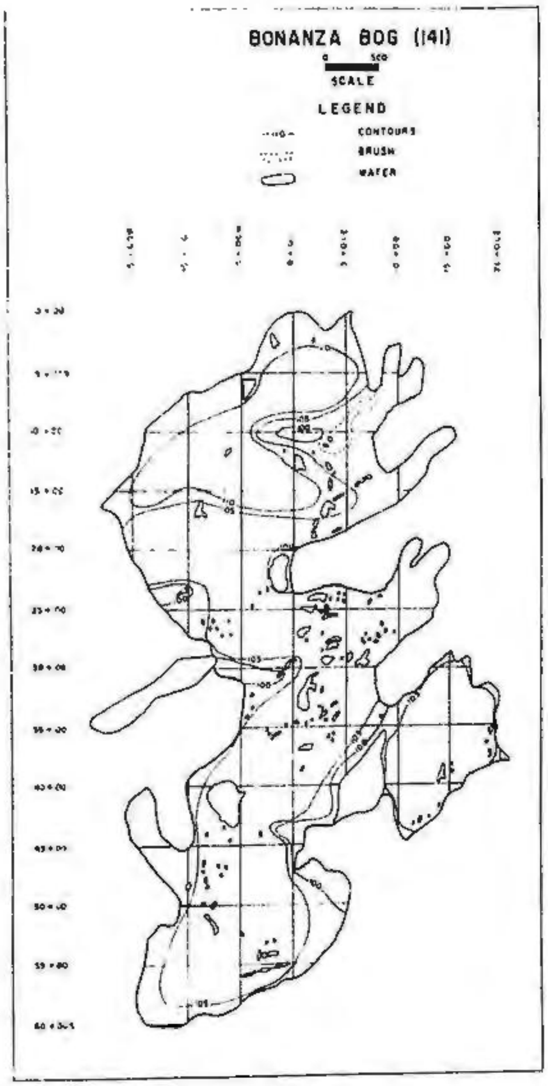

Figure 60. Map of Bonanza Bog showing contours, sampling stations and coordinates. There is a raised center in the northeastern portion of the bog.

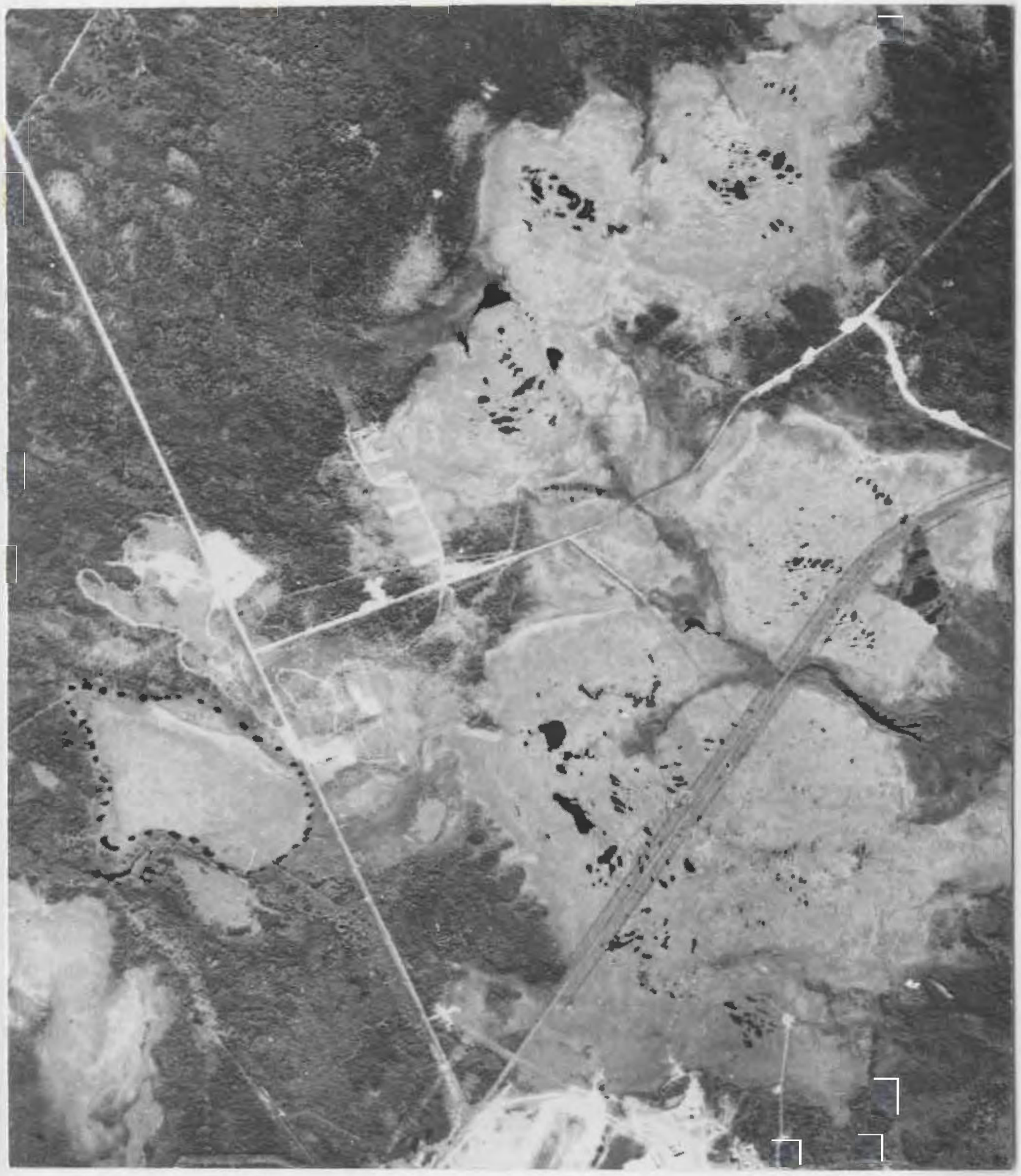

Figure 61. Aerial photo of Gander Bog (139); this is composed of a number of raised portions subdivided by drainage channels and wooded zones.

Figure 62. Aerial photo of Gambo Bog (134) showing the distribution of ponds, vegetation and drainage system. (Scale 1" = 1,600')

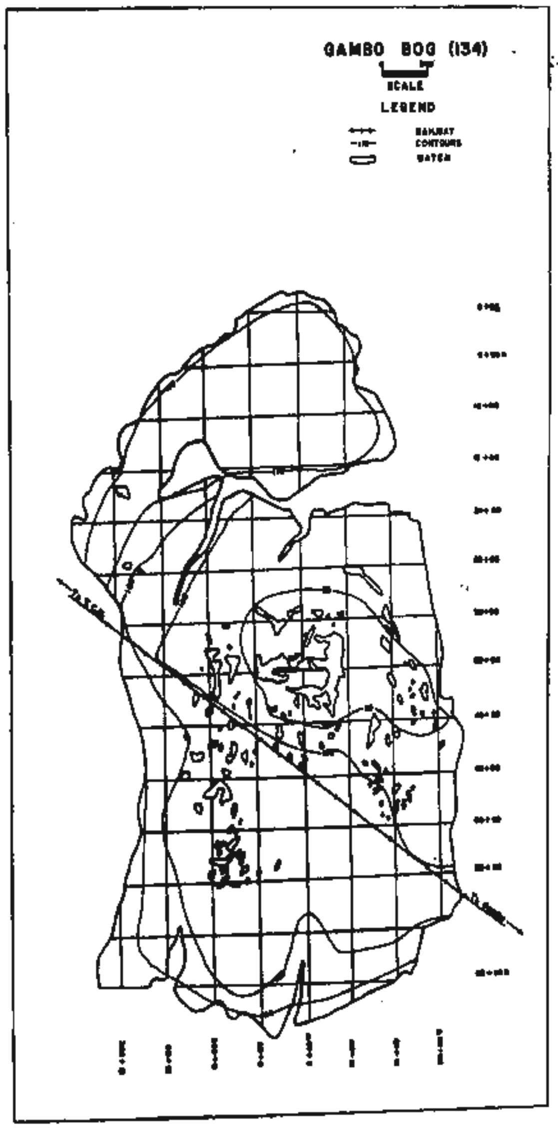

Figure 63. Map of Gambo Bog giving contours, sampling stations and coordinates.

Figure 64. Aerial photo of Hare Bay Bog (138) showing the terrain. Note the distribution of outcrop and drainage channels. North of the bog is Hare Bay Pond. (1" = 2,500')

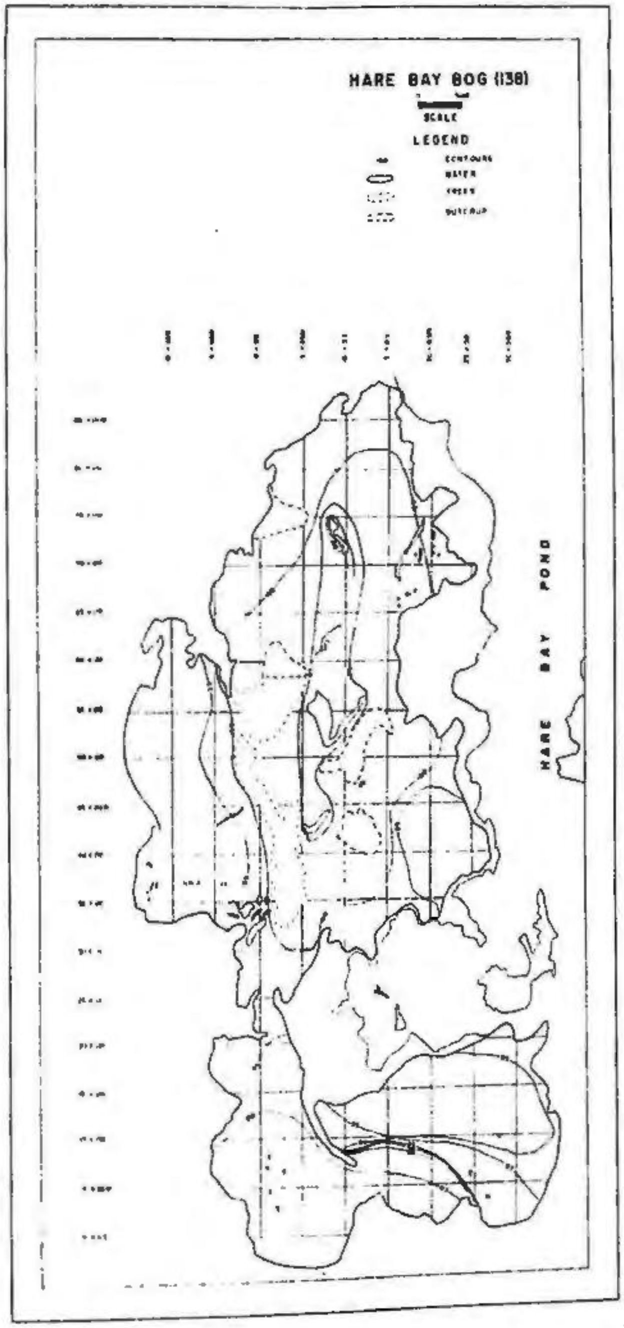

Figure 65. Map of Hare Bay Bog (138) with contours, sampling stations, and coordinates shown. From the contours it can be seen that there are a number of raised centers.

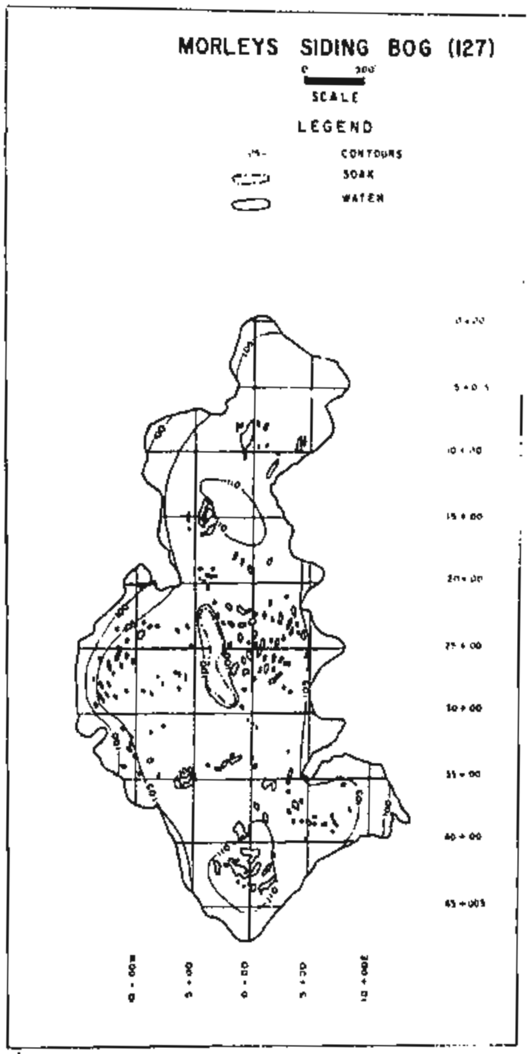

Figure 66. Map of Morley's Siding Bog C (127) showing contours, distribution of ponds as well as sampling stations and coordinates. There is a soak shown near the center of the bog, outlined by the 100 foot contour.

Figure 67. A poor fen located south of Little Bonanza Bog (140); Carex spp. are dominant.

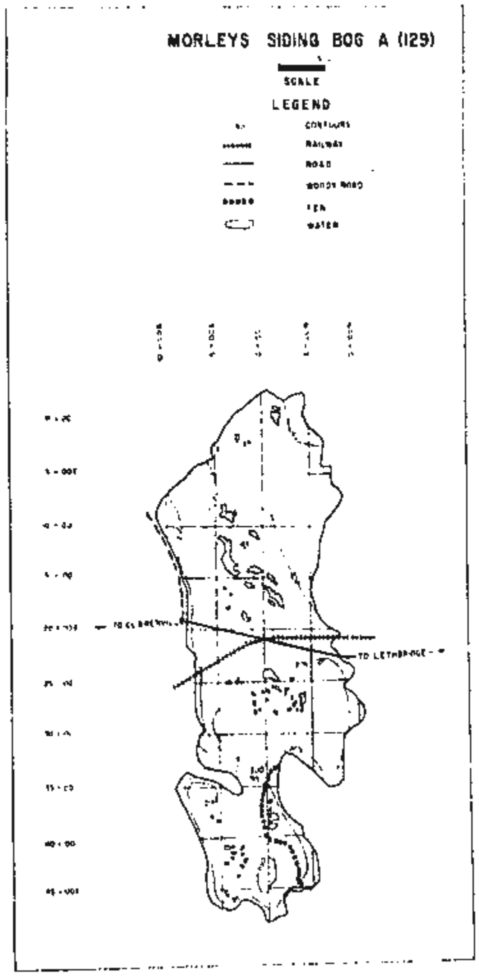

Figure 68 . Map of Morley's Siding Bog A (129) with contours, sampling stations and coordinates shown. A mesotrophic fen is situated in the northeastern corner.

ericaceous shrubs, spruce and tamarack.

Fens are also found near large ombrotrophic bogs; these are almost always poor fens (see Glossary of Terminology) dominated by *Carex* with scattered tamarach, and a little *Sphagnum*. Figure 67 shows the *Carex* growth of a poor fen at the southern end of Bog 140. Mesotrophic fens, as seen in Region I, are generally separated from ombrotrophic sites. Bog 129, in Morley's Siding, has such a fen bordering the northeastern portion (Figure 63). This site, too, has many characteristic plants. *Menyanthes trifoliata* L., *Thalictrum polygamum* Muhl., *Solidago* spp. and *Smilacina trifolia* (L.) Desf. are common herbs; *Myrica gale*, *Potentilla fruiticosa* L. and *Chamaedaphne calyculata* are the dominant while *Betula michauxii* Spach, *Juniperus communis* L. and *Juniperus horizontalis* Moench compose the higher forms in the site. The aquatic species *Equisetum fluviatile* L. and *Nuphar microphyllum* are also common. Sedges are dominant in this mesotrophic fen, the species *Scirpus hudsonianus* (Michx.) Fern., *Scirpus cespitosus*, *Carex rostrata* Stokes and *Eriophorum viridi-carinatum* (Engelm.) Fern. are most abundant. These plant species comprising this fen are most eutrophic and favour sites influenced by mineral water.

On the ombrogenous surfaces the vegetation is typical of sphagnaceous bogs with the regeneration complex evident, especially on the bogs in the Gander area. The growth of *Sphagnum* and the filling of small bog ponds was investigated on Gander Bog. This sequence is shown in Figures 68 to 73. Most of the small ponds are partially filling by *Sphagnum cuspidatum* Ehrh. and *Sphagnum pulchrum* (Lindb.) Warnst. The bog mat surrounding these ponds consists mainly of *Sphagnum magellanicum*

Figure 69. _Sphagnum_ species lying flaccid over surface of small flashet.

Figure 70. More consolidated and uniform _Sphagnum_ on flashet with some _Andromeda glauophylla_ and _Scirpus cespitosus_.

Figure 71. Further development with hummock-forming species Sphagnum rubellum. Sphagnum magellanicum is found near the edge with more sedges.

Figure 72. Drier portion of Gander Bog (139) with Cladonia islandica and ericaceous shrubs on the right and bog spruce Picea mariana on the left.

Figure 73. Mid-July vegetation in Gander Bog (139) with flashet (A) partially filled, and drier hummock (B). Also note the distribution of Eriophorum angustifolium and the larch (Larix laricina).

with hummocks dominated by Sphagnum fuscum, Sphagnum rubellum with lesser amounts of Sphagnum imbricatum and Sphagnum flavicomans. Sphagnum tenellum and Sphagnum pylaesii were also found in small ponds on Bog 129. This filling in of bog ponds is similar to the colonization described by Ratcliffe and Walker (1959). Firstly flaccid, submerged or floating sphagna are present, followed by a denser growth covering the pool. At this stage Scirpus cespitosus, Eriophorum angustifolium Roth. and Andromeda glaucophylla are present; and outward from these species Sphagnum magellanicum and the hummock forming species are found. This stage is followed by an increase in the Cyperaceae, Ericaceae, lichens and other bryophytes.

(vi) Subsurface Characteristics:

The stratification of the raised bogs in Region IV was examined in detail. The bogs in the region have an average depth of more than ten feet with a maximum depth of approximately thirty feet. The profiles for these bogs (Appendix II) show their depth as well as peat types comprising the various strata. These profiles are based on information obtained from sampling stations along the survey lines. Each cross-section can be correlated with the corresponding coordinates on the bog maps shown for Region IV.

Morley's Siding Bog C (127) is a raised bog with an average depth of 10.5 feet (Table 11). It can be seen from these cross sections that the formation is as generally expected, rising toward the center. Line 25+005 (Figure 66) indicates a constriction near the center; this is the soak. Line 35+005 also shows a hollow about ten feet below the normal elevation at this point. This is because of a small pond which has an inflow of soligenous water. This prevents a substantial Sphagnum growth and supports more mesotrophic bog species.

Bog 127 is characterized by thick Sphagnum moss (H 1-3) underlain by Sphagnum peat (H 3-5); but more often directly underlain by peat (H 6+). This lack of transition Sphagnum peat may be because of a change in the influence of mineral water. This boundary between the upper and lower layers is the line of demarcation at which they bog changed from any minerotrophic influence to be ombrotrophic. This change is not as sharply defined at stations with considerable depths of transition peat (H 3-5). Following this change leading to ombrotrophic conditions the site was favourable for the accumulation of Sphagnum (H 1-3)

At station 5+00W on line 25+00S (Figure vii, Appendix II) there is a thick deposit of transition peat. This deposit is near a soak which has influenced the decomposition of the Sphagnum on its downslope. Once the Sphagnum accumulation is higher than the soak this influence is lessened.

Morley's Siding Bog E (130) (Figure 54; Figure xxxii, Appendix II) raised bog characterized by thick Sphagnum deposits (H 1-3) underlain mainly by transition peat (H 3-5) followed by peat (H 6+). Carex peat (see Glossary of Terminology) both decomposed (H 6+) and relatively undecomposed (H 2-5) is present. This is concentrated toward the edges in the vicinity of mineral soil. It is also found in deposits near the bottom giving an indication of its role in the growth pattern.

Morley's Siding Bog A (129) (Figure 68) and Bog D (128) (Figure 57) differ from Bogs 127 and 130 in that peat accumulation is similar to the substrata in blanket bogs. Bog A (129) has variable strata constituents (Figure vi , Appendix II); Bog D (128) has Sphagnum moss (H 1-3) underlain by peat (H 8-10). In both bogs the growth follows the contour of the mineral substratum.

The Gander Bogs (139 to 141) are the deepest recorded and have great thicknesses of Sphagnum moss (H 1-3). Bog 140 (Figure 59) and Bog 141 (Figure 60) are underlain by sedge species indicating their development from a fen type vegetation. The upper layers are mainly composed of a coarse-fibered acutifolia-type Sphagnum (H 1-3) with little sedge. Gander Bog (139) like Hare Bay Bog (138) are two large bogs resulting from the coalescence of smaller bogs, both raised and blanket types. The cross sections from these two bogs (Appendix II) are inconsistent and have many peat types in their substrata. The substrata are influenced by the many drainage channels, outcrop, and wooded zones which can determine the rate and extent of accumulation.

Unlike most of the bogs in Region IV, those in the Gambo - Dark Cove area are primarily flat or slope in one direction. Despite this the bogs 134-136 are deep with cross sections indicating substrata similar to the raised bogs. The upper layers are composed of a coarse-fibered Sphagnum (H 1-3) underlain by more decomposed transition moss (H 3-5) and peat (H 6+). Profiles of these bogs are included in Appendix II.

Bog 131 is the largest blanket bog in the study area. The bog is shallow with an average depth of less than four feet, but has isolated pockets of Sphagnum moss up to 11 feet in depth. This is a Cyperaceae-Sphagnum bog formed by the coalescence of these deep pockets by means of paludification.

In many bogs there are lenses of Sphagnum peat (H 3-5) and other muddy layers (H 6-10) which have Sphagnum moss (H 1-3) both above and below. These decomposed lenses or mud spots may be the result of burning or may be due to some minerotrophic influence such as natural erosion tracts or man-made ditching resulting in drying and acceleration of humification. Another source of the lenses is the bottom layer of ponds which have filled. This layer is well decomposed because of its vegetal content (Waksman, 1932). Mud spots are common in zones supporting an active regeneration complex, where drier summits of hummocks are reverted to wet hollows. The decomposition of the lichens and ericaceous shrubs will result in muddy material of 0.1 to 2 inches in thickness.

In the cores taken woody peat was almost non-existent, limnetic deposits were also lacking. Auer (1930), Waksman et al.(1943) and Riggs (1958) frequently mention these peat types as major components of bog substrata. This lack of limnetic and woody deposits could be due to the age of the bogs in Newfoundland and if time after the last ice age permitted it, peats of this nature might accumulate.

Discussion:

Region IV includes a number of bogs which are grouped in particular sites. Many of these bogs have surface patterns characteristic of raised bog or hochmoor; some, such as Gambo Bog (134) and Dark Cove Bog A (135), although have a concentric pattern, are flat. The profiles of these bogs are similar to those compiled for raised bogs; showing considerable Sphagnum thicknesses. Bogs 134 and 135 may be termed flat-raised bogs. The bogs in both the Morley's Siding Area and Gander Area are principally raised bogs. Hare Bay Bog (138) although deeper than other bogs with similar morphology is classified as a blanket bog, however, some portions are more characteristic of an oligotrophic raised bog. Terra Nova Bog (131) is a blanket bog with a predominance of sedge; and shows minerotrophic influences. Morley's Siding Bog D (128) is also a blanket bog but with a less substantial growth of sedge. Collectively these bogs are the deepest recorded for Newfoundland (Table 11).

Bog formation by succession of a lake filling, Sphagnum accumulation, drying and reversion to forest; that is, the formation of basin peat, is not commonly found in Newfoundland. If time after the last ice age permitted it, peat of this type might accumulate. The principal pattern followed in bog succession in Newfoundland is as follows. Formation begins with the development of a fen in wet depressions, followed by the influx of Sphagnum into the site. This Sphagnum is primarily comprised of more mesotrophic species, succeeded by more oligotrophic species as the accumulation outgrows the minerotrophic influences. The bog expands outward from these centres over gentle slopes and gradually coalesce forming a larger bog surface. If this bog, through climate and topography, retains minerotrophic influences it will remain a blanket bog, however, conditions being favourable the bog will develop into a genuine hochmoor. This is the type of formation principally found in Region IV.

Table 11. Average and maximum depths of bogs investigated in the Gander, Gambo - Dark Cove, Hare Bay and Morley's Siding areas; Region IV.

Area	Average Depth (in feet)	Maximum Depth (in feet)
Gander Area:		
Little Bonanza Bog (140)	13.3	26
Bonanza Bog (141)	13.4	30
Gander Bog (139)	10.2	24
Gambo - Dark Cove:		
Gambo Bog (134)	12.6	24
Dark Cove Bog A (135)	12.9	18
Dark Cove Bog B (136	12.5	19
Hare Bay Area:		
Hare Bay Bog (138)	10.2	20
Morley's Siding Area:		
Bog A (129)	7.0	21
Bog B (129)	9.0	15
Bog C (127)	10.5	23
Bog D (128)	6.2	14
Bog E (130)	12.2	21

E. Region V - St. George's:

(i) Field Work:

The survey covered the area on the west coast from St. George's southward to Heatherton. One bog at Point au Mal, outside the study region, was surveyed in detail (Figure 1). South of Heatherton a reconnaissance survey was conducted to Port aux Basques, however, no large areas were sampled. Other bogs in this region are inland, and are accessible only from the Trans Canada Highway. The bogs numbered

142 to 166 inclusive are included in Region V (Figure 74). The emphasis is on three bogs, predominantly Sphagnum; Shallop Cove Bog (150), Flat Bay Bog (151) and Fishel's Bog (168) (Figure 75).

(ii) Topography:

The area is part of the west coast lowland or coastal plain, the maximum elevation being in the order of five hundred feet. Lewis Hills (2,672 ft.) and Table Mountain (1,235 ft.), on the northern boundary belong to the highlands and Long Range Mountains. The areas favourably disposed as far as bog formation is concerned are governed largely by the drainage pattern.

The main drainage channels are the Robinson's River, Fishel's Brook and Flat Bay Brook. These rivers, along with many smaller streams, flow westward into the ocean. In many areas the bogs are partially drained by streams or rivers bordering them. This factor probably prevented thick accumulation of peat, thereby making it difficult for such bogland to become ombrotrophic. For example, bogs from St. Teresa south to Fishel's are all separated by brooks and as a result do not coalesce but rather develop as individual units.

(iii) Climate:

In this region the mean July temperature is 60^{o}F and the January mean is 23^{o}F. The precipitation budget (Table 7) favours bog growth since there is a mean annual total of 43 inches and a surplus of 24 inches. The vegetative season is about 150 days. An important factor is the uniform distribution of precipitation in the western region which has a regular rainfall throughout the summer months. South of the region, annual precipitation increases until it

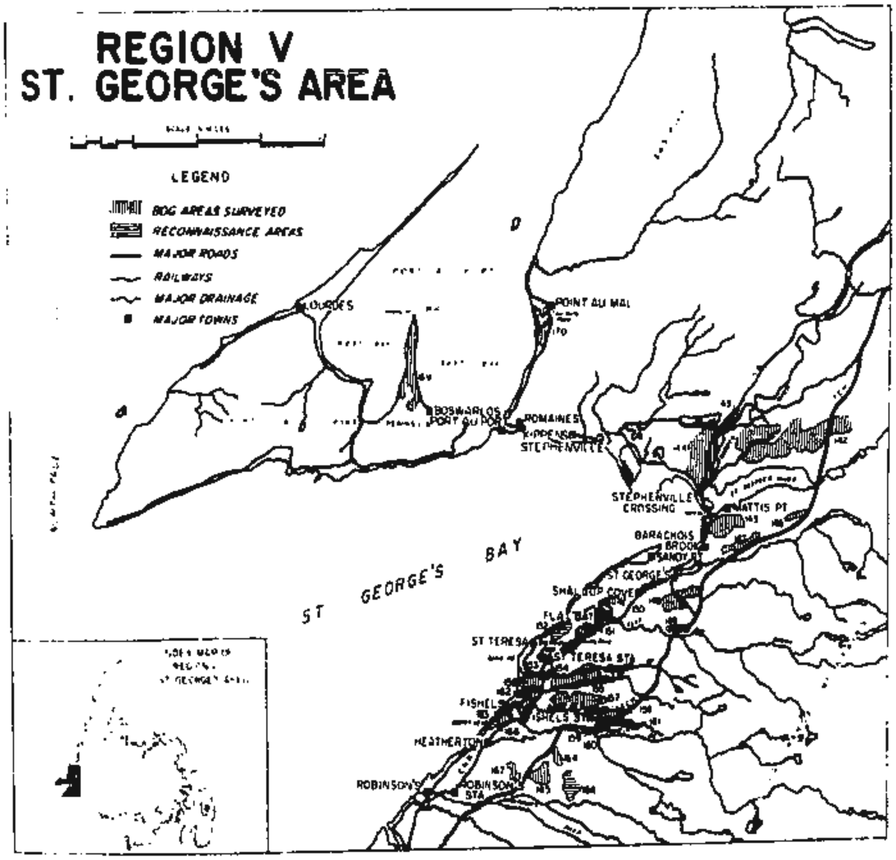

Figure 74. Bogs surveyed in Region V - St. George's. The east-west drainage pattern is shown; this is a major factor in separation of bog areas.

A. Bog 150

B. Bog 151

C. Bog 168

Figure 75. Aerial photos of three bogs in the St. George's Region showing distribution and texture of vegetation. The pond patterns are typical for blanket bogs, indicating the direction of slope.

reaches a maximum of 55 inches near Channel. Bogland near Channel is extremely thin; the average dpeth being two feet. The surface is dominated by sedges with little or no Sphagnum spp.

(iv) Geology:

The substrata of the coastal bogs (Figure 9) are predominantly gravel. Some bogs, however, are underlain by sand and silt. The bedrock of the coastal lowland is Carboniferous sandstone whereas inland there is mainly calcareous rock. Flat Bay Bog (151) lies, in part, on gypsum and is adjacent to a gypsum quarry; but there is no evidence of calcareous drainage influencing the bog. This may indicate the predominance of climatic influence over geology in bogland formation. The Sphagnum moss (H 2-3) in this bog (151) has a maximum thickness of 13 feet.

Other bogs, 153 to 163, are influenced mainly by the mechanics of drainage rather than by the mineral content of the waters. Bog 159 is very shallow and has little Sphagnum. Sedges occur in tussocks which are eroded about the edges. This may be the result of either minerotrophic water or else the result of drainage by Journois and Middle Brooks. Progressive uplift may have affected drainage to the extent that thick peat accumulations did not develop.

Bogs 155 and 157 are large blanket bogs in which the vegetation has well defined boundaries. For example, for no obvious reason, the Sphagnum dominated surface borders a surface dominated by sedges with little Sphagnum. This relstionship could be due to sharp boundaries in the mineral soil constituents.

(v) Surface Features:

Most of these bogs are blanket bogs in which the morphology is controlled by the substratum. Bog 159 (Figure 76) has a slope of more than 85 feet in a distance of one mile. This type of bog is generally dominated by the Cyperaceae with smaller zones of Cyperaceae-Sphagnaceae.

Few of the bogs in the region, such as 150 (Figures 75 and 77) and 168 (Figures 75 and 78) are Sphagnaceae - Cyperaceae. The majority, however, are wither Cyperaceae or Cyperaceae - Sphagnaceae. The surfaces are mainly wet oligotrophic with both embrotrophic and minerotrophic sites (e.g. 164, 166). Large portions of 157, 165 and 166 are minerotrophic, both wet and dry, with Myrica gale and sedges commonly occurring. Mesotrophic bog is common, but marshes and true fens are not plentiful except in localized areas such as the vicinity of Rushy Ponds.

A detailed survey of the vegetation was conducted on the surface of Bog 166 (Figure 77) which may be considered typical of the surface features found on the thicker peat deposits in the region. The Sphagnaceae - Ericaceae - Cyperaceae ends abruptly at 30 +00W and the remainder is a mesotrophic site with sedges, Carex exilis Dewey, Carex oligosperma Michx. and Carex paupercula Michx., as well as grassea and larch. The main surface is comprised of Sphagnum spp., with the mat made up of a Kalmia - Scirpus - Cladonia association. Near the borders Picea mariana, in the bog scrub form, is common, as is also Camaedaphne calyculata and other ericads.

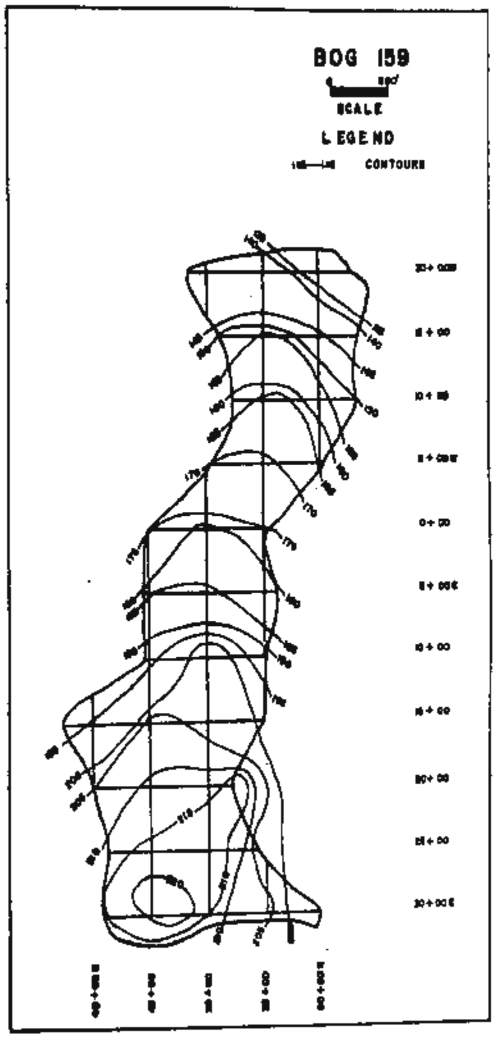

Figure 76. Map of a bog (159) showing the slope over a distance of one mile.

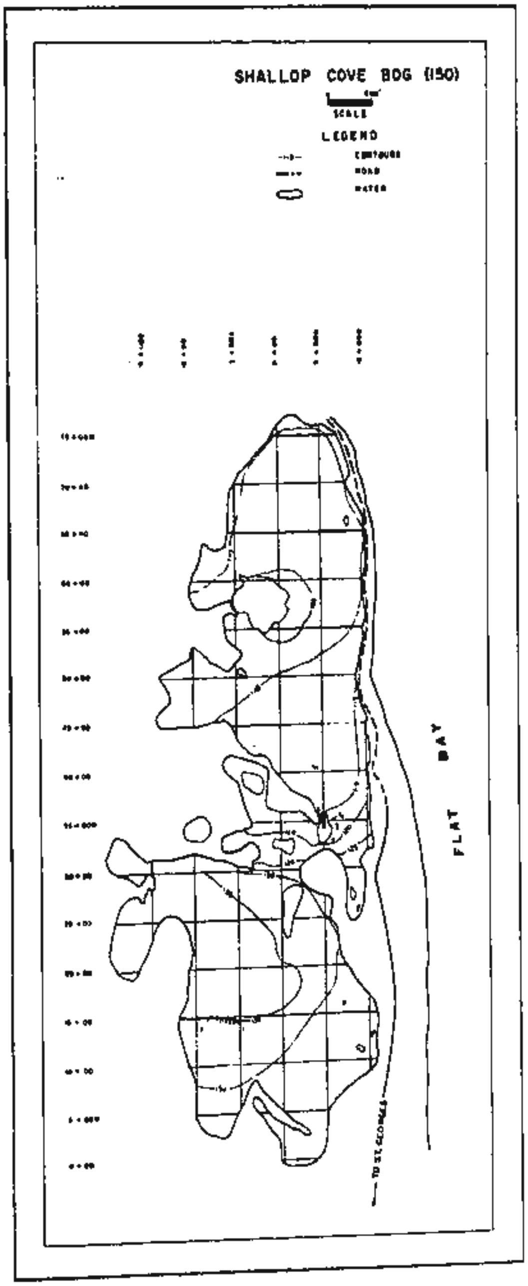

Figure 77. Map of Shallop Cove Bog (150) showing contours, sampling stations and pond distribution.

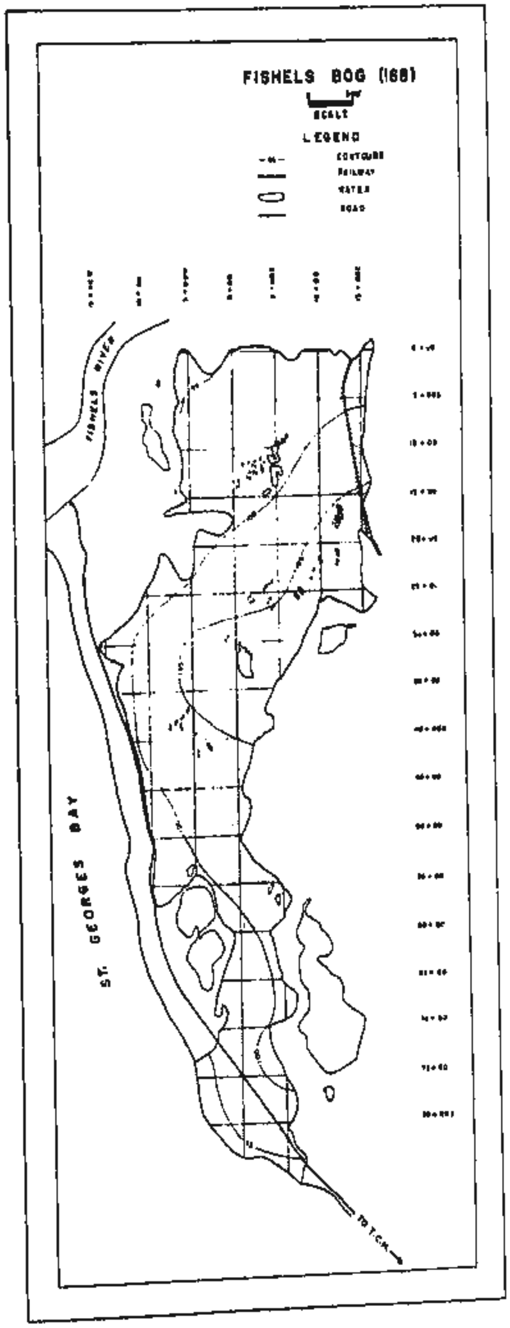

Figure 78. Map of Fishels Bog (168) showing contours, sampling stations and transportation routes. Note position of Fishels River and St. George's Bay.

Bogs located inland on slopes at higher elevations have a more diverse vegetation than those on the coastal plain. Bog 157, for example, is flanked by a marsh on the northwest with sedges and bulrushes. The lower western portion has been burned and Vaccinium spp. are common there. The southern portion grades into a spruce scrub - alder fen. In the drier areas such shrubs and herbs as Pyrus floribunda Lindl., Cornus canadensis L., Nemopanthus mucronata (L.) Trel., Solidago purshii Porter, Juniperus communis, Amelanchier sp. Medic., Smilacina trifolia and Maianthemum canadense Desf. were found with grass Muhlenbergia glomerata (Willd.) Trin., and conifer Pinus strobus L. Bog 160 has the surface dominated by Vaccinium angustifolium. This appears to be the result of drainage by road excavation through the bog.

(vi) Subsurface Characteristics:

These bogs are mainly shallow with average depths varying from 2.3 feet to 11.2 feet. There is a mean depth of about 6.0 feet, which is less than that of Regions II, III and IV. From the cross sections of bogs 150 (Figure xxxi, Appendix II) and 168 (Figure xxx Appendix II), it can be seen that sedge peat is important and is present in thick deposits. The upper layers of bogs 150, 151 and 166 are composed of a coarse to medium fiber Sphagnum moss (H 1-3) with little transition peat (H 3-5).

The distinction between Sphagnum and sedge peat is sharp at most stations. On Bogs 160 and 165 the upper layers are transition peat (H 3-5) with Sphagnum moss (H 1-3) occupying the middle layers. This is the result of drainage. In Bog 160 the natural drainage has been disrupted by road construction; in Bog 165 the upper layers were drained for experimental farm purposes. In both cases the drying has been accompanied by humification.

(vii) Discussion:

Bogs on the west coast are principally blanket bogs located on a coastal plain and separated by a series of nearly parallel streams and rivers. The bogs are shallow and are generally humified beyond H 3-5 because of the influence of minerotrophic water. Many of the younger bogs, near the coast, have developed since coastal emergence and with age may spread inland between drainage channels and hills. The surface vegetation is usually dominated by one type of vegetation, which in most cases is sedge (Table 12).

Drainage from the Long Range Mountains is calcareous. This water which drains to the coast has little overall effect on vegetation but may have localized influence. Point au Mal Bog (170), the most northerly bog in the region, is near the foot of the Table Mountains. Bogland in the area is mainly shallow and well humified; Bog 170, however, is protected from this drainage by a pond and as a result this is a *Sphagnum* raised bog with an average depth of 12.7 feet.

Despite mineral water influence the bogs are wet oligotrophic with mesotrophic sites restricted to borders and drainage channels. There is a lack of raised bogs, but Bog 154, which has a raised surface, does resemable the concentric dome shaped surfaces familiar from Region IV.

Table 12. Areas, soundings and depths of all bogs surveyed in Region V. These are classified according to vegetation type.

Bog No.	Area (acres)	No. of Soundings	Average Depth of Bog (feet)	Maximum Depth of Bog (feet)	*Vegetation Type (according to surface cover)
142	4,500	479	6.83	15.0	C - S
143	410	93	7.18	10.0	C - S - E
144	4,089	364	6.80	14.0	C - S
145	897	100	11.30	21.0	C - S - E
146	241	297	5.54	21.0	C
147	465	237	4.08	17.0	C
148	1,250	88	6.70	19.0	-
149	218	51	7.60	22.0	S - C
150	194	53	6.73	24.0	C - S
151	459	482	7.92	21.0	S - C
152	70	6	-	-	Marsh
153	101	10	3.60	12.2	C
154	118	31	5.00	14.0	C - S
155	645	166	5.60	16.0	C - S - E
156	281	61	2.31	9.5	C
157	530	93	6.20	13.5	C - S
158	122	37	6.10	14.5	S - C
159	155	30	6.84	16.0	S - C
160	75	31	6.15	14.0	E - S - C
161	185	45	8.10	21.5	S - C
162	163	39	6.32	11.0	C - S
163	261	65	6.00	15.5	S - C
164	193	47	5.17	14.5	C
165	375	113	11.50	24+	S - C - E
166	-	-	-	-	C
167	165	52	5.33	16.5	C
168	170	47	6.50	15.0	S - C
169	1,250	91	11.60	18.0	-
170	120	59	12.35	22.0	S - E - C

*The families are listed in order of dominance: C - Cyperaceae
S - Sphagnaceae
E - Ericaceae

F. Region VI - Cow Head

(i) Field Work:

This region is the most northerly one that was studied. None of the bogs was surveyed in detail, but random sampling was conducted to obtain the required data. Bogs 171 to 178, which are included in the study, extend over great areas and some of them are joined (Figure 79). Some bogland north of this region was investigated in a cursory manner.

(ii) Topography:

The bogs in this region are on the coastal lowland west of the Long Range Mountains. There is, generally, a gradual slope from sea level eastward to the mountains which rise steeply and attain a maximum elevation of the order of 2,500 feet. The bogs have their long axis oriented generally in a north-south sirection and are found occupying the full width of the lowland including, in some cases the steeper slopes at the foot of the mountains. Drainage is accomplished principally by small interconnecting ponds and streams rather than by major rivers, which have little influence.

There is little record, onshore, of the history of glaciation, but moraines are reported to have been deposited in what is now the immediate offshore area.

(iii) Climate:

The climate, according to available data, is not extremely severe. There is a growing season of 140 days and a mean temperature of 18.3°F in January and 57.5°F in July. The mean annual wind

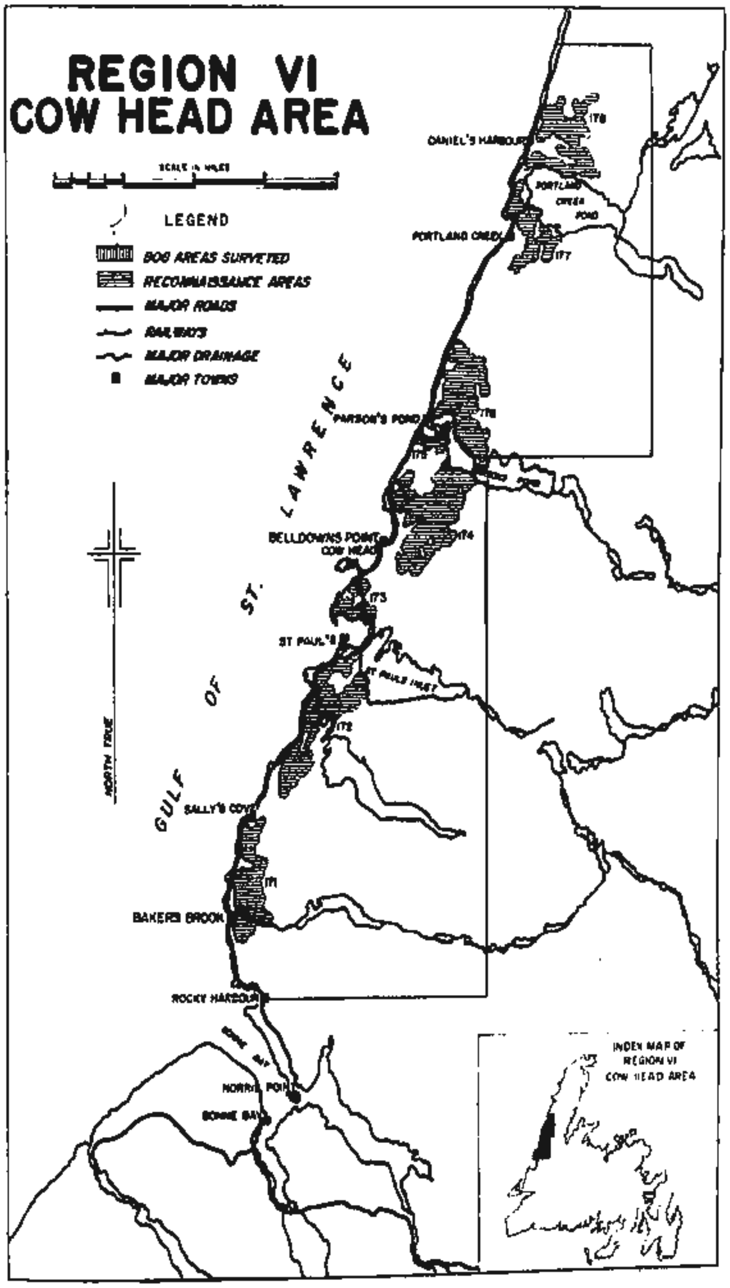

Figure 79. Region VI - Cow Head, showing bogs examined. All bogs in this region were examined cursorily.

velocity is 13.1 mph. The precipitation rate is 32 inches per year. According to the temperature, length of the growing season and moisture surplus available there should be extensive thick accumulstions of peat moss. This, however, is not the case, as the bogs of the region are quite shallow.

Wind conditions may be an important factor in the supression of the growth of particular species on the bogs. Along the coastline the trees are markedly stunted and have a layering structure not unlike krumholz. In fall, the coast begins to experience cold winds off the ice, and from December to early May the straits are often ice-bound. Strong, cold winds retard the spring and, thus, have an adverse effect upon the vegetation.

(iv) Geology:

As in Region V, bog formation is influenced to some degree by drainage from the Long Range Mountains. Although the principal rock types are typical Grenville gneisses and granites, there are extensive exposures of carbonate rocks along the western slopes. Drainage from these calcareous rocks could have a considerable effect on the inland bogs by reducing acidity and thereby making the environment unsuitable for oxyphylous plants. This, however, seems to have had little real affect on the bog area except to retard the rate of accumulation.

The coastal bogs are underlain in part by acid podzols of gravel texture and elsewhere by a dry clay which has considersble organic material in it. It is difficult to penetrate beyond a depth of two feet.

(v) Surface Features:

The first impression upon viewing these large, relatively flat bogs is that there is little variability in the vegetation. This is true for some of these bogs; however, most are quite diversified. Bog 162 near Baker's Brook is level and has a moderate growth of Scirpus cespitosus and other sedges and a fair Sphagnum content. This bog, judging from the vegetation, was thought to be deep, however, it is only about four feet. Bog 163 near St. Paul's is a Cyperaceae bog similar to Bog 1 near Sunnyside in Region I. It is flat and has a number of bog ponds which are dried (Figure 80). In contrast to this, Bog 165 has a diversified vegetation (Figures 81 and 82). This one is level but has a well developed hummock-hollow complex. The hummocks are numerous; about one foot high and about two feet in diameter, surfaced by Cetraria islandica. Figure 83 shows these white topped hummocks interspersed with sedges, Scirpus cespitosus and others. Figure 84 shows a close-up of a hummock with Rubus chamaemorus, Empetrum nigrum and ericaceous shrubs. This bog has not developed a lagg or rand, but rather is bordered by a low spruce zone with tattered forest growth behind. Figure 82 shows the line of demarcation from the bog proper to dwarf shrubs, followed by black spruce. The Sphagnum mat is difficult to describe because there appears to be little new growth in flashets and ponds. The main species is Sphagnum imbricatum which forms the basis for hummock development.

North of the study region, about 40 miles south of St. Anthony, the coastal area is barren but for a broken cover of coarse till with some

Figure 80. Large blanket bog near St. Paul's dominated by sedges.

Figure 81. Edge of small bog near Parson's Pond, with scrub spruce and ericaceous shrubs bordering on wetter oligotrophic zone.

Figure 82. Central portion of bog near Parson's Pond showing extensive hummock-hollow development.

Figure 83. Hummock on small bog near Parson's Pond with typical plant species; Rubus chamaemorus, Empetrum nigrum, Cetraria islandica and Ledum groenlandicum.

Figure 84. Shallow pond indicating depth of surrounding bog area. Bogs are about 40 miles south of St. Anthony.

Figure 85. Bog 20 miles south of St. Anthony in forested zone showing surface features.

Figure 86. Bog area 20 miles south of St. Anthony with species indicating dryness. Various lichens and short shrubs are common.

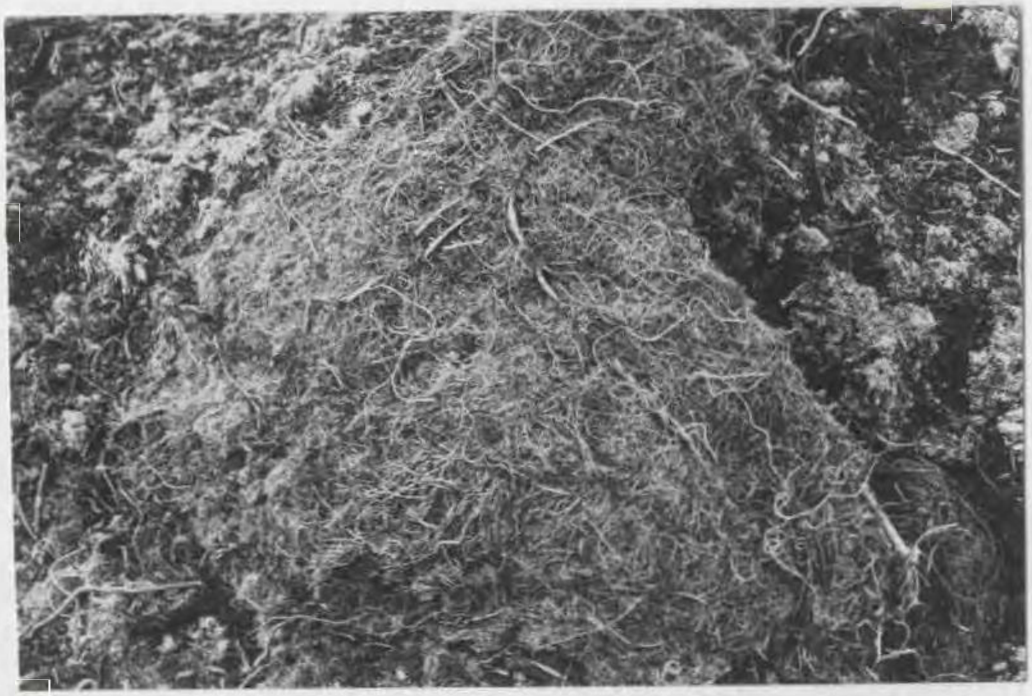

Figure 87. Subsurface peat taken from a small bog area 20 miles south of St. Anthony.

very shallow bog areas. Figure 85 shows one bog area which is very shallow as evidenced by the exposure of boulders in the pond. Inland from the coast 20 miles from St. Anthony, the forest cover thickens and there are some small bogs which differ from those on the more exposed coastal areas. These bogs are almost devoid of any trees or high shrubs. On the one shown in Figure 86 the surface is dry because of drainage from roadside ditches. The dominant plant species are Empetrum nigrum, Cetraria islandica and very short shrubs such as Vaccinium sp., Ledum groenlandicum and Rubus chamaemorus. Sedges and Sphagnum are not abundant. Figure 87 shows a closeup of the surface showing the abundance of lichens and low shrubs.

(vi) Subsurface Characteristics:

The subsurface featuares were not examined in any great detail. There was a random sampling from which it was established that the bogs are shallow with a slow rate of accumulation. The peat moss is generally dense as if formed under pressure, and whre there is raw moss the fiber is fine to medium. These are shallow bogs with well humified peat (H 6+) and little or no Sphagnum moss (H 1-3). Bogs with an active regeneration complex are deeper, however, Bog 177 is an exception being only four feet in depth. On a small bog near Parson's Pond the average depth, based on random sampling, is about four feet with a maximum of about nine feet. Figure 87 shows the matted structure of subsurface peat near St. Anthony. This is a tangle of roots and plant residue composed primarily of Empetrum sp.

and sedge. There is surprisingly little Sphagnum in this peat.

(vii) Discussion:

The coastal plain of the Northern Peninsula is characterized by great expanses of blanket bog stretching northward. These bogs are mostly oligotrophic wet to dry, dominated by lower shrubs and sedges. Ericaceous shrubs are much smaller here in comparison to other regions and are on a level with Rubus chamaemorus. There is little variety in bog type, the most common being blanket bogs. No raised bogs were observed, but some of them exhibit an active regeneration complex. Some bogs occur at the base of the mountains on relatively steep slopes. One bog near St. John Bay is located on a limestone deposit.

In most bogs in the region there is little variation in the Sphagnum species, a fact which was substantiated by subsurface studies. The peat varies from hard and dry to soft and wet. It is well decomposed (H 6+). One area has Sphagnum (H 1-3) down to four feet. In this area the peat is fine fibered, reflecting a predominance of small-leaved Sphagnum, such as Sphagnum imbricatum.

Further north, between Eddies Cove and Big Brook, and north of Big Brook, what is termed "bog" is only six inches to one foot thick, forming a veneer over the rocky till.

General Discussion and Conclusions

A. General Discussion:

(i) Peat Deposits in Newfoundland:

Peat deposits in Newfoundland differ from those in southern Canada (Auer, 1930) and in parts of the United States (Waksman, 1942, 1943; Rigg, 1925, 1940, 1958). The sedimentary type of deposit which is important there was not found in Newfoundland during the investigation. Some of the Minnesota peat deposits are similar to those found in Newfoundland bogs (Farnham, 1963, 1964, 1965), but most of the former have resulted from sedimentary deposition (Heinselman, 1963; Farnham, 1963). According to Leverin (1946, 1947), Givard (1947) and Graham and Tibbets (1961, 1965), peat deposits in various provinces are comprised of many species common to those in Newfoundland bogs. The latter, however, are not as complex floristically and have very distinct strata with fewer dominant vegetative types. Ganong (1897) noted that the raised bogs of New Brunswick show little variation in the type and structure of peat stratification; this holds true for Newfoundland. A discussion of the peat types can be found in Appendix II.

(ii) Classification of Bogs:

Any classification would be difficult to reconcile with the literature. Newfoundland bog development is largely controlled by the influences of maritime location and climate and may be compared to other maritime countries. In such countries as Ireland, Scotland and England there are two main types of bog. According to Jessen (1949), these are, topogenous - those bogs controlled by the level of ground water,and secondly climatic - those controlled by climate.

(i) Topogenous Bogs

(a) Basin bogs

(b) Paludification bogs

(ii) Climate Bogs

(a) Soligenous

(b) Ombrogenous

(1) Raised

(2) Blanket

In Newfoundland this terminology is not as applicable as is the English classification, after Tansley (1949). He divides English bogs into three categories:

(i) Raised bog

(ii) Blanket bog

(iii) Valley bog

In the text most bogs are referred to as either raised or blanket. There is a third type which is a complex of the two, composed of raised centers coalesced by blanket bog.

In Germany and the U.S.S.R. bog classification is similar and is uncomplicated. Much of the technical literature on bog refers to the German method:

(i) Hochmoor - high moor

(ii) Neidermoor - low moor

(iii) Uebergangsmoor - transition moor

This classification is influenced by the fact that there are no blanket bogs in Germany. Thus, this should only be applied in areas of continental climate, whereas bogs in maritime areas should be broken down further into two groups, topogenous and climatic.

According to Pyarchenko (1963) these types previously mentioned are based on morphological characteristics and should be taken to mean a present stage of development rather than indicating the type of vegetation. In most cases, however, certain vegetative features can be attributed to both raised and blanket bogs.

The Scandanavian countries divide the bogs into classes, based on vegetation, for example, in Finland there are four classes (Kivinen, 1963):

(i) Spruce bogs

(ii) Pine bogs

(iii) Open Sphagnum bogs

(iv) Open brown moss bogs

There are a number of sub-types in each class based on the dominant species present in the vegetation. In the Scandanavian literature terms based on morphological differences are also common, such as raised, aapa, palsa and Carelian types.

Damman (1964) has divided Newfoundland bogs into three main types based on vegetation and nutrient content:

(i) Dwarf shrub

(ii) Oligotrophic

(iii) Mesotrophic

A bog may be subdivided into all three types. That is, there may be sites on the same bog which are mesotrophic, oligotrophic or dwarf shrub. Newfoundland bogs may be further classified according to the family and sometimes according to the species which dominate the surface. The main families and their species are:

(i) Sphagnaceae

  (a) _Sphagnum_ spp.

(ii) Cyperaceae (Sedge Family)

  (a) _Scirpus_ spp.

  (b) _Carex_ spp.

  (c) _Eriophorum_ spp.

  (d) _Rhynchospora_ spp.

(iii) Ericaceae (Heath Family)

  (a) _Kalmia_ spp.

  (b) _Vaccinium_ spp.

  (c) _Ledum groenlandicum_

  (d) _Andromeda glaucophylla_

  (e) _Rhododendren_ sp.

  (f) _Chamaedaphne calyculata_

These families dominate other species commonly found on the bogs, such as, the lichens _Cladonia_ spp. and _Cetraria islandica_; the cranberry, Empetrum spp.; the sweet gale, Myrica gale; and the bakeapple, Rubus chamaemorus. The trees Picea mariana and Larix laricina are also commonly found on or near the bog habitat. Any individual bog may be identified by the dominant species, for example, a Scirpus - Cladonia bog. This surface vegetation is subject to change with environmental conditions, and the place of the bog within this type of classification could change according to species change. In summary, any bog may be classified according to its morphological and vegetative features, neither of which are permanent, but rather subject to change in time.

(iii) Growth and Expansion of Bogs in Newfoundland:

In many areas of Newfoundland, places which were originally forest are now partially covered by bog. The principal means of expansion is paludification. According to Auer (1930) this may take place by four main methods. All four modes may operate together:

(a) paludification of depressions, caused by surface waters,

(b) paludification caused by a rise in the ground water level,

(c) paludification due to spreading of peat bogs previously formed,

(d) paludification of land caused by water flowing from peat bogs at higher levels.

In Newfoundland all modes have been experienced. The paludification of depressions begins with the formation of a fen followed by Sphagnum growth. This is common on the poor moranic soils of the

Avalon Peninsula and Bonavista Regions. The fen species of the genus _Carex_ forms an almost impermeable bottom layer over which _Sphagnum_ spreads. Trees, especially _Larix laricina_ are associated with the fen vegetation, however, these die and are buried by _Sphagnum_.

Paludification of depressions, caused by a rise of the ground water level, has been brought about in many cases in southeastern Canada, particularly near the sea, as a result of forest fires (Auer, 1930). In Newfoundland this is evident on the Avalon Peninsula and in the Wesleyville Regions. In Region V where bogs are found on relatively fertile soil this factor is also prevalent.

Paludification due to peat bogs previously formed depends on biological, adaptive and topographical factors (Auer, 1930). This can be seen in all regions studied, however, it is greatest in areas of barren soil such as on the Avalon Peninsula and on the south coast of Newfoundland.

The fourth mode was observed only on a small scale, such as near drainage channels where bog plants or grasses follow down the slope from the bog. There, plants may eventually form a basis on which _Sphagnum_ will grow.

B. Conclusions:

Blanket bogs predominate over raised bogs in all the regions surveyed. Region IV has a greater number of raised bogs, however, these are of less area than the blanket type. Blanket bogs are largest in

Region III covering many square miles of land near the coast from Badger's Quay to Musgravetown. Outside the study regions there are great expanses of blanket bog along the south coast, in the area south of Gander Lake and north from Buchans to the Canadian National Railway. Blanket bogs are most prevalent in coastal areas. This is due to the high humidity of the air near the sea which aids paludification. In Newfoundland, as in the other maritime areas, the climate promotes the spreading of *Sphagnum* and eclipses other physiographic processes.

Raised bogs were not uncommon and only in the Bonavista and Wesleyville Regions were none recorded. Region IV - Terra Nova - has the best examples of raised bogs; Bogs 127 and 140 have convex centers, concentric pond pattern and well developed rand and lagg. Raised bogs found in Region I - Avalon Peninsula - are mainly restricted to small depressions surrounded by forest. This forest growth favors the growth of raised bogs by regulating the water table within the depressions. Other bogs such as 138 and 139 are complexes consisting of raised centers united by blanket bogs spreading outward from these centers.

The origin of bogs in Newfoundland gives little evidence of variation, with plants characteristic of mesotrophic fen and bog obtained from the bottom layers in nearly all cases. Such a mesotrophic site can be seen in Figures 25 and 26. The more classical mode of formation, deposition of sedimentary peat, did not play an important role in Newfoundland. No large, true basin deposits were recorded. This is accepted because of the age of the bogs which have formed since the last ice age about 7,000 to 10,000 years ago. With time the glacial ponds and lakes may accumulate appreciable limnetic deposits of peat on which Sphagnum bogs will develop.

From the cross sections compiled (Appendix II) the succession of growth for a typical raised bog can be ascertained. As stated, the growth of the bog stems from an initial fen-type vegetation, the residue of which forms a thin, well-decomposed (H 8-10) layer. Above this the succeeding strata, or intermediate layers, consist principally of a semi-fibrous peat composed of sedges (Cyperaceae peat) or of sedges and Sphagnum (Cyperaceae-Sphagnum peat). This is generally well-decomposed (H 6+), but in some deposits there is little evidence of decomposition. Succeeding the intermediate layers (H 6+), are transition layers, moderately decomposed (H 3-5), composed of a Sphagnum-Cyperaceae complex where Sphagnum is usually dominant over the sedges; in many cases the reverse is true. Above the transition layers, and more often directly on the intermediate strata, are the upper layers. These layers nearly always are Sphagnum peat (H 1-3). There are many exceptions to this norm, for example, in Bog 138 Sphagnum moss (H 1-3) is found to extend from the upper layers down to the mineral soil, with thicknesses up to twenty feet. The influence of the medium determines this sequence. When mineral waters percolate or run underneath the bog it will result in minerotrophic species predominating in that site. Such sites are found near outcrop, along drainage channels and in some bogs on the ombrotrophic surfaces; the latter are soaks . The transition layers usually mark the end of mineral water influences in decomposition of the strata. Inversions are common and often show in cross sections. These anomalies are caused by climatic changes, fires and drainage through mechanical means.

The surface features vary with each bog and any generalization would not be without exceptions. A bog type cannot be readily identified from surface vegetation or surface patterns. Bog 108, for example, has surface features similar to a typical raised bog, yet the profile (Figure 32), shows that this is a blanket bog. Sedges are dominant on blanket bogs and *Sphagnum* is dominant on raised bogs. The wet oligotrophic surfaces of bogs in all regions have a good growth of *Sphagnum* and Cyperaceae. The dwarf shrub bogs are drier and sometimes are restricted to particular zones; dwarf shrub bog is nutrient poor and covered principally by ericaceous shrubs on a *Sphagnum* mat. The mesotrophic bog is wet and is influenced by eutrophic waters. In such a bog the species such as *Carex* spp. and *Myrica gale* determine the physiognomy of the vegetation. In many bogs these sites are restricted to drainage channels and borders.

Some blanket bogs have a continuous vegetation dominated by one family and in some cases by one species. Examples of this are some bogs on the west coast which are dominated by *Scirpus cespitosus*. Raised bogs tend to have a more diversified vegetation as reflected in the regeneration complex (hummock and hollow complex). Such a bog is characterized by low wetter hollows dominated by the more hydrophilous *Sphagnum* spp. as well as sedges and *Andromeda glaucophylla* and hummocks formed by the hummock forming *Sphagnum* species, *Sphagnum fuscum*, *Sphagnum rubellum*, *Sphagnum flavicomans* and *Sphagnum imbricatum*. These hummocks are topped by ericaceous shrubs and the lichens Cetraria islandica and Cladonia sp., along with Rhacomitrium lanuginosum, which is common on coastal bogs, and Dicranum bergeri. The latter is found only in small tufts in drier hummocks. The bog mat between the hummocks and hollows is generally dominated by Sphagnum spp. with Sphagnum magellanicum most abundant. Scirpus cespitosus is an important species of sedge with its tufts spotted over the surface. Also associated with the raised surface are small clumps of juniper, Juniperus communis, as well as scattered larch Larix lavicina and spruce, Picea mariana. The bogs in Region VI lack any appreciable abundance of higher dwarf shrubs and trees. Two of the common hummock-forming Sphagnum species, Sphagnum flavicomans and Sphagnum imbricatum were not recorded on the Northern Peninsula.

Fire has radically changed the surface vegetation of bogs in Regions I, II and III. Certain dwarf shrubs such as Kalmia polifolia are seldom found on burned-over surfaces, whereas other species such as Vaccinium spp. and Empetrum spp. flourish after a fire. In the Wesleyville area Vaccinium and Empetrum dominate on some bog surfaces. Rhacomitrium lanuginosum is greatly affected by fire, however, it recovers quickly and generally covers the tops of higher hummocks on burned-over bogs. As expected, drying changes the surface vegetation, resulting in grasses, bryophytes other than Sphagnum, such as Polytrichum strictum and Dicranum bergeri, as well as higher shrubs and trees. Much of the bog surface in Newfoundland remains in a natural state.

The fens near bogs are under minerotrophic control and their vegetation is dominated by greyish-green sedges. These fens are generally mesotrophic, such as the fen near Morley's Siding Bog A (129) or eutrophic, similar to the fen near Little Bonanza Bog (140). Also, near raised bogs, between the bog and the mineral substrate, is the lagg, or drainage channel, which is minerotrophic. This area is characterized by the species *Myrica gale*, *Chamaedaphne calyculata*, *Methanthes trifolia*, *Carex* spp. and *Sphagnum* spp.

Development and growth of the bog is controlled by climate in Newfoundland, with annual precipitation varying from 63 inches in Region I to 32 inches in Region VI. Most of the island has a mean annual potential evapotranspiration of 19 inches; thus, all areas would have a high moisture surplus. The vegetative season and temperatures also affect the development and rate of accumulation. The July isotherm of 60^{o}F (Figure 14) covers most of the central part of the island. South and north of this region the bogs are shallow, however, along a central belt near 49^{o} latitude the deepest deposits are found. These deep deposits are found in areas with a mean annual precipitation of 35 to 40 inches, having a growing season of 150 days and within the July isotherm of 60^{o}F. Region III (Bog 122) and Region IV (Bog 141) have accumulated peat deposits up to thirty feet thick.

Regions with high precipitation have a higher percentage of blanket bogs and a marked decrease in raised bogs. The bogs on the Avalon Peninsula are generally more humified (H 5+) and less thick than bogs in the other study areas. The increase in surface water carries more nutrients to these bog areas, resulting in accelerated humification. Region V - St. George's - also has similar deposits; but the average depth exceeds that of Region I with many bogs exceeding ten feet in depth. Both the Avalon Peninsula and St. George's areas have exceptions with some deposits of twenty feet. These bogs, however, are surrounded by tree growth which may regulate the ground water to such a degree that all excess water is utilized by the trees thus favouring bog growth through a decrease in minerotrophic influence.

Region VI - Cow Head - has a relatively low annual precipitation (32 inches) and a moisture surplus of 16 inches. Other climatic factors are not as favourable for bog growth. The severe winds may result in the drying of some bog areas, thus causing greater oxidation and subsequent decomposition. Also the slow growth rate due to low temperatures and a short growing season of 150 days does not favour the rapid growth and accumulation of Sphagnum spp. There is seldom a good bog mat and on many bogs there is an abundance of small shrubs, lichens and other bryophytes to the exclusion of the typical Cyperaceae-Sphagnum surface. One bog (Figure 82) was sounded to a depth of 9 feet. This bog has a good regeneration complex, is not raised, but rather is in a depression with the scrub spruce about the edges higher than the bog center. The surrounding vegetation may protect the bog from severe winds and the topography is such that this is a catchment area for precipitation; both factors favouring peat accumulation.

Fire, other than affecting surface vegetation, also affects the accumulation and expansion of bogs by disrupting the water economy. Region III - Wesleyville - has been burned so many times that areas of naked soil replaced the forest. This soil without the forest growth had a high water level and because of low evaporation in the area, due to high humidity, the soil became soaked and paludification began. Fire charcoal and other fire products, when washed into a depression, form an impermeable layer, resulting in moist conditions, and provides a habitat for oxyphylous species. The peat can accumulate in these depressions, raising the water level. The acidophilous vegetation spreads outward from these centers of growth which coalesce to form a blanket bog. Raised bogs tend to grow upward, establishing their own parabolic water table.

Another factor favouring bog development is the fact that Newfoundland is recently glaciated. Bogs have developed on outwash plains (Gambo Bog 138) and on coastal plains which have undergone progressive uplift such as in the St. George's area. Recently glaciated areas also favour the production of bogs with fluvioglacial deposits such as drumlins and eskers acting as barriers and producing irregular drainage. The blanket bogs near Whitbourne (Region I) are excellent examples of this pattern.

In general, geology has little influence on bog development in Newfoundland. The bedrock and soils are mainly acidic and where there are calcareous soils or bedrock the climate predominates such that if topography is suitable, bogs may develop. Bog 151 (Region IV) is partially underlain by a gypsum deposit, and near St. John (Region VI) bog was recorded directly on limestone.

Newfoundland, with its acid soils and bedrock, a history of recent glaciation and with a maritime climate of cool temperatures and high precipitation, is a favourable habitat for both raised and blanket bogs.

Bogs are found in all regions and, depending on topography, vary from less than one acre to many square miles in area and from inches to 30 feet in depth. Of the approximately 7,000 square miles of bog in Newfoundland only little has been studied, leaving the field wide open to prospective investigators.

LITERATURE CITED

ALLINGTON, Kathleen R. 1961. The bogs of central Labrador-Ungava; an examination of their physical characteristics. Stockholm, Geog. Ann. 43(3-4):404-417.

ANDREWS, A. L. 1913. North American Flora, 15(1); Sphagnaceae: New York Botanical Garden.

ANREP, A. 1915. Investigation of the peat bogs and peat industry of Canada 1913-1914. Canada Dept. of Mines, Mines Branch, Bull. 11: 185 pp.

AUER, V. 1930. Peat bogs in southeastern Canada. Canada, Dept. of Mines, Geological Survey, Memoir 162, 21 pp.

BANNATYNE, B. B. 1964. Preliminary survey of bogs for peat moss in southeastern Manitoba. Manitoba, Dept. of Mines and Natural Resources, Publ. 63-5: 43 pp.

BARRY, T. A. 1954. Some considerations affecting the classification of the bogs of Ireland and their peats. Proc. Int. Peat Symp., Sect. B2; Bord na Mona, Dublin.

BECKING, R. W. 1957. The Zurick-Montepellier School of Phytosociology. Bot. Rev. 23:411-488.

BRAUN-BLANQUET, J. 1932. Plant Sociology: the study of plant communities. (Translated and edited by G. D. Fuller and H. C. Conrad.) McGraw-Hill Book Co. Inc., New York.

BUELL, M. F. and H. F. BUELL. 1941. Surface level fluctuation in Cedar Creek Bog, Minnesota. Ecol. 22:317-321.

CAJANDER, A. K. 1913. Studien uber die moore Finnlands. Acta Forest, Fenn. 2:1-208.

CHAPMAN, S. B. 1964. The ecology of Coom Rigg Moss, Northumberland, pt. 1. Stratigraphy and present vegetation. J. Ecol. 52:229-314.

CHRISTIE, A. M. 1950. Geology of Bonavista map-area, Newfoundland. Geol. Surv. Can. Paper 50-7.

CLIFFORD, P. M. and D. M. BAIRD. 1962. Great Northern Peninsula of Newfoundland - Grenville inlier. Can. Inst. Mining Metallurgy Bull. 599:150-157.

CONWAY, Verona M. 1947. Ringinglow Bog near Sheffield, pt. 1. Historical. J. Ecol. 34:149-181.

__________ 1949. The bogs of central Minnesota. Ecol. Monogr. 19:172-206.

COOMBS, D. B. 1954. The Physiographic subdivisions of the Hudson Bay Lowlands south of 60 degrees north. Ottawa, Geor. Bull. 6:1-16.

COPES, P. 1961. St. John's and Newfoundland, an economic survey. St. John's, Nfld. Board of Trade. 233 pp.

DACHNOWSKI, A. P. 1912. Peat deposits in Ohio, Ohio Geol. Surv. Bull. 16: 424 pp.

DACHNOWSKI-STOKES, A. P. 1935. Peatland as a conserver of rainfall and water supplies. Ecol. 16(2):173-177.

DAMMAN, A. W. H. 1964.a Some forest types of central Newfoundland and their relation to environmental factors. Can. Dept. of Forestry, Forest Sci. Monogr. 8:62 pp.

__________ 1964.b Key to the *Carex* species of Newfoundland by vegetative characteristics. Dept. of Forestry Publ. 1017: 39 pp.

__________ 1965. The distribution patterns of northern and southern elements in the flora of Newfoundland (French summary). Rhod. 67 (772):363-392.

__________ (Unpublished map). Potential evapotranspiration in Newfoundland, after Thornthwaite, 1948.

DANSEREAU, P. 1957. Biogeography: an ecological perspective. Ronald Press, New York, 394 pp.

__________ and P. SEGADAS-VIANNA. 1952. Ecological study of peat bogs of eastern north America, pt. 1. Structure and evolution of vegetation. Can. J. Bot. 30: 490-520.

DAVIES, E. G. 1944. Flgyn Blaen Brefi, a Welsh upland bog. J. Ecol. 32: 147-166.

DEPARTMENT OF TRANSPORT. 1964. Temperature normals for Atlantic provinces. C.D.S. No. 8-64.

__________ 1965. Precipitation normals for Atlantic provinces. C.D.S. No. 11-64.

DITTRICH, J. 1954. Afforestation of bog soils. Proc. Int. Peat Symp., Sect. F. 1, Bord na Mona, Dublin.

DYAL, R. S. 1965. Peat in Europe, report of a technical study tour. U.S. Dept. Agri. Special Rept. 123: 55 pp.

EARDLEY, A. J. 1951. Structural Geology of North America. Harper and Brothers, New York.

FALINI, F. 1965. On the formation of coal deposits of lacustine origin. Geol. Soc. Amer. Bull. 76: 1317-1346.

FARNHAM, R. S. 1963. Classification of peat in the U.S. Int. Peat Congress, Leningrad.

FERNALD, M. L. 1918. The contrast of floras of eastern and western Newfoundland. Amer. J. Bot. 5:237-247.

__________ 1950. Gray's Manual of Botany (8th ed.). Amer. Book Co., New York, 1632 pp.

__________ 1926. Two summers of botanizing in Newfoundland. Rhod. 28:49-63, 74-97, 89-111, 115-129, 145-155, 161-178, 181-204, 210-220, 234-241.

FLINT, R. F. 1940. Late Quaternary changes of level in western and southern Newfoundland. Geol. Soc. Amer. Bull. 51:1757-1788.

__________ 1940. Glacial geology and the Pleistocene epoch. John Wiley & Sons, N.Y., 589 pp.

__________ 1952. The ice age in the north American arctic. Arctic 5(3):135-152.

FRASER, G. K. 1954. Classification and nomenclature of peat and peat deposits. Proc. Int. Peat Symp., Sect. B2, Bord na Mona, Dublin.

GANONG, W. F. 1897. On raised bogs in New Brunswick. Trans. Roy. Soc. Can. 11:3:131.

GATES, F. C. 1914. Evaporation in vegetation at different heights. Amer. J. Bot. 13: 167-178.

__________ 1941. Bog levels. Sci. 91:449-450.

__________ 1942. The bogs of northern lower Michigan. Ecol. Monogr. 12: 213-254.

GILLESPIE, C. R. 1954. Preliminary report on peat investigations in Newfoundland. Nfld., Dept. of Mines.

GODWIN, H. and Verona CONWAY. 1939. The ecology of a raised bog near Tregaron, Cardiganshire. J. Ecol. 27: 313-363.

GORHAM, E. 1957. The development of peat lands. Quart. Rev. Biol. 32: 145-166.

GRAHAM, B. R. and T. E. TIBBETTS. 1961. Evaluation of peat moss as applied to some bogs in southern Ontario. Ottawa, Dept. of Mines and Tech. Surv., Tech. Bull. 22: 99 pp.

GRANLUND, E. 1932. De svenska hogmossarnas geologi. Srevig. geol. Unders. Afh., Sev. C. No. 373. (German Summary).

HANSON, H. C. 1950. Canada geese of the Mississippi flyway. Bull. Ill. Nat. Hist. Surv. 25(3): 92.

__________ 1962. Dictionary of ecology. Peter Owen Ltd., London.

HARE, F. K. 1952. The climate of the Island of Newfoundland. A geographical analysis. Can. Dept. Mines and Tech. Surv., Geogr. Bull. 2: 36-88.

HARWOOD, T. A. and N. W. RADFORTH. 1964. Northern landform as it affects potential development in organic terrain. N.R.C. Assoc. Cttee. on Soil and Snow Mechanics, Tech. Memo. 81: 7-19.

HEALY, J. V. 1963. Some aspects of organic terrain in Newfoundland. N.R.C. Assoc. Cttee. on Soil and Snow Mechanics, Tech. Memo. 77: 32-36.

HEINSELMAN, M. L. 1963. Forest sites, bog processes, and peatland types in the Glacial Lake Agassiz region, Minnesote. Ecol. Mong. 33: 327-372.

HENDERSON, E. P. 1959. Surficial geology, St. John's. Geol. Surv. Can., Map 35- 1959.

JENNESS,S. E. 1957. Gander Lake (east half) Newfoundland. Geol. Surv. Can., Map 3-1957.

__________ 1960. Late Pleistocene glaciation of eastern Newfoundland. Bull. Geol. Soc. Amer. 71:171-180.

__________ 1963. Terra Nova and Bonavista map areas, Newfoundland (2 DE ½ and 2C). Dept. of Mines and Tech. Surv., Geol. Surv. Can. Memoir.

JESSEN, K. 1949. Studies in later Quaternary deposits and floral history of Ireland. Proc. Roy. Irish Acad. 52 B6.

KAY, G. M. and E. H. COLBERT. 1965. Stratigraphy and life history. John Wiley and Sons Inc., N.Y., 736 pp.

KIVINEN, E. 1963. On the spread and characteristics of bogs in Finland. Int. Peat Congress, Leningrad.

LEAR, E. 1960. Report on Lories peat bog and six other bog areas in the Burin Peninsula. Nfld., Dept. of Mines, Peat Rept. 1960. 66 pp.

LEGGETT, R. F. 1961. Soils in Canada: geological, pedological and engineering studies. 229 pp.

LEVERIN, H. A. 1946. Peat deposits in Canada. Ottawa, Department of Mines and Resources, Publ. 817: 102 pp.

LINDROTH, C. H. 1963. The fauna history of Newfoundland, illustrated by carabid beetles. Opan. Ent. Suppl. 23: 1-112.

LIST, R. J. 1963. Smithsonian meterological tables (6th ed.). Smithsonian Institution Publ. 4014: 527 pp.

LODDESOL, A. A. 1955. Report on the investigation and utilization of the bogs of Newfoundland. Nfld., Dept. of Mines. 48 pp.

MACCLINTOCK, P. and W. H. TWENHOFEL. 1940. Wisconsin glaciation in Newfoundland. Geol. Soc. Amer. Bull. 51: 1729-1756.

MACFARLANE, I. C. 1958. Guide to a field description of muskeg. Ottawa, N.R.C. Assoc. Cttee. on Soil and Snow Mechanics, Tech. Memo. 44: 36 pp.

MARSHALL, N. C. 1907. Mosses and lichens. Doubleday Page and Co., New York,

MCCARTNEY, W. D. 1958. Geology of Sunnyside map-area, Newfoundland. Geol. Surv. Can. Paper 58-8: 21 pp.

MCKILLOP, J. 1963. Peat occurrences readily accessible on Avalon Peninsula. Newfoundland, Dept. of Mines. 68 pp.

__________ and R. DAY. 1962. Peat exploration in Newfoundland, 1962. Nfld. Dept. of Mines, Mineral Resources Division. 28 pp.

MILLINGTON, R. J. 1954. Sphagnum bogs of the New England Plateau, New South Wales. J. Ecol. 42: 328-344.

Newfoundland Royal Commission on Agriculture. 1955. Nfld., Dept. of Agric. Roy. Comm. Dept. 1956: 391-pp.

NEWBOULD, P. J. and E. GORHAM. 1956. Acidity and conductivity measurements on some plant communities of the New Forest Valley bogs. J. Ecol. 44: 118-128.

ODUM, E. P. 1959. Fundamentals of ecology. W. B. Saunders Co., Philadelphia and London.

OLSON, E. A. and W. S. BROECKER. 1958. Lamont natural radiocarbon measurements, V. Amer. J. Sci., Radiocarbon Supp. 1: 1-28.

OSVALD, H. 1923. Die vegetation des hochmoores komosse Svenka Vaxtsoc. Sallsk. Handl. 1.

________ 1949. Notes on the vegetation of British and Irish mosses. Acta phytogeogr. succ. 26.

PEARSALL, W. H. 1938. The soil complex in relation to plant communities, moorlands and bogs. J. Ecol. 26: 298-314.

____________ 1956. Two blanket bogs in Sutherland. J. Ecol. 44: 493-516.

PETRIDES, G. A. 1958. A field guide to trees and shrubs. Houghton Mifflin Co., Boston. 431 pp.

POLLETT, F. C. 1964. Peat moss report, 1964. Nfld., Dept. of Mines. Mineral Resources Division. 186 pp.

____________ 1965. Peat moss report, 1965. Nfld., Dept. of Mines, Mineral Resources Division. 220 pp.

POTZGER, J. E. and A. COURTEMANCHE. 1966. Permafrost and some characteristics of bogs and vegetation of northern Quebec. Rev. Can. Geogr. 9: 109-114.

PYAVCHENKO, N. I. 1963. Basic terminology in bog science. Int. Peat Congress, Leningrad.

RADFORTH, N. W. 1956. Muskeg access with special reference to the problems of petroleum industry. Can. Mining and Metallurgical Bull. 59: 271-276.

____________ 1964. Prerequisites for design of engineering works on organic terrain - a symposium. Part II - Definitions and Termiuology. N.R.C. Assoc. Cttee. on Soil and Snow Mechanics, Tech. Memo. 81: 24-34.

RADCLIFFE, D. A. and D. WALKER. 1958. The silver flow, Galloway, Scotland. J. Ecol. 46: 407-445.

RAYMENT, A. F. and H. W. R. CHANCEY. 1966. Peat soils in Newfoundland, reclamation and use. Agric. Inst. Rev. Jan-Feb.

RIGG, G. B. 1925. Some Sphagnum bogs of the north Pacific cosst of America. Ecol. 6(3): 260-278.

__________ 1940. Comparisons of the development of some Sphagnum bogs of the Atlantic coast, the interior, and the Pacific coast. Amer. J. Bot. 27(1): 1-14.

________. 1940. The development of Sphagnum bogs in North America. Bot. Rev. 6: 666-693.

________ 1958. Peat resources in Washington. Wash. Div. of Mines and Geol. Bull. 44: 272 pp.

________ and C. T. Richardson. 1938. Profiles of some Sphagnum bogs of the Pacific coast of North America. Ecol. 19(3): 408-434.

RILEY, G. C. 1962. Stephenville map-area, Newfoundland. Ottawa, Geol. Surv. Can. Memoir 323. 72 pp.

ROLAND, A. E. 1945. The flora of Nova Scotia. Proc. N.S. Institute Sci. 21(3): 552 pp.

ROSE, E. R. 1948. Geology of the area between Bonavista, Trinity and Placentia bogs, eastern Newfoundland. Geol. Surv. Nfld. Bull 32(2).

ROWE, L. S. 1949. Forest regions in Canada. Ottawa, Dept. Northern Affairs and Natural Resources. Forestry Branch. Bull. 123: 71 pp.

SCOTT, W. W. 1942. Standard methods of chemical analysis,(5th ed.) D. van Nostrand Co., Inc. 2617 pp.

SJORS, H. 1959. Bogs and fens in the Hudson Bay lowlands. Arctic 12(1): 3-19.

________ 1963. Bogs and fens on Attawapiskat River, northern Ontario. Nat. Mus. Can. Bull. 186: 45-133.

SMITH, R. E. and W. A. EHRLICH. 1964. Soil survey of the southeastern map sheet area. Man. Soil Surv., Soils Rept. 14: 108 pp.

SZCZAWINSKI, A. F. 1964. The heather family (Ericaceae) of British Columbia. B.C. Prov. Mus., Dept. of Rec. and Conservation.

TANSLEY, A. G. 1949. The British Islands and their vegetation. Cambridge Univ. Press, Cambridge, 2 vol., 970 pp.

TARR, R. S. and L. MARTIN. 1930. College physiography. The Macmillan Co., New Jersey.

THORNTHWAITE, C. W. 1948. An approach toward a rational classification of climate. Geog. Rev. 28(1): 55-94.

TOMTER, A. 1954. Notea from the survey of Scottish peat deposits. Proc. Int. Peat Symp., Sect. B-1. Bord na Mona, Dublin.

TWENHOFEL, W. H. and P. MACCLINTOCK. 1940. Surface of Newfoundland. Geol. Soc. Amer. Bull. 51: 1665-1728.

U.S. DEPT. OF AGRIC. 1938. Soils and Men. Washington.

VON POST, L. 1926. Sver. Geol. Unders: C, 19: No. 4, 1926.

WAKSMAN, S. A. 1932. Principles of soil microbiology. Williams and Wilkins Co., Baltimore (out of print). 894 pp.

__________ 1942. The peats of New Jersey and their utilization. New Jersey Dept. Cons. and Devel. Bull. 55B: 155 pp.

__________ 1943. The peats of New Jersey and their utilization. New Jersey Dept. Cons. and Devel. Bull. 55B: 278 pp.

WELCH, P. S. 1935. Limnology. McGraw-Hill Book Co. Inc., New York. 538 pp.

__________ 1938. A limnological study of a retrograding bog lake. Ecol. 19: 435-453.

WILLIAMS, H. 1963. Twillingate map-area, Newfoundland 2 E/10. Ottawa, Geol. Surv. Can. Paper 63-36.

ZIEGLER, C. M. 1964. Field manual of soil engineering. Mich. State Highway Dept., Lansing, Michigan: 303 pp.

APPENDIX I

Glossary of Bogland Terminology

This terminology, found in common usage in the literature concerning peat studies, describes some of the environment in which the investigator finds himself. The adoption of terms from one language to another is sometimes difficult and a new meaning evolves for the same word on either side of the ocean. This glossary is put forth to give students a better understanding of some of the terms which are not common to North American readers.

Aapamoor - See String-Bog

Acidophilous - (Dansereau, 1957)

This is an adjective referring to the response shown by organisms adapted to life in an acid medium.

Acid Soil - (Smith and Ehrlich, 1964)

This is a soil having a pH value less than 6.6. It is commonly applied to the surface layer or some other specific horizon of the soil.

Acutifolia Peat -(International Peat Symposium, 1954)

This is peat which is composed of Sphagnum species with nearly flat leaves, and in-rolled edges. It is generally dense in structure and has great resistance to humification. It is also characterized by low acidity and poor aeration.

Air Form Pattern - (Radforth, 1964)

This is a pattern based on the arrangement of shapes apparent at a particular altitude, which is characteristic for significant terrain entities and their spatial relationships and thus useful in the application of aerial interpretation.

Alder Swamp - (Damman, 1964)

Vegetation of wet, nutrient rich, often mucky soils, dominated by alders (Alnus rugoss). The nutrient-poorer alder swamps with abundant black spruce and poorly growing alder shrubs have been separated as mesotrophic alder swamps. They often occur at bog borders influenced by seepage water.

Allochthonous Peat - (Farnham, 1963; after Waksman, 1942)

This term refers to peat of sedimentary origin. This peat is formed from the remains of plants brought in from outside the site of deposition.

Allogenic - (Dansereau, 1957)

This term refers to a sere wherein the replacement of one association by another results principally from changes in the substratum, and is independent of the plants.

Amorphous Granular - (Radforth, 1964)

This is a descriptive term applied to one of the primary macroscopic elements of peat which is granular in nature but to which no particular shape can be ascribed.

Apiculoid - (Radforth, 1956)

This term described an air form pattern observed at an altitude of 5000' and characterized by a "fine textured expanse" bearing minor projections.

Autochthonous Peat - (Farnham, 1963; after Waksman, 1942)

This term refers to true peat which has formed in place. That is, peat which has formed from plants growing in situ.

Autogenic - (Dansereau, 1957)

This refers to a sere within the replacement of one association by another which results chiefly from the transformation by the plants themselves.

Banks - See Lanieres

Basin Bog - (Dyal, 1965; after Jessen, 1949)

This is a bog which has built up to the water level in a lake or a river channel and the upper surface of the peat is either horizontal or gently sloping.

Basin Peat

This is a common term which refers to a water-filled basin which is replaced by a succession beginning with limnetic deposits on which there is a gradual formation of peat. Such a sequence is rare in Newfoundland.

Belt - (Dansereau, 1957)

A belt is a ecological unit characterized by its vegetation such as strips of Carex, Ledum or Chamedaphne in a bog.

Bog

(a) (Gates, 1942)

Bog is an area of vegetation, developing in undrained or poorly drained situations, which by the development of mat invading open water, forms a cover over a body of water.

(b) (Dansereau & Segadas-Vianna, 1952; after Welch, 1935)

Bog includes those situations in which the water manifests different reaction in different areas. A marginal, semi-floating mat often exists (or may have existed at some time), composed of an aggregation of characteristic plants; and deposits of peat are invariably present.

(c) (Heinselman, 1963)

Bog is a peat-covered or peat-filled area, generally with a high water table dominated by mosses, especially *Sphagnum*; although the water table is near the surface there is little standing water except in ponds.

(d) (Radforth, 1964)

This is an area of confined organic terrain, the limits of which are imposed by the physiography of the local mineral terrain.

(e) (Damman, 1964)

Bog refers to a wet, extremely nutrient-poor organic site with a vegetation in which *Sphagnum* species play a very important role, and the remains of which make up a major part of the organic horizon. It may be divided into three types; dwarf shrub, oligotrophic and mesotrophic bog.

(f) (Committee on Nomenclature of the Ecological Society of America, 1933)

A bog is that stage in the physiographic succession of an area during which its surface is entirely of living *Sphagnum*, immediately under which is a fibrous brown peat composed mainly or entirely of partially disintegrated *Sphagnum*, the habitat excerising a distinctly selective influence on its flora.

(g) (Pyavchenko, 1963)

A bog is a geographical landscape regularly forming and developing under the influence of specific interrelation and interplay of environment and vegetation which is determined by constant or periodic abundant moisture and is manifested in hydrophill vegetation resulting in a bog type of soil forming an accumulation of peat.

Blanket Bog - (International Peat Symposium, 1954)

This term is used in the British Isles for bog covering undulating semi-uplands.

(a) Bogs of cool temperate regions formed under a maritime rainfall at lower elevations.

(b) Bogs on hills developed under high rainfall and low temperatures.

Bog Lake - (Welch, 1952)

This is defined as an area of open water, commonly surrounded either wholly or in part, by true bog margins, possessing peat deposits about the margin, in the bottom, or both; usually with a false bottom composed largely of very finely divided, floculent, vegetable matter; containing considerable amounts of colloidal materials; and so constituted generally that in time it may become completely occupied by bog vegetation.

Boglands - (Pyavchenko, 1963)

These are the initial stage of bog development which, depending on the environment, can last for more or less long periods of time. The root systems of plants in boglands are in or next to mineral ground.

Braun Torf

This is the German equivalent of Hypnum peat.

Carex Peat - (Auer, 1930)

(a) This peat is developed on wet ground. In some bogs it forms a lower thin layer, while in others it is quite thick, generally mixed with _Amblystegium_ peat.

(b) This refers to peat composed of sedge species, primarily _Carex_ with _Juncus_, _Eriophorum_ and _Scirpus_ with well-decomposed _Sphagnum_. In some instances sedge peat is so termed because a unit proportion of peat has more than 50% sedge although it may still have _Sphagnum_ less than H 3.

Closed Pond

(a) (Radforth, 1964)

This is a pond filled with organic material often made up of living plants.

(b) This refers to a pond which has its surface covered by recent _Sphagnum_ growth, but which cannot support much weight because the cover is underlain by water.

Synonym: Quaking Bog

Coarse Fibrous - (Radforth, 1964)

This is a term applied to the primary macroscopic elements of peat which may be woody or non-woody, and which have a diameter greater than 1 mm.

Concentric Domes

This is a descriptive term applied to the surface of high bogs in which the ponds lie at right angles to the slope of the bog, following contours and comprising a series of concentric circles.

Cymbifolia Peat - (International Peat Symposium, 1954)

This peat is composed of Sphagnum species in which the leaves are not flat, but boat-shaped, and with rolled-in edges; generally loose and bulky with good water movement. This type of peat mainly comprises high bog formation and is composed of such species as Sphagnum imbricatum, S. papillosum Lindb. and S. magellanicum.

Dermatoid - (Radforth, 1956)

This describes an air form pattern taken at an altitude of 30,000' and is characterized as "featureless and plain" with a simple covering, lacking ornamentation.

Dwarf Shrub Bog - (Damman, 1964)

This refers to a nutrient-poor, relatively dry bog covered with ericaceous dwarf shrubs and Sphagnum species.

Dystrophic - (Dansereau, 1957)

(a) This is a bog lake in which the waters have been rendered turgid by allogenous materials that have seeped in. It is very poor both floristically and faunistically.

(b) (Odum, 1954)

This is a term used to denote high concentrations of humic acid in water. It generally refers to bog lakes with peat-filled margins which eventually develop into peat bogs.

Eutrophic - (Heinselman, 1963)

This adjective is applied to bog composed of plants growing in "hard waters" which are rich in nutrients.

Fen - (Heinselman, 1963)

(a) This is a European term applied to grass, sedge, or reed covered peatlands, commonly having some scrub and, in some cases, sometimes a scanty tree layer. The water table is at the surface most of the time. The water and peats are not exceptionally acid.

(b) (Damman, 1964)

This refers to a meadow-like vegetation dominated by low sedges on moderately rich and rich wet sites. Sphagnum species are subordinate or absent, whereas Campylium polygamuna, C. stellatum, Scorpidium scorpioides, and Drepanocladus spp. are abundant.

Flachmoor - See Lowmoore

Flark - (Sjors, 1961)

A Swedish term referring to a limited, usually elongated, wet, and muddy area. The flark may be several hundred meters in length. On sloping sites flarks are narrow, being only a few meters wide, on horizontal peatland may be a hundred or more meters wide. The bog axis is always in the direction of the contours.

Synonyms: Mare (French-Canadian)
Rimpi (Finnish)

Flat Raised Bog - (International Peat Symposium, after Osvald, 1923)

This refers to a bog which has a tendency for peat growth to extend up the sloping valley sides, leaving the boundary between bog and valley side to be poorly marked. There is a very weak rand and poorly developed lagg.

Flowe - (Ratcliffe and Walder, 1958)

This is the name given to a flat area of bog land.

Forest Peat - (Waksman, et al., 1943)

This is the forest mold or litter and is brown to dark brown, fluffy and somewhat fibrous. Its reaction is between pH 3.8 and 5.5. The total nitrogen 1.0 to 2.5 per cent on a dry basis, and the ash content is between 4 and 20 per cent.

Forested Fen - See Alder Swamp; Swamp

Forsumpning - See Paludification

Gleization - (Dansereau, 1957)

This is a soil-forming process in cold climatic conditions whereby a structureless horizon involving reduced iron compounds forms at the bottom of the alluvial layer and peat accumulates at the surface.

Gyttai - See Sedimentary Peat

Heath - (Heinselman, 1963)

This is an expanse of ground dominated by shrubs of the heath family Ericaceae. The ground may or may not be peat covered, if it is, then it can be termed a bog.

Highmoor

Hochmoor

Hogmosse

These are all synonyms for "Raised Bog"

Hummock - (Lea et al., 1964)

(a) This is a microtopographic feature which refers to a raised area on a hochmoor, composed principally of hummock-forming species such as Sphagnum fuscum, S. imbricatum and S. flavicomans.

(b) In some areas it may be a peat core topped with Ericaceaeous plants, lichens, and small bush.

(c) (Sjors, 1963)

These are structures built up by high Sphagnum cushions and usually covered by high dwarf shrubs. This Sphagnum is partially replaced by other byrophytes or lichens.

Hygric - (Dansereau, 1957)

This refers to the quality of an organism adapted to wet conditions, or the site that provides them.

Inorganic Ooze - (Auer, 1930)

This is a blue or grey, sometimes brownish or yellowish, amorphous tough substances, which in some instances, is distinguished with difficulty from underlying clay. The ooze formed on the bottom of ponds and lakes is limnetic.

Jelly-like Ooze - (Auer, 1930)

It is a limnetic, light brown or semi-transparent jelly-like ooze.

Lacustrine Bog - (Gorham and Pearsall, 1956)

This refers to the transitional stage in which some mineral water is still a major influence in the development of the bog.

Lagg

(a) (Godwin and Conway, 1937)

This is the zone where the waters flow or stagnate at the edge of the bog near the hard ground of the valley site. The water is relatively rich in bases and supports an eutropic type of vegetation, with the communities resembling that of a fen.

(b) (Sjors, 1961)

This refers to fen belts which separate the bog from mineral soil.

Synonym: Marginal Fen (Conway, 1949)

Lanieres - (Hamelin, 1957)

These are the drier low winding ridges located between the flarks or "Mares". They have a slight damming affect on the water drainage down the seepages.

Synonyms: Strings
Ribs
Banks

Limy Ooze - (Auer, 1930)

This refers to an ooze formed from the remains of molluscs. It is limnetic.

Lowmoor

(a) This is a common European term for peatland occupying basins or depressions not elevated above their perimeter.

(b) (Waksman, 1932)

This is a term referring to peat which is made up of sedges, reeds and certain trees and shrubs. Sphagnum plants are absent or rare. This occurs in chiefly river valleys and is fed by ground waters rich in mineral salts.

Synonyms: Niedermoor
Flachmoor
Niederungs

Mares - See Flark

Marginal Fen - See Lagg

Marbloid - (Radforth, 1956)

The term describes an air form pattern from an altitude of 30,000' which shows a polished marble effect.

Marsh - (Heinselman, 1963)

(a) This term refers to grassy wet places, usually with little peat and much standing water which is not acidic. The grass or sedge sods are not consolidated and are frequently interspersed with open water.

(b) (Damman, 1964)

Marshes are usually rich sites covered with a high vegetation of sedges and grasses, a vegetation of periodically flooded alluvial soil or shore vegetation of nutrient rich ponds and lakes. This is a relatively rare habitat in Newfoundland.

(c) A marsh is a low lying tract of land usually covered with grass or sedge-like plants growing directly on mineral terrain. It is also characterized by a high water table.

Mesotrophic

This is an adjective used in European literature to describe transitional bogs.

Mesotrophic Alder Swamp - (Damman, 1964)

See Alder Swamp

Mesotrophic Bog - (Damman, 1964)

This term refers to a bog which is wet, moderately nutrient-poor to poor. <u>Sphagnum</u> species are abundant but higher plants help to determine the physiognomy of the vegetation. Parts of the bog are influenced by sonewhat richer water. Characteristic sites for mesotrophic bogs are: bog borders, surroundings of drainage channels in bogs and shallow bogs.

Mesotrophic Fen - (Damman, 1964)

This is a moderately nutrient-poor fen where greyish-green sedges are predominant and <u>Sphagnum</u> species occur frequently.

Mineral Soil Water Limit - (Sjors, 1963; after Thunmark, 1942)

This is a line of demarcation between bog and fen. It reflects an equally sharp boundary or limit of minerotrophic ground water flow. Du Rietz, 1954, refers to it as the boundary for mineral soil water indicators.

Synonym: Exclusive fen plant limit (Sjors, 1946)

Minerotrophic - (Sjors, 1961)

This term refers to sites which, in addition to precipitation, receive terrestrial mineral nutrition; indicating that nutrients are brought to the peat by water that has previously extracted them from a mineral soil.

Mire - (Godwin and Conway, 1939)

This is an English word which is in the general sense, a term embracing all kinds of peat lands and all kinds of peat land vegetation.

Mire Complex - (Sjors, 1961; after Cajander, 1913)

This refers to the occurrence, together, of bog and fen vegetation.

Moor - (Tansley, 1949)

This is from the German and applied to any area of deep peat whether acid or alkaline. In English the word is applied to high lying country covered with heather and other Ericaceous dwarf shrubs, mainly Vaccinium. It is often used to refer to land having any of the oxphylous communities.

Moos - See Moss

Mose - See Moss

Moss

(a) (Tansley, 1949)

This is synonymous with "bog" in the English texts and is related to the words "Mosse" (Swedish), "Mose" (Danish and Norwegian) and "Moos" (German) which are applied to the same type of vegetation.

(b) (Heinselman, 1964)

From the Swedish term (mosse) applied by Sjors (1949) to areas dominated by mosses within "Mire complexes". Usually there is considerable peat, and waters within the mosses are acid.

Mosse - (Sjors, 1949)

See Moss

Moss Peat - (International Peat Symposium, 1954)

This refers to peats composed generally of Sphagnum such as cymbifolia peat and acutifolia peat. It also includes peats which have a high percentage of other constitutents such as Carex - moss peat, Woodmoss peat, and Moss-Carex peat.

Muck

(a) This term refers to black well-decomposed peat in which the original constituents are hardly recognizable.

(b) (Ziegler, 1946)

It is a well-decomposed organic soil material, dark in colour and accumulated under conditions of imperfect drainage.

Muck Soil - (Ziegler, 1946)

This soil is made up of thoroughly decomposed organic material with a considerable amount of mineral soil material finely mixed with a few fibrous remains.

Muskeg

(a) This is an old Algonquin Indian term applied to a large expanse of Sphagnum peatland bearing stunted black spruce and tamarack with Ericaceous shrubs prominent.

(b) (Radforth, 1964)

This is a term designating "organic terrain", the physical condition of which is governed by the structure of the peat it contains and its related mineral sub-layer considered in relation to topographic features and the surface vegetation with which the peat co-exists.

Myr - (Godwin and Conway, 1939)

This is a Swedish term which means any type of peat land and at the same time the vegetation type characteristic of such land. The nearest English equivalent is mire.

Niederungs - See Lowmoore

Niedermoor - See Lowmoore

Oligotrophic - (Heinselman, 1963)

This adjective describes bog formed of plants growing in "soft" waters which are poor in nutrients. An example of this type of bog is the Hochmoors.

Oligotrophic Bog - (Damman, 1964)

This is a wet, extremely nutrient-poor bog often ombrotrophic and dominated by Sphagnum species.

Ombrogenous - (Heinselman, 1963)

This is an adjective describing bogs with a convex surface and dependent directly on precipitation for water.

Ombrotrophic - (Sjors, 1961)

This is a term meaning "nourished by rain" and refers to areas exclusively dependent on nutrienta from precipitation.

Open Pond - (Radforth, 1964)

This is a topographic feature in which "water rises above organic debros".

Organic Matter - (Ziegler, 1964)

This is the more or less decomposed material of the soil derived from organic sources, usually from plant remains. The term covers matter in all stages of decay.

Organic Terrain - (Radforth, 1964)

This is a tract of land comprising a superficial layer of living material (vegetation) and a sub-layer of peat or fossilized plant detritus of any depth existing in association with various hydrological conditions and underlying mineral formations.

Organic Ooze - (Auer, 1930)

This is a limnetic deposit of organic remains consisting of diatoms, pollen particles and plankton. The colour varies but is commonly brown to green.

Oxyphylous - (Dansereau, 1957)

This is an adjective referring to a habitat which is controlled by excessive acidity of the substratum.

Paludification - (Auer, 1930)

This term was used first by Von Post for the process of bog expansion caused by a graduate rising of the water table as peat accumulation impedes drainage.

Synonyms: Swamping
Forsumpning (Swedish)
Versumpfung (German)

Paludification Bog - (Dyal, 1965; after Jessen, 1949)

This refers to a bog formed in a depression where a rise in the water table makes the bottom wet without forming a lake.

Palsa - (Sjors, 1961)

This is a perennially frozen peat-mound of moderate size, generally much less than 100 meters across and from one to several meters high. In Fennoscandia palsas are generally treeless, however, in North America they commonly have a few stunted tamaracks or black spruce.

Planmosse - (Sjors, 1961; after Osvald, 1930)

This term refers to a type of slightly sloping, yet usually purely ombrotrophic bog,found in western, central and, less commonly, in northern Fennoscandia.

Palynology - (Dansereau, 1957)

This is the study of pollen, spores and other microfossils. For example, pollen analysisis one aspect of palynology which concerns itself with a record of fossil pollens in bogs.

Peat - (Heinselman, 1963)

This is a layer consisting largely of organic residues originating under more or less water-saturated conditions through the incomplete decomposition of plant and animal constituents due to anaerobic conditions, low temperatures and other complex causes.

Peat Deposit - (Pyavchanko, 1963)

This refers to a bog with a well developed peat layer.

Peat Moss - (Leverin, 1946)

The term refers to a peat which consists mainly of Sphagnum and which is unhumified or slightly humified.

Synonym: Raw Moss

Peatland - (Heinselman, 1963)

This is a generic term including all types of peat-covered terrain. Many peatlands are a complex of swamps, bogs and fens, sometimes called a "Mire complex".

Pool - (Sjors, 1963)

This is a deeper depression than a hollow; characterized by permanent open water.

Pothole Muskeg - (Coombs, 1954; after Hanson, 1950)

This term refers to muskeg with a myriad of ponds and small lakes often closely grouped with narrow strips of land separating one from the other.

Pounikko - (Sjors, 1963)

This is a Finnish term referring to an extensive, elevated hummock which is frozen solid in its interior during most of the summer.

Quagmire - (Hanson, 1963)

This refers to a wet, boggy area which quakes or yields underfoot.

Quaking Bog - (Buell and Buell, 1941)

This is a bog which has developed upon a mat of Carex or Sphagnum growing over a water surface.

Raised Bog

This is a bog with an elevated central area caused by peat accumulation. This central zone is generally isolated from the local water table and chiefly dependent on precipitation for water and minerals.

Synonyms: Highmoor
Hochmoor (German)
Hogmosse (Swedish)
Red Bog (Irish)

Rand - (Godwin and Conway, 1939)

This is the name given to the most steeply sloping marginal region of the bog. It is characterized by distinct plant communities. The distribution of these communities depends on the slope of the rand in any particular place.

Raw Moss - (Leverin, 1946)

This is applied to moss (especially *Sphagnum*) which is unhumified or slightly humified. It would range between H 1 to H 2.5 on the Von Post Scale.

Reed Peat - See Sedge Peat

Red Bog - See Raised Bog

Regeneration Complex

This refers to an aggregation of hummocks and hollows on the surface of the bog. The hollows are characterized by more aquatic *Sphagnum* such as *Sphagnum cuspidatum*, *Sphagnum dusenii* and *Sphagnum cymbifolium* Ehrh. The hummocks are formed by the hummock-forming species such as *Sphagnum flavicomans*, *Sphagnum rubellum*, *Sphagnum fuscum*. The bog growth is achieved by an alternation of these successions forming a raised bog.

Reticuloid - (Radforth, 1956)

This term describes an air form pattern taken at an altitude of 30,000' which is characterized by a "network effect".

Ribs - See Lanieres

Rullen - See Seepages

Sedge Peat - (Waksman, et al., 1943)

Peat referred to as "low-moor peat", usually dark brown to black, powdery when dry and containing varying amounts of fibrous material. Wood particles are commonly present. The pH is 4.5 to 6.8, nitrogen 2.0 to 3.5 per cent and organic content 70 to 95 per cent.

Synonym: Reed Peat

Sedimentary Peat - (Waksman, 1932)

This is a type of mud peat, formed largely by algae and other aquatic plants and animals, with an admixture of spores, pollen and particles of clay and sand. It is usually the lowest layer of the peat bog.

Synonym: Gyttai

Sedimentary Peat - (Waksman, et al., 1943)

This is peat which generally contains coarse fibrous material, together with large amounts of mineral sediment.

Seepages - (Sjors, 1963)

This consists of a ladder-like row of small,shallow, narrow pools or flarks in a step-like arrangement. The pools parallel the contours and are at right angles to the slope.

Synonym: Rullen - (Weber, 1902)

Seggen Torf

This is the German equivalent of Sedge Peat.

Smallpox Muskeg - (Coombs, 1945; Hanson, 1950)

This term refers to areas of former lake and pond beds now free of water and characteristically saucer-like in shape. The former rims have a good growth of small trees and bushes which produce a pock-marked effect.

Soaks - (Sjors, 1963)

These are strips in the bog that have minerotrophic water. They may be present even near the center of a large ombrotrophic bog.

Soligenous - (Heinselman, 1963)

This is an adjective referring to peatlands with water percolating through them and carrying minerals into the peatland from outside sources.

Sphagnum Moss - (Leverin, 1946)

This is almost raw peat moss which consists of *Sphagnum* with an admixture of residues from *Eriophorum*, *Carex*, *Andromeda glaucophylla*, *Ledum groenlandicum*, *Vaccinium oxycoccus* and *Empetrum nigrum*. There are other plant residues in smaller amounts.

Synonyms: White Moss
Genuine Peat Moss

Sphagnum Peat

This is peat which develops in drier areas than _Carex_ peat and forms thick bodies whose plant composition is exceptionally pure and homogenous. The mosses are chiefly cymbifolium and acutifolium and are generally raw. Wood fragments may be more abundant in certain horizons.

Spruce Bog

This is a loosely applied term describing confined areas of organic terrain where coniferous trees (not always spruce) are a prominent feature of the vegetation cover.

Stipploid - (Radforth, 1956)

This is a term applied to a 30,000' air form pattern; the pattern is that of closely spaced dots.

Strangmoor - See String Bog

String Bog - (Radforth, 1964)

This term refers to striations webbed into an open net usually joined and very tortuous. Such a bog is usually a coarse textured expanse.

Synonyms: Strangmoor (German)
Aapamoor (Finnish)

Swamp

(a) Swamp is a forested wetland, usually with shallow peat and waters with slightly acid reaction. It is chemically allied with fens (American).

(b) (Tarr and Martin, 1930)

A swamp is a part of the surface of the land which is wet and saturated with moisture though not usually covered with standing water. Some swamps are called marshes, bogs, muskegs.

(c) (Zeigler, 1946)

Swamps are flat, wet areas usually covered with standing water and supporting a growth of trees, shrubs and grasses.

(d) Similar to a marsh but usually with a higher water table and interruptions of the vegetation mat.

Synonym: Forrested Fen (European)

Tachmoose - See "Flat Raised Bog"

Telmatic Peat - (Auer, 1930)

This is a general term for peat developed on wet ground, such as Carex peat.

Terrazoid - (Radforth, 1956)

This is a descriptive term applied to an air form pattern taken from an altitude of 30,000' which shows a patchwork quality.

Topogenous - (Heinselman, 1963)

This is an adjective indicating that the source of water for a peatland is the regional water table in a depression that predated peat formation.

Transition Bog

This refers to vegetation intermediate between a raised bog and a low bog.

Synonym: Uebergangsmoor (German)

Uebergangsmoor - See Transition Bog

Upland Peat

This term refers to peat on slopes and undulating uplands. It has no particular water table.

Valley Bogs - (Newbould and Gorham, 1956)

This term is English and is first referred to by Tansley (1939). This refers to complexes of reed swamp, sedge fen, and Molinia - Myrica - Sphagnum communities which form in drier areas where ombrogenous bog cannot.

Von Post Humification Scale

This scale describes peat moss in varying stages of decomposition ranging from H 1 which is completely unconverted to H 10 which is completely converted.

Weiss Torf

This is the German equivalent of Sphagnum Moss.

White Peat - See Sphagnum Moss

APPENDIX II

Profiles of Bogs Investigated in Regions III, IV and V

These profiles are representative of the deeper bogs found in Newfoundland, showing the types of peat and their thicknesses. The surface and bottom contours are also given. Maps and figures corresponding to these cross-sections are given in the text.

Peat Types:

The legend (Figure 1) shows the various peat types as they appear in the cross-sections. These types are based on the botanical composition, as well as a number of physical and chemical factors. The absorptive values, ash content, moisture content, nitrogen content and pH were determined for samples from each type of peat in each of the study regions. Even with these added factors the best method of classification is by means of the Von Post humification scale (Table 1).

A. *Sphagnum* peat: True *Sphagnum* peat consists mainly of many *Sphagnum* species, slightly humified (H 1 to H 2.5) but with leaves and stems identifiable and mostly intact. It is usually light brown, although many deposits exhibit darker shades, as well as light reddish brown. The colour variation in some cases is due to environmental conditions. There are two varities of *Sphagnum* peat. Firstly, there is Cymbifolia peat which is coarse fibered and composed principally of the species comprising a raised bog formation; examples are Sphagnum imbricatum and Sphagnum magellanicum. The second variety is Acutifolia peat which is finer textured and is generally dense in structure; consisting of the remains of such species as Sphagnum rubellum and Sphagnum fuscum. The Sphagnum peat, or moss, is a mixture of Sphagnum, sedges, and ericaceous plants. In most cases the Sphagnum content is more than 80% the total volume. Sphagnum moss is generally found in raised bogs, but considerable thicknesses are recorded in ombrotrophic blanket bogs as well.

Absorptive value (times its own weight) ...	20 - 3.0+
Moisture content	92 -96%
Nitrogen content	0.1 - 1.2%
Ash content	0.2 - 1.24%
pH	4.0 - 4.8%

B. Transition peat: This peat is humified to a moderate degree (H 3 to H 5), and is composed principally of Sphagnum species. It is generally found between the more humified lower layers and the living Sphagnum moss occupying the upper layers. Many bogs have little transition peat and, in these cases, the definition between Sphagnum and the lower peat (H 6+) is quite sharp. This transition peat may represent a line of demarcation from the influence of mineral water to the true ombrotrophic condition. This layer (or layers) is usually thin, but in many cases it has an erratic distribution and in some bogs it may form the bulk of the Sphagnum deposits. In general the Sphagnum content is high but a higher content of sedge is not uncommon.

The absorptive values and moisture content are a little lower for this peat than for the previous type.

Absorptive value .... 15 - 25

Moisture content .... 90 - 93%

The nitrogen and ash content, as well as pH, is similar to the values recorded for Sphagnum moss (H 1 to H 3).

C. Sedge peat: This peat is composed mainly of sedges; Scirpus spp., Carex spp., and Eriophorum spp. being most common. The Sphagnum content is less than that in the upper layers. Sedges comprise more than 50% of the total volume and govern the structure of the peat, givint it a stringy appearance. A two-foot core can be suspended vertically without any support, whereas a Sphagnum core would break away. Sedges are distributed throughout the deposit with Scirpus cespitosus most common in the upper layers and both Carex spp. and Eriophorum spp. prevalent in lower layers. The sedge, especially in the lower layers of raised bogs, can be divided into two varieties; humified (H 5+) and less humified (H 2 to H 3.5) peat. Sedge peat is primarily associated with blanket bogs, but is also found in the intermediate and transition layers of raised bogs. Some physical parameters for sedge peat in Newfoundland are:

Absorptive value	15	-	22
Moisture content	≃90%		
Nitrogen content	0.66	-	1.27
Ash content	0.75	-	1.44
pH	4.5	-	5.0

D. Humified <u>Sphagnum</u>-Sedge peat: This is perhaps the most prevalent type found in Newfoundland bogs. The components are difficult to identify; it is composed, however, mainly of disintegrated or decomposed remains of both <u>Sphagnum</u> and sedge plants. This is peat (H 6+) not dominated by any particular species or family. It generally occupies the lower layers of the bog. Physical parameters for the humified (H 6+) peat are:

Absorptive	12	-	17
Moisture content	85	-	90%
Nitrogen content	0.79	-	0.92%
Ash content	1.10	-	3.05%
pH	3.5	-	4.8

E. Woody peat: Very little woody peat is found but where it was observed it consisted largely of small wood fragments. These may have been derived from the fen species <u>Chamadaephne calyculata</u>, <u>Myrica gale</u> or higher forms such as <u>Larix laricina</u> or <u>Picea mariana</u>. Woody peat is almost always toward the bottom of the accumulation. The physical parameters (based on only two samples) are:

Absorptive value	10	-	13
Moisture content	79	-	88%
Nitrogen content	1.8	-	2.9%
Ash content	14.3	-	25.9%
pH	5	-	6

F. Fen peat: This is a thin layer of peat not more than a few inches to about one-foot thick. It is well-humified but generally has identifiable remains of Carex spp. and wood. Fen peat represents the initial deposit and is composed of species such as Myrica gale, Carex spp., Scirpus spp. and other acidophilous species, depending on minerotrophic influences. Some physical parameters for fen peat in Newfoundland are:

Absorptive value	15	-	18
Moisture content	85	-	90%
Nitrogen content	2.28	-	3.74%
Ash content	11.4	-	12.2%
pH	5.1	-	6.7

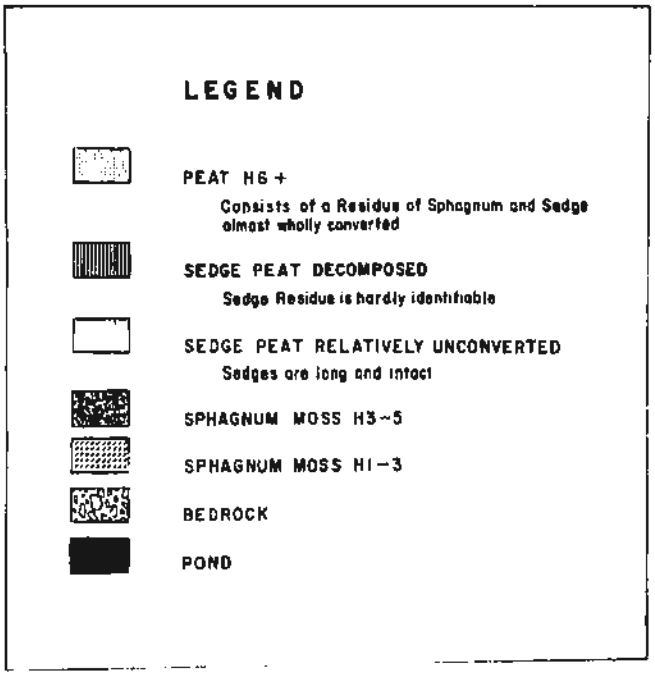

Figure i. This legend gives the various types of peat found in Newfoundland bogs which are shown in the cross-sections (Figures i - xxxi). Symbols for bedrock and ponds are also given.

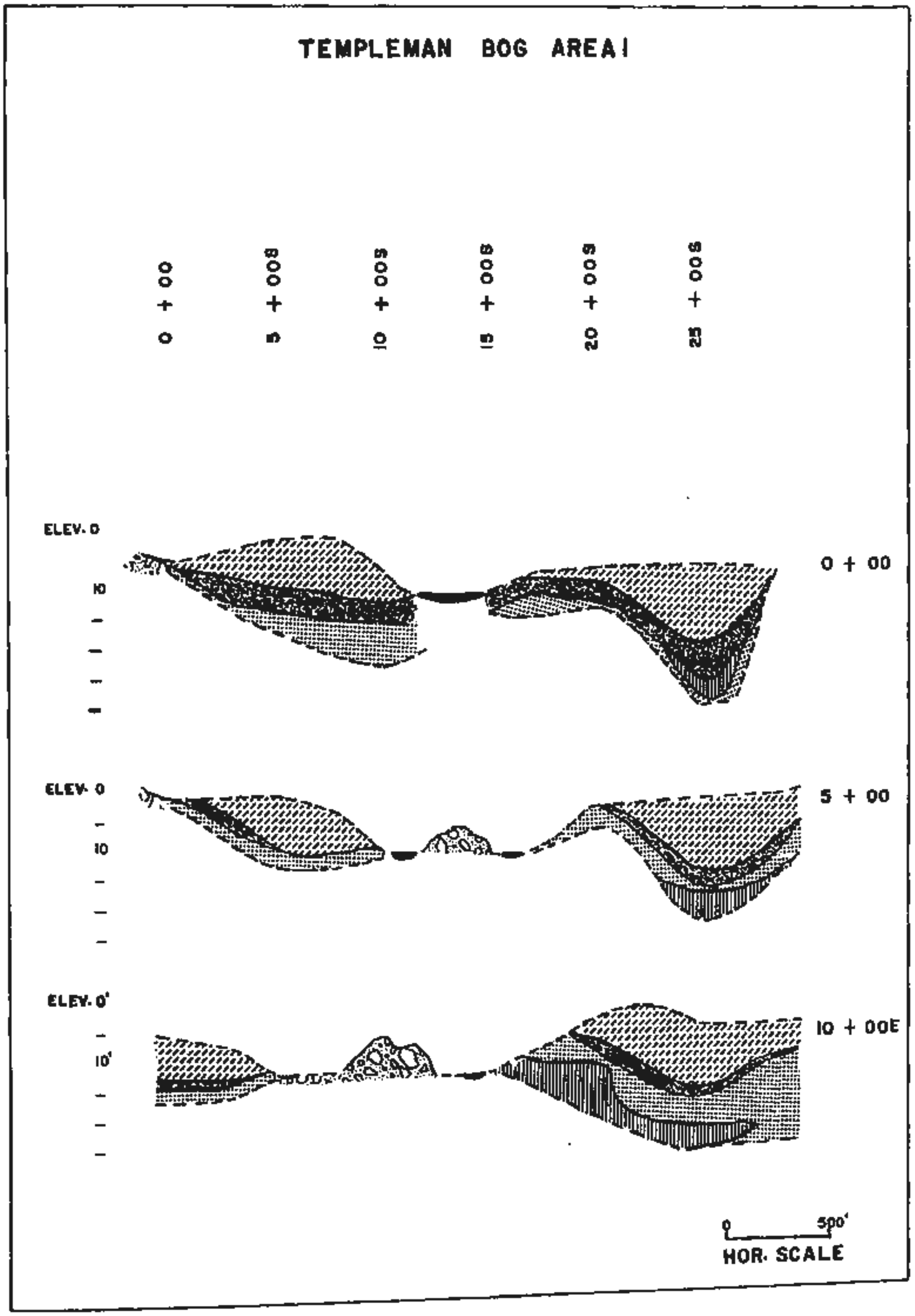

Fig. ii. Section of Templeman Bog (122) showing the subsurface strata. On 5+00E and 10+00E there are outcrops and water which disrupt the growth of the bog.

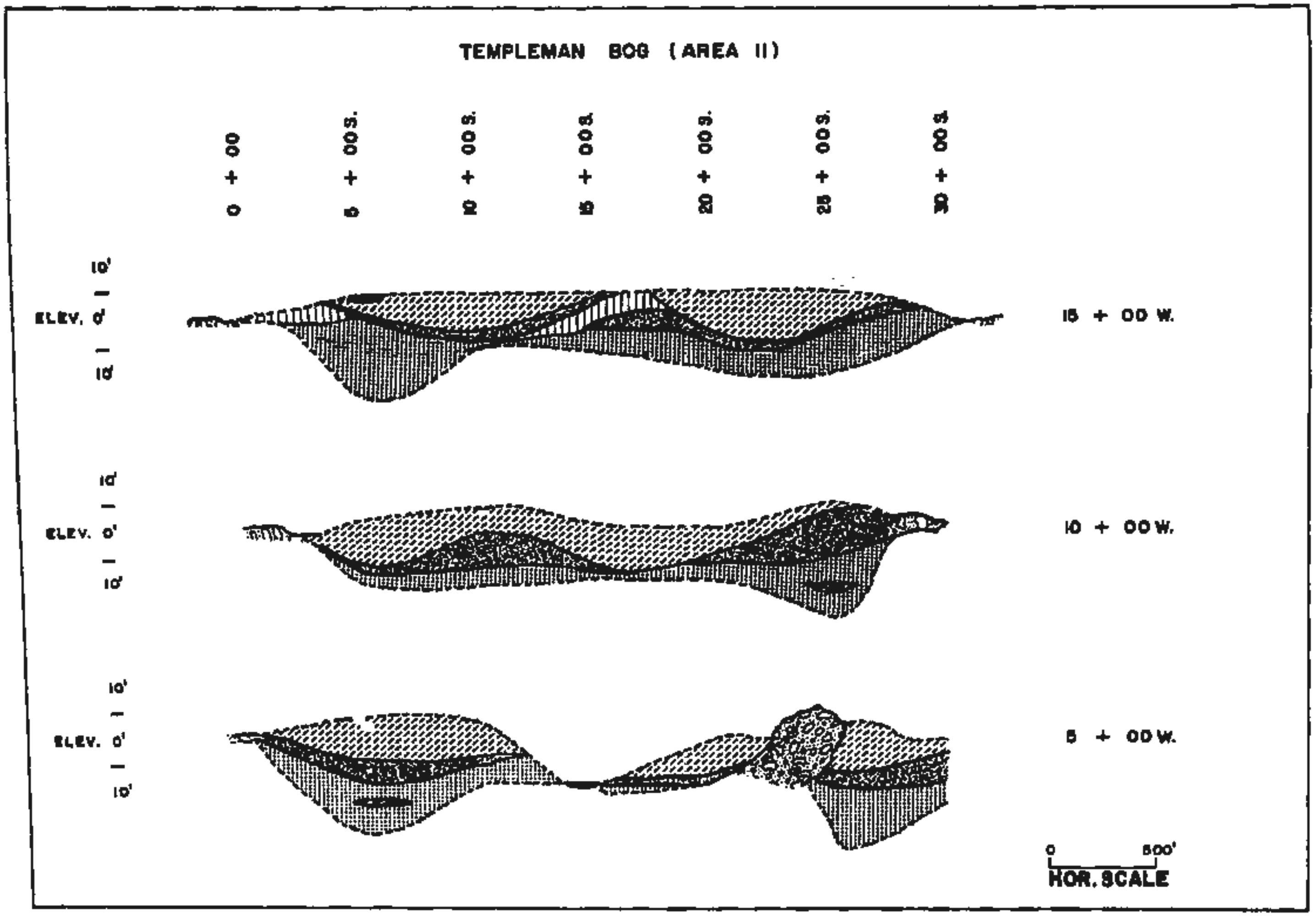

Figure iii. Section of Templeman Bog (122) showing the substrata. Humified peat (H6+) is prevalent; transition peat (H3-5) is also common. Note in 15+00W that near a minerotrophic site sedge peat extends to the surface.

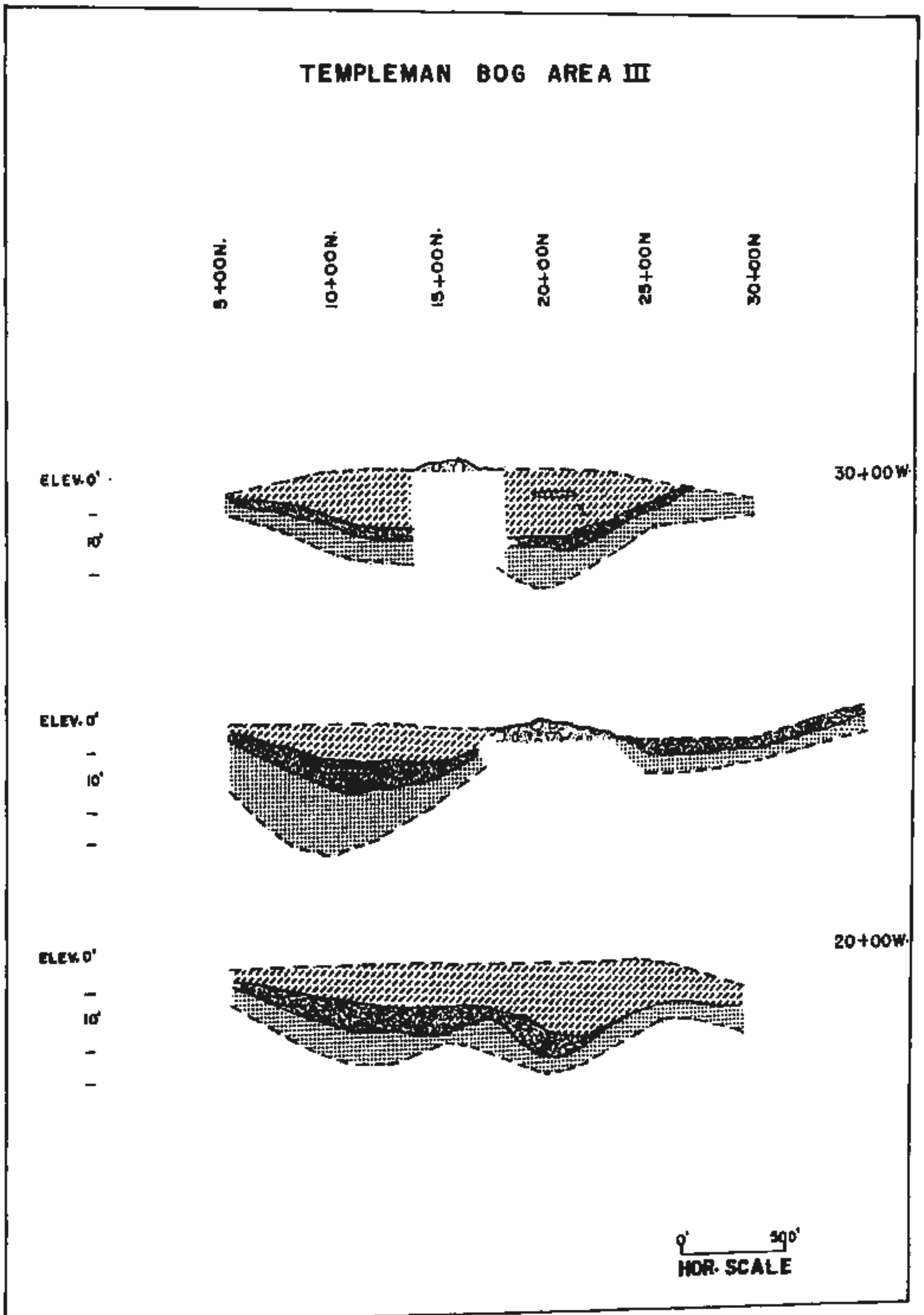

Figure iv. Section from Templeman's Bog (122). This is a section with fairly uniform layers. In 25+00W and 30+00W there are lenses of humified peat (H6+) in the upper layers.

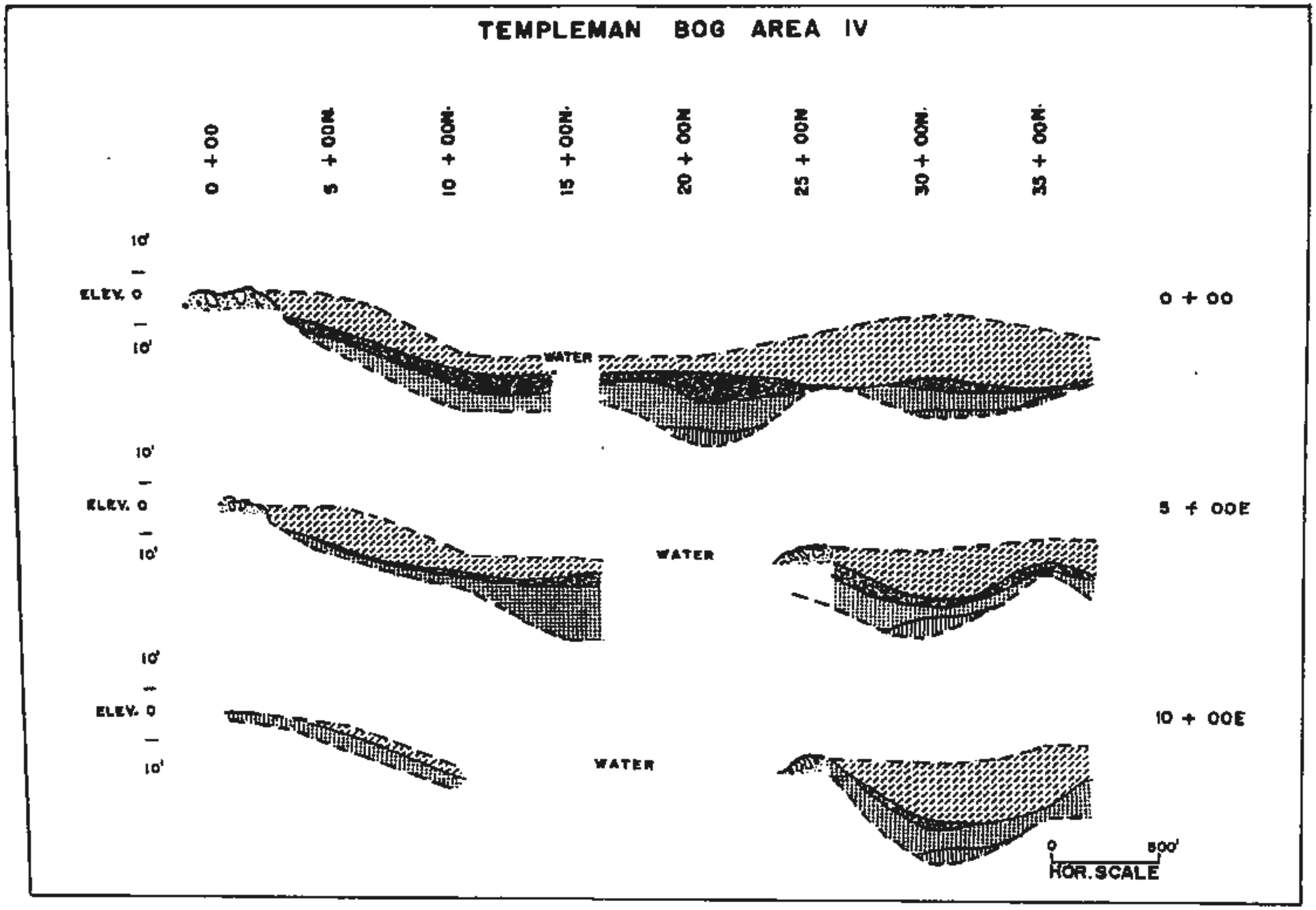

Figure v. Section of Templeman Bog (122). It can be seen that this portion of the bog is not convex. This is due to the presence of water. The bottom layers are often decomposed sedge; this may be the remains of the fen which gave rise to initial bog development.

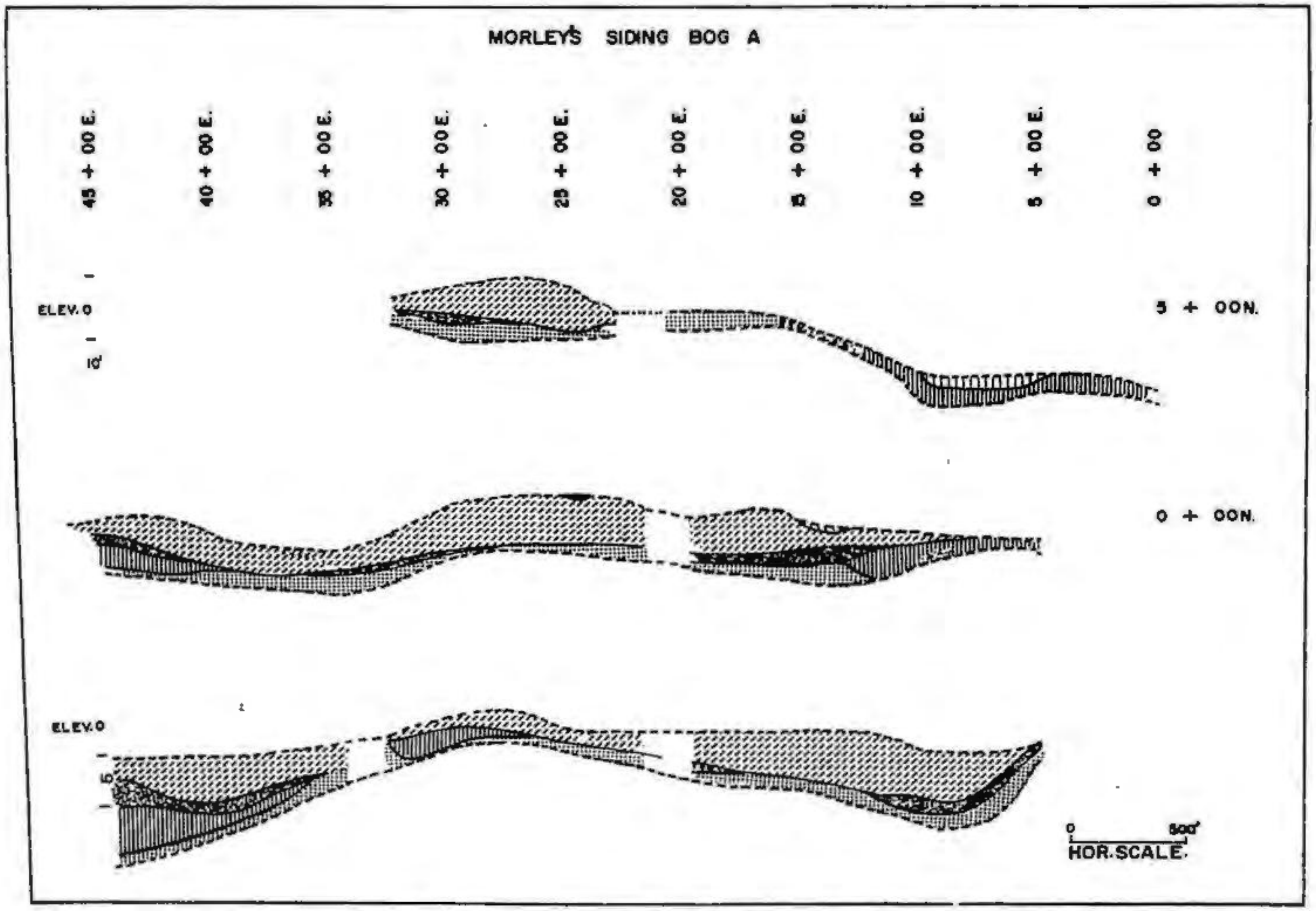

Figure vi. This section is from Morley's Siding Bog A (129). This bog is not uniformly convex, but rather follows the substrata. Woody peat is found on the slopes in lines 5+00N and 0+00.

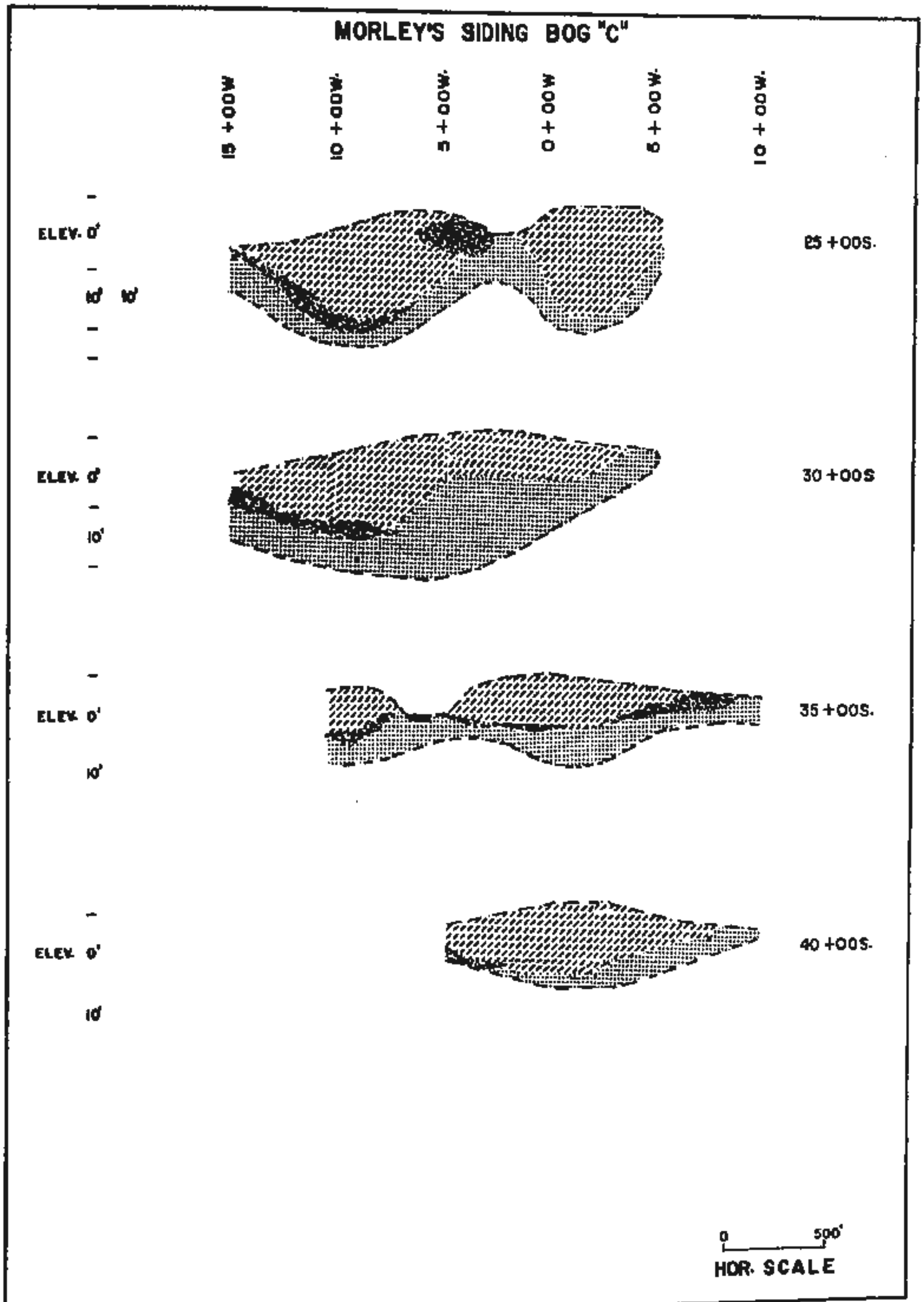

Figure vii. Section of Morley's Siding Bog C (127); a raised bog. On 25+00S humified peat extends to the surface. This is near a sock.

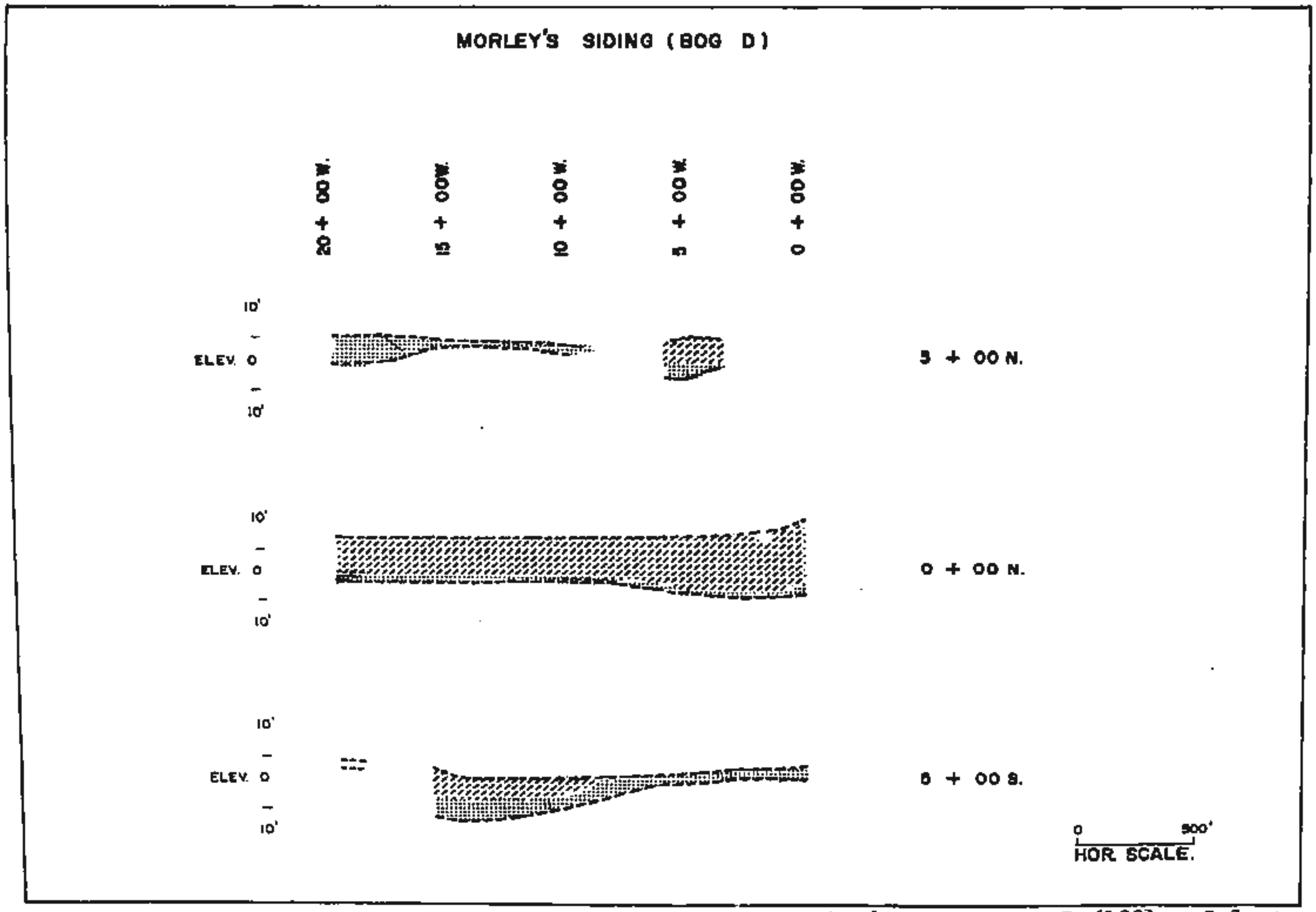

Figure viii. Sections of an ombrotrophic blanket bog, Morley's Siding Bog D (128). Only two types of peat are present with Sphagnum moss forming the greater thicknesses.

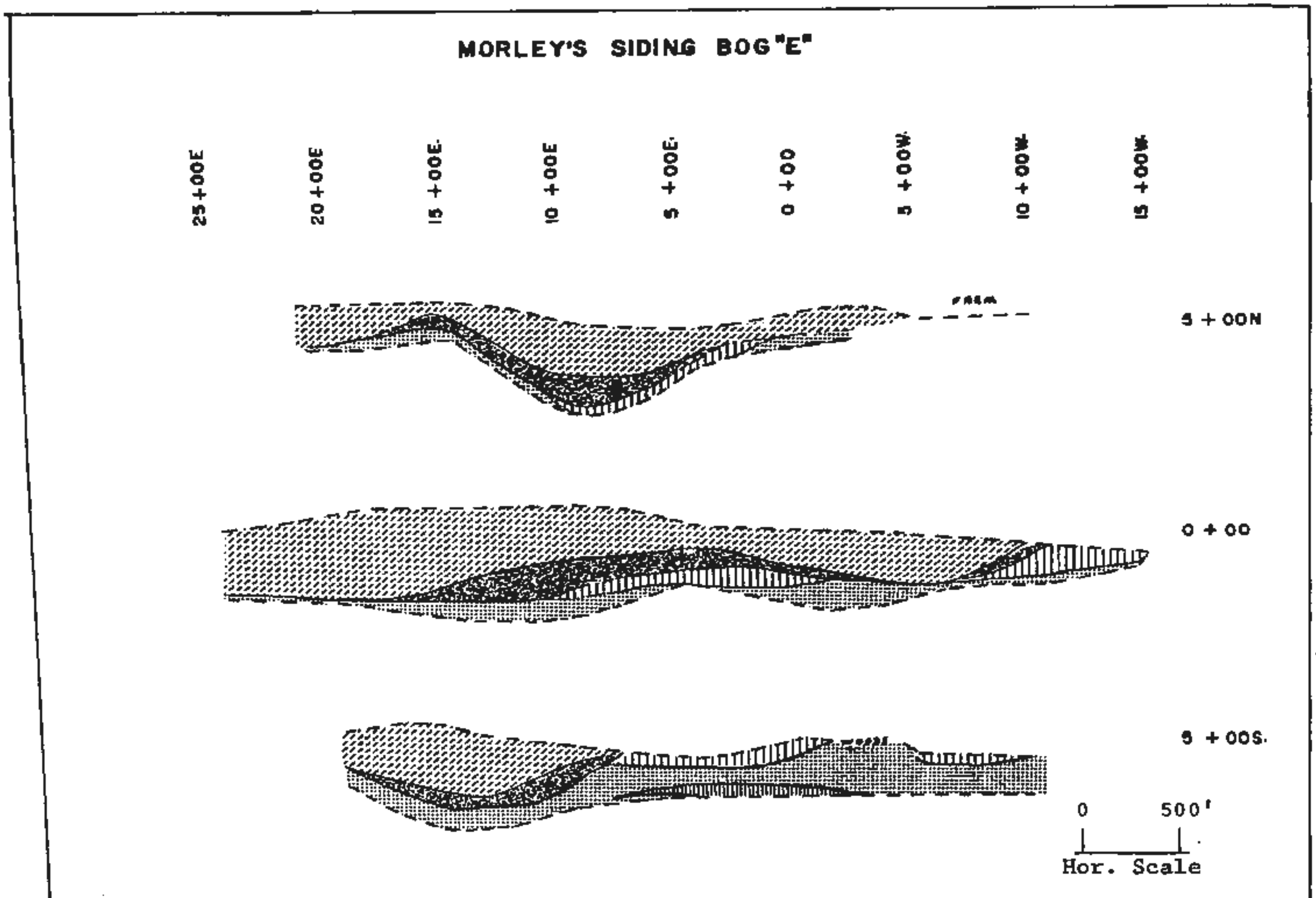

Figure ix. Sections of a raised bog showing the peat substrata. There are great thicknesses of _Sphagnum_ moss (H1-3) in all but 5+00S, where sedge peat is dominant near the surface.

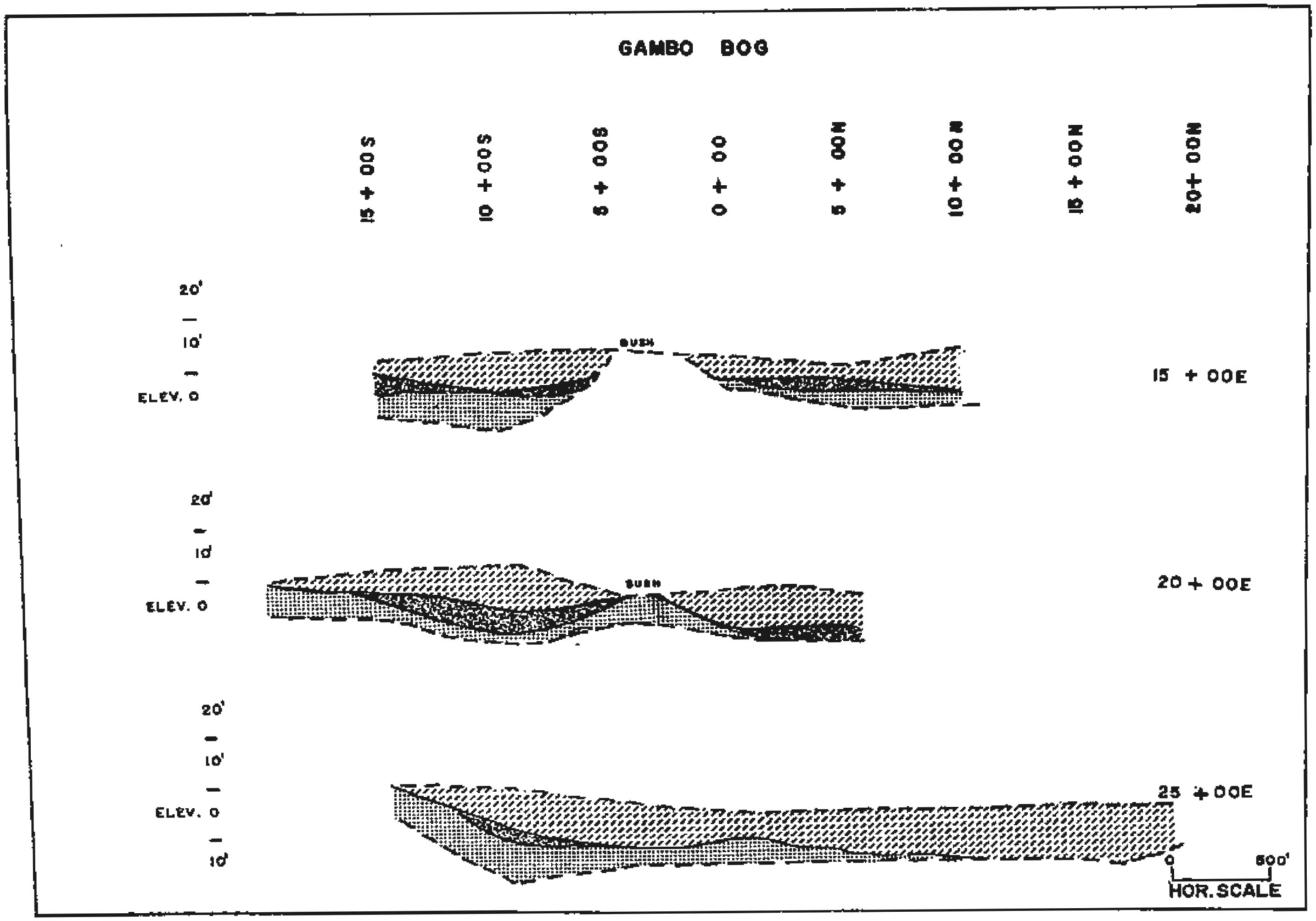

Figure x. Sections of a large flat raised bog; Gambo Bog (134).

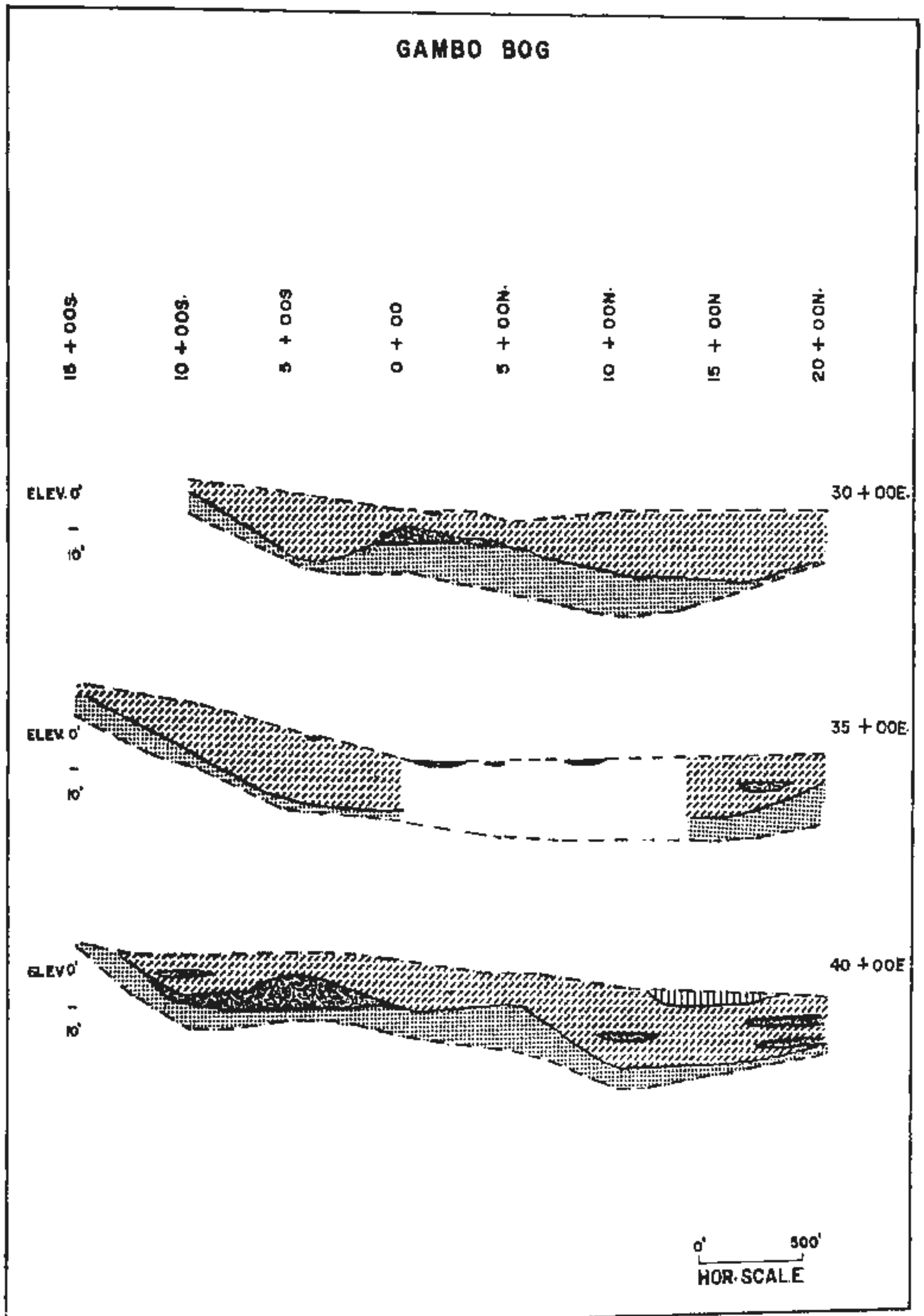

Figure xi. Sections of Gambo Bog (134). A portion of this bog was too wet for sampling. Note in lines 35+00E and 40+00E, the presence of lenses of transition peat found in the Sphagnum moss (H1-3).

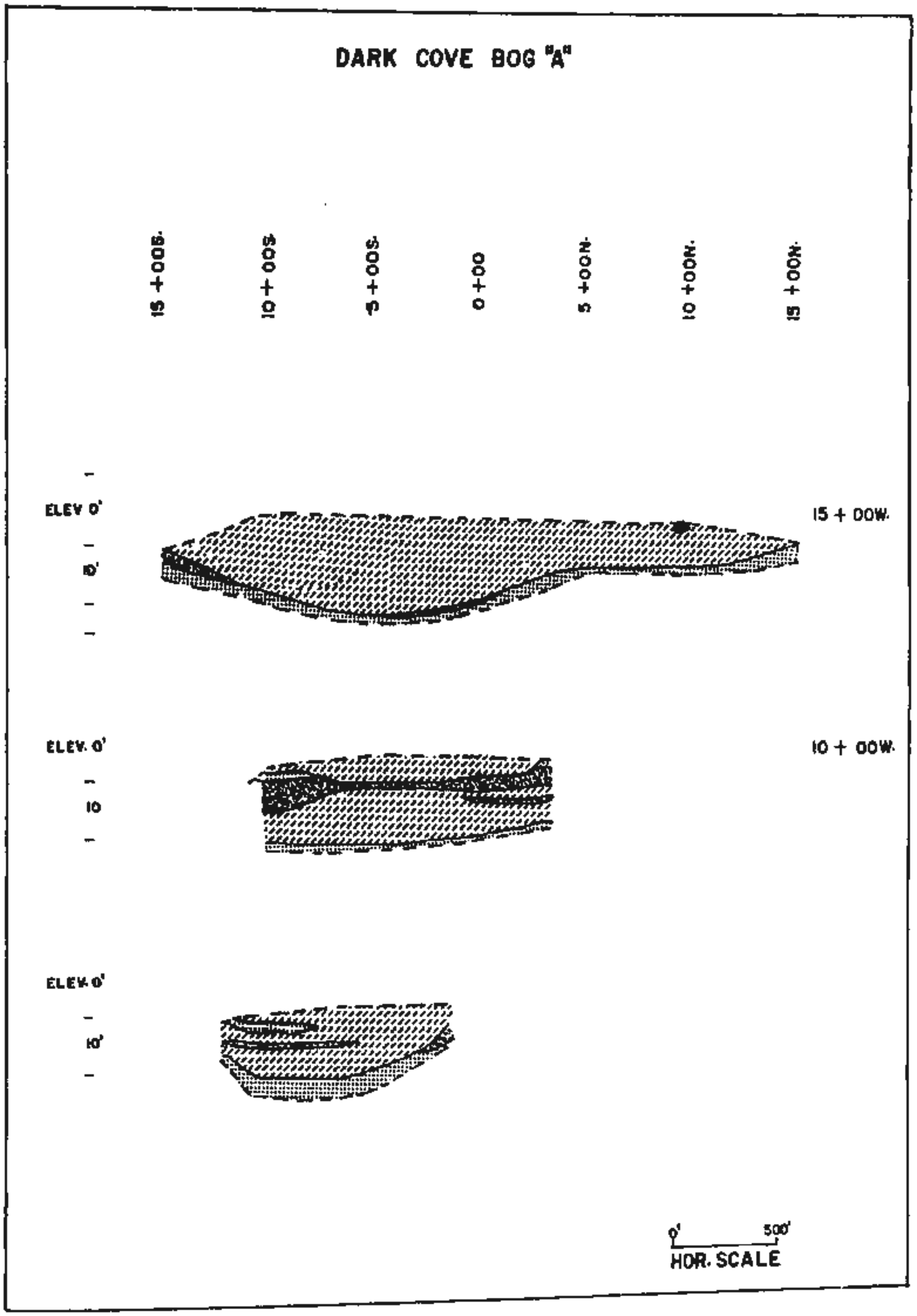

Figure xii. Sections of Dark Cove Bog A (135), a raised bog near Gambo. The _Sphagnum_ (H1-3) is unusually thick. There are layers and lenses of both transition (H3-5) and humified (H6+) peat in the upper layers.

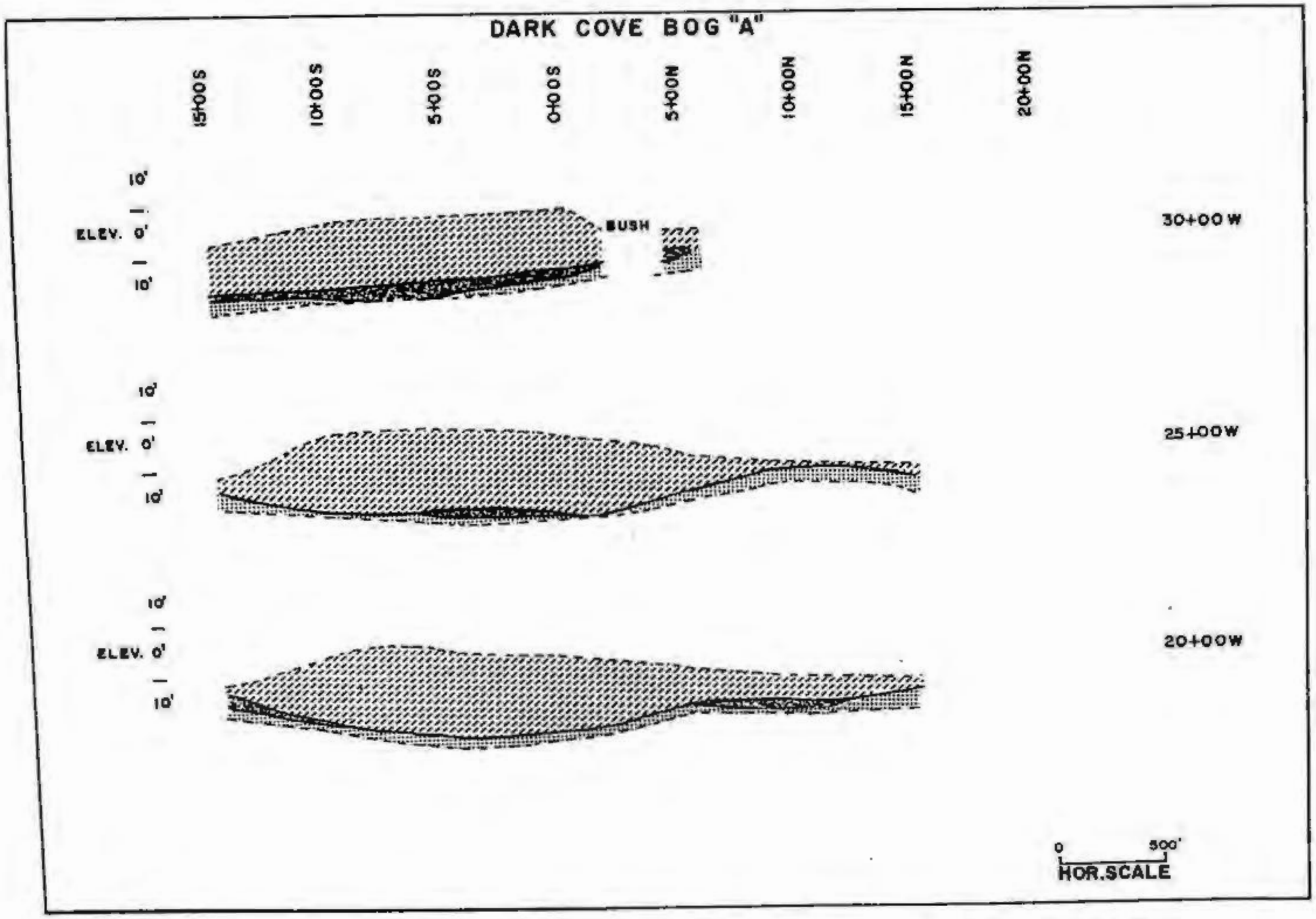

Figure xiii. Sections of Dark Cove Bog A (135). This raised bog is almost wholly <u>Sphagnum</u> moss (H1-3).

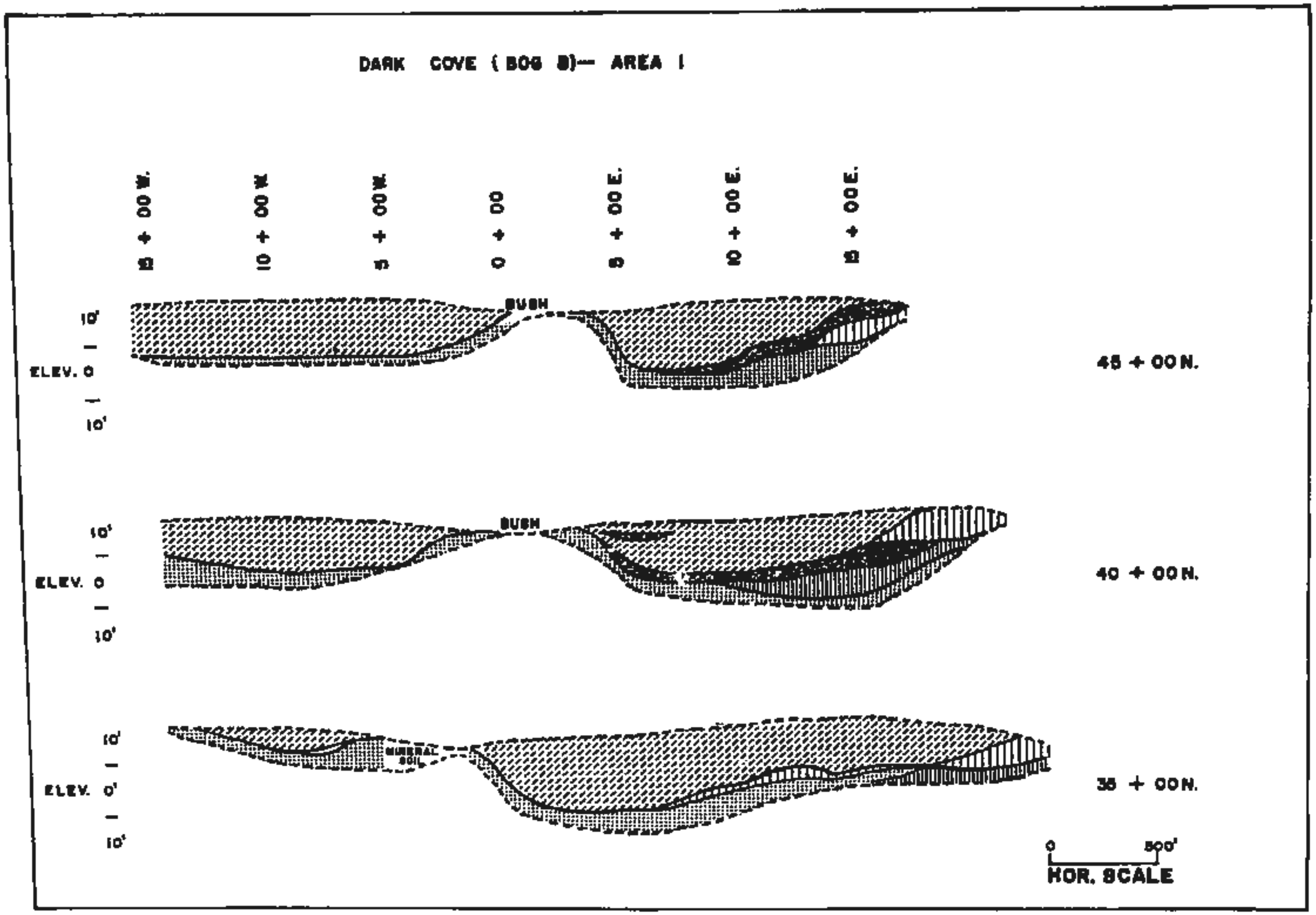

Figure xiv. Sections of Dark Cove Bog B (135); a raised bog near Gambo. The strata near the end of line 40+00N are complex with five different peats present.

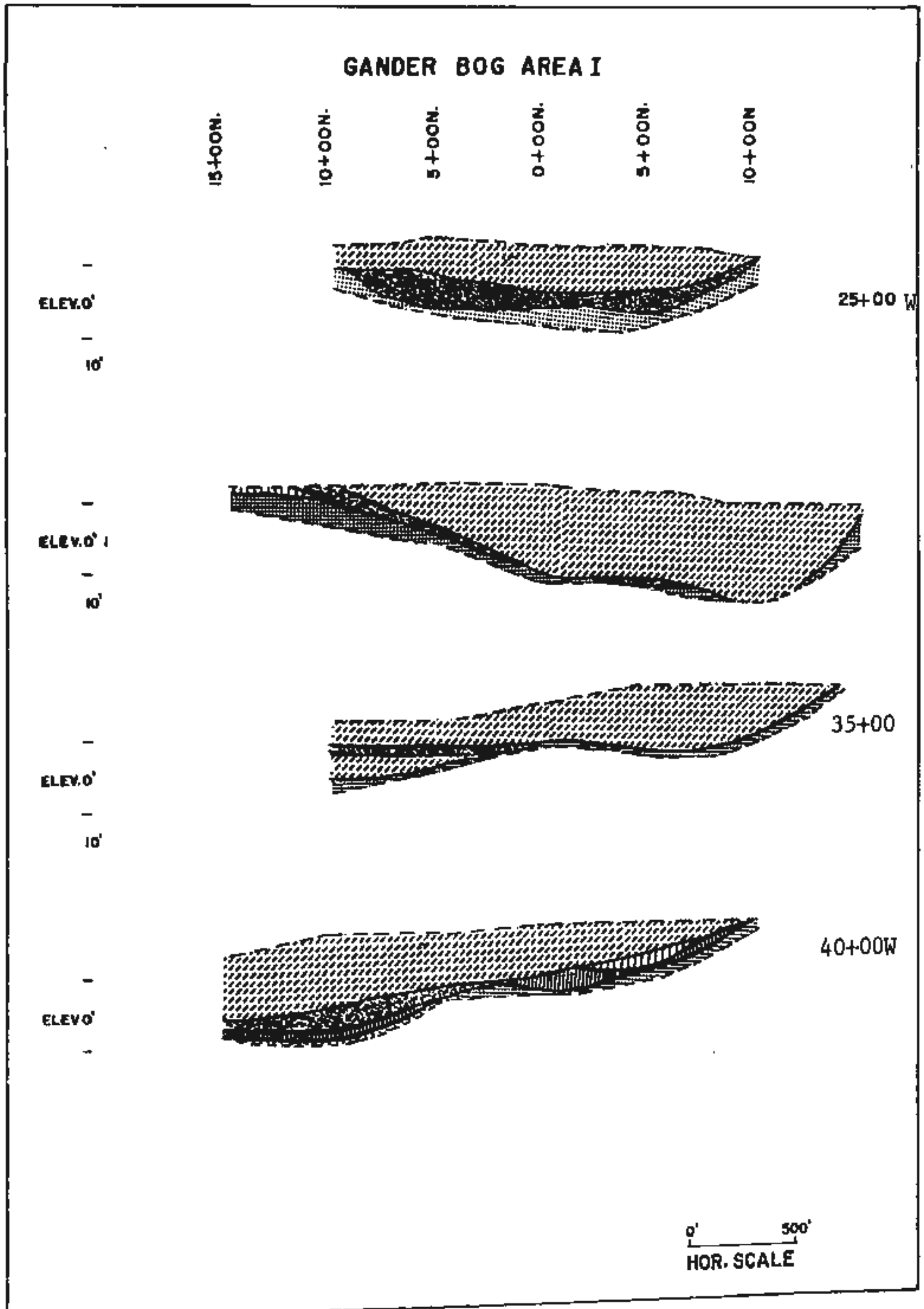

Figure xviii. Sections of a raised portion of Gander Bog (139).

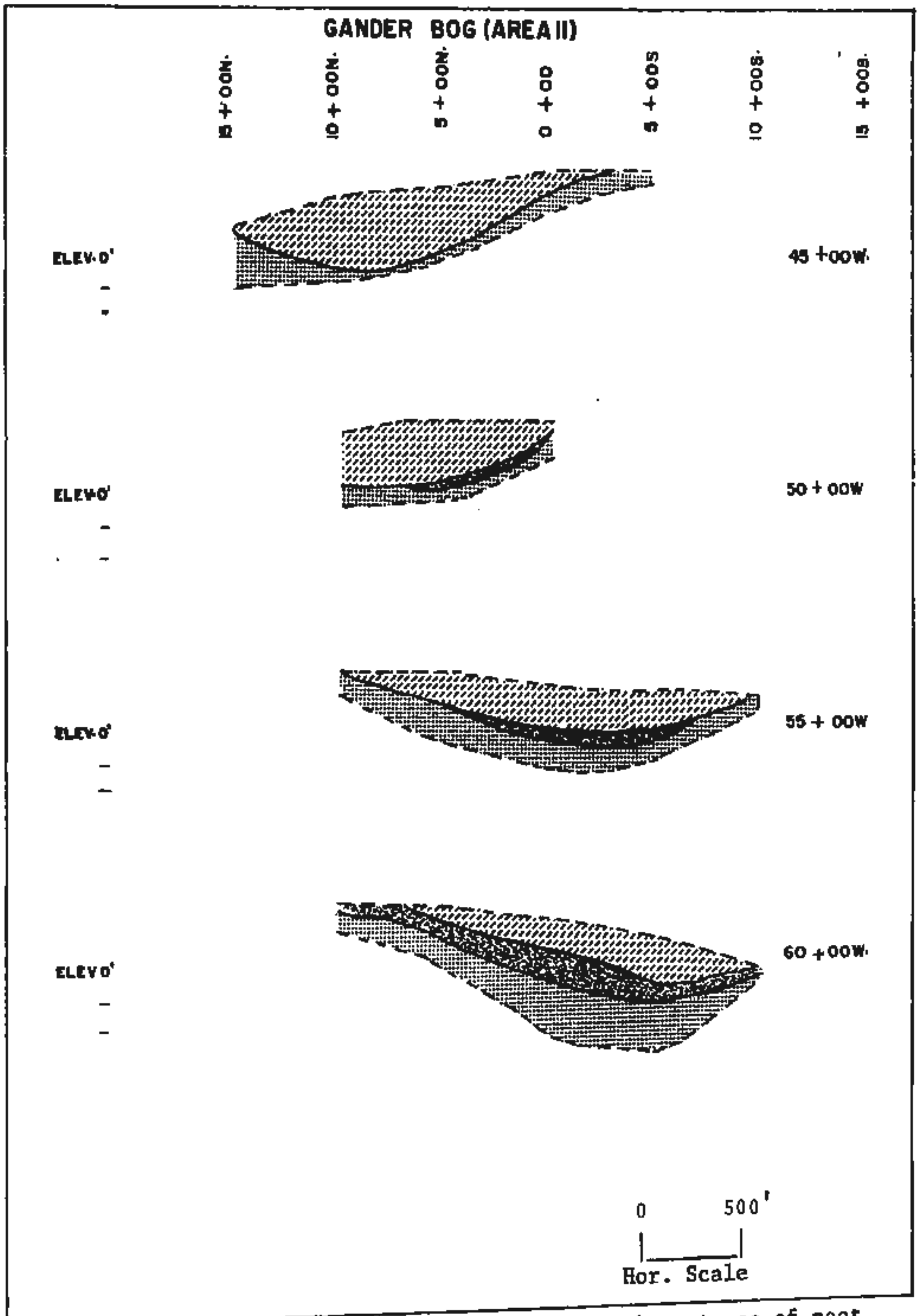

Figure xix. Sections of Gander Bog (139); only three types of peat are present.

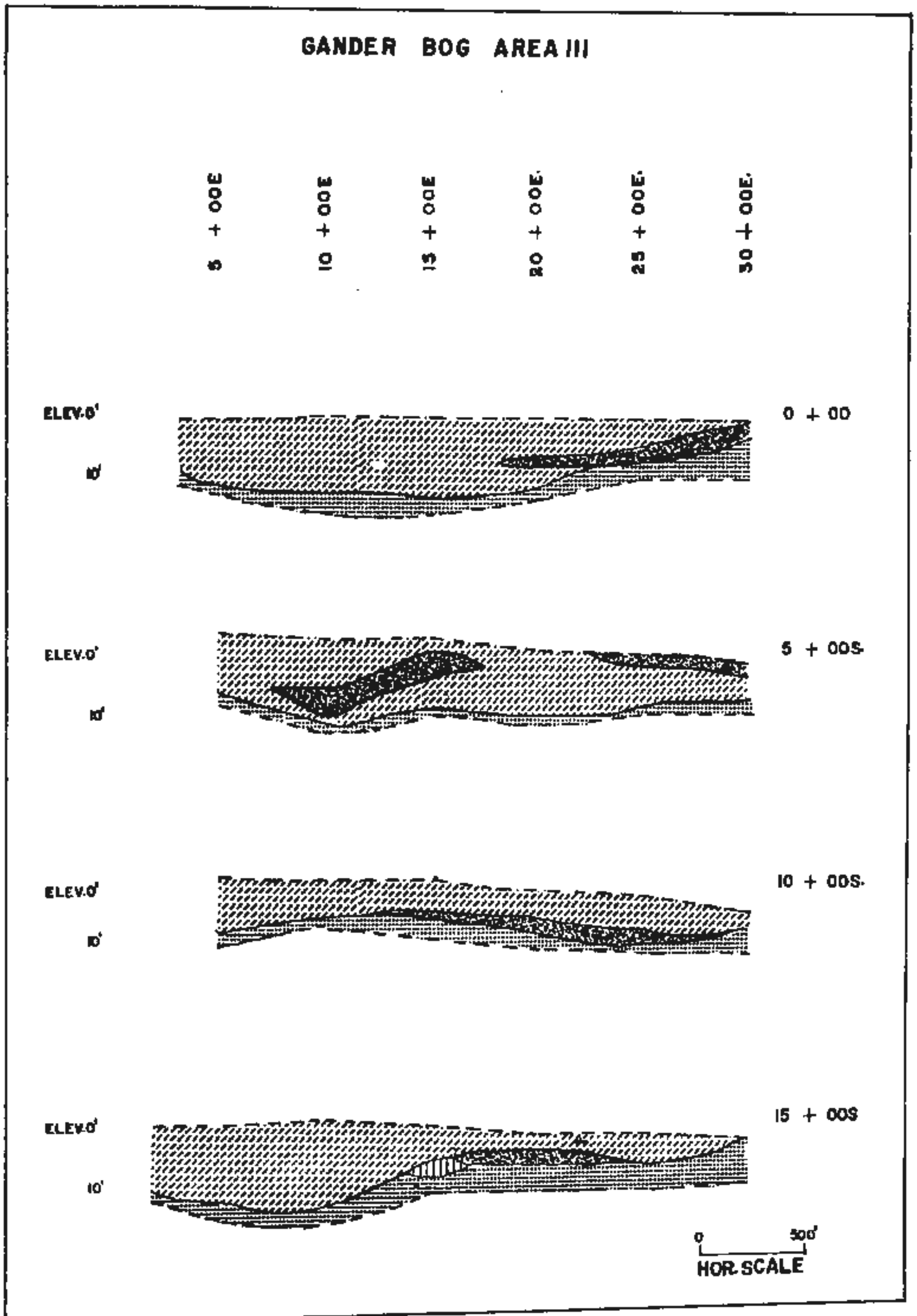

Figure xx. Sections of Gander Bog (139). Transition peat is found directly on Sphagnum moss (H1-3) and protrudes into the upper layers.

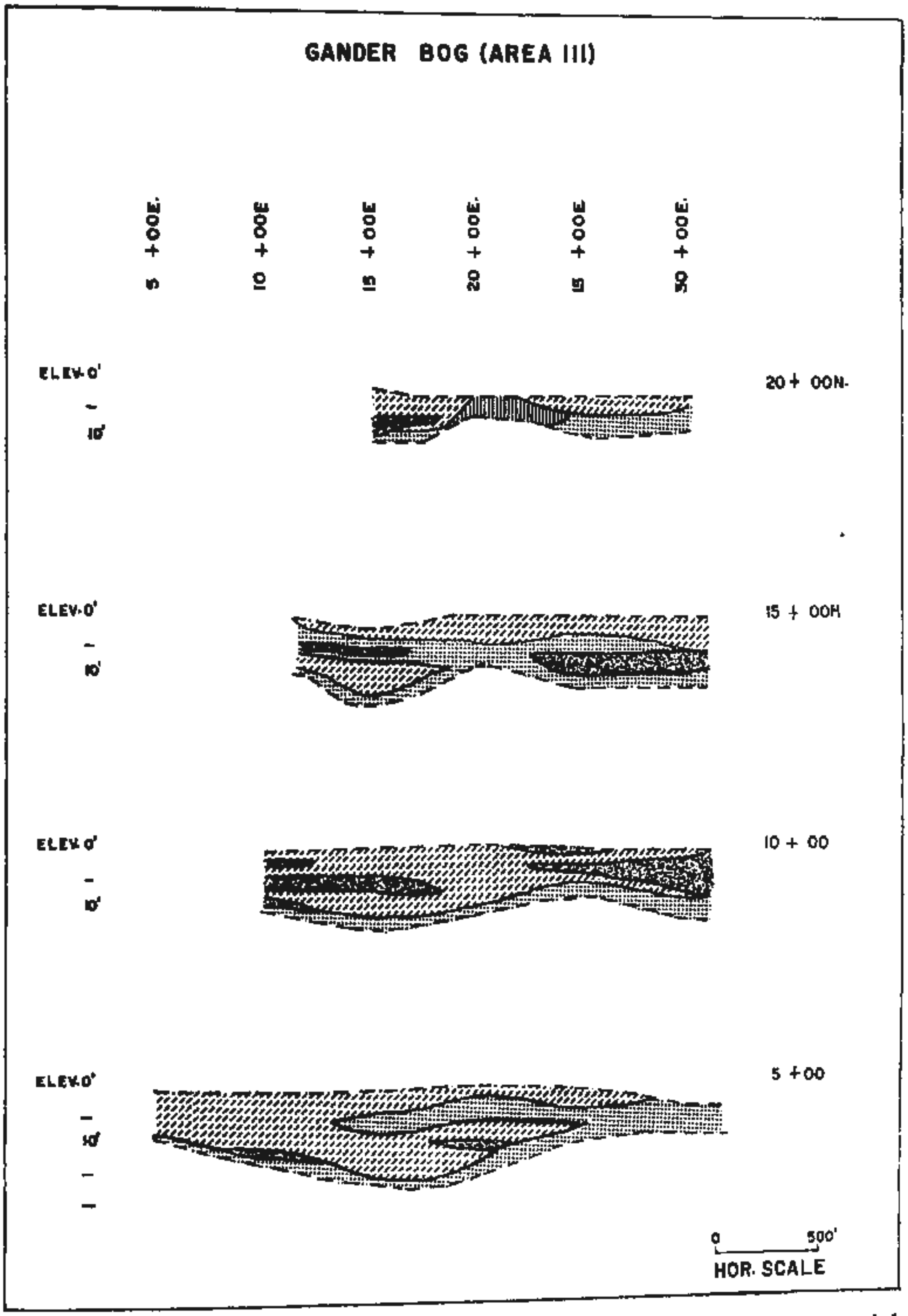

Figure xxi. Sections through Gander Bog (139); in an area influenced by mineral water. The Sphagnum (H1-3) layers are not uniform and are mixed with sedge peat (H5+), humified peat (H6+) and transition peat (H3-5).

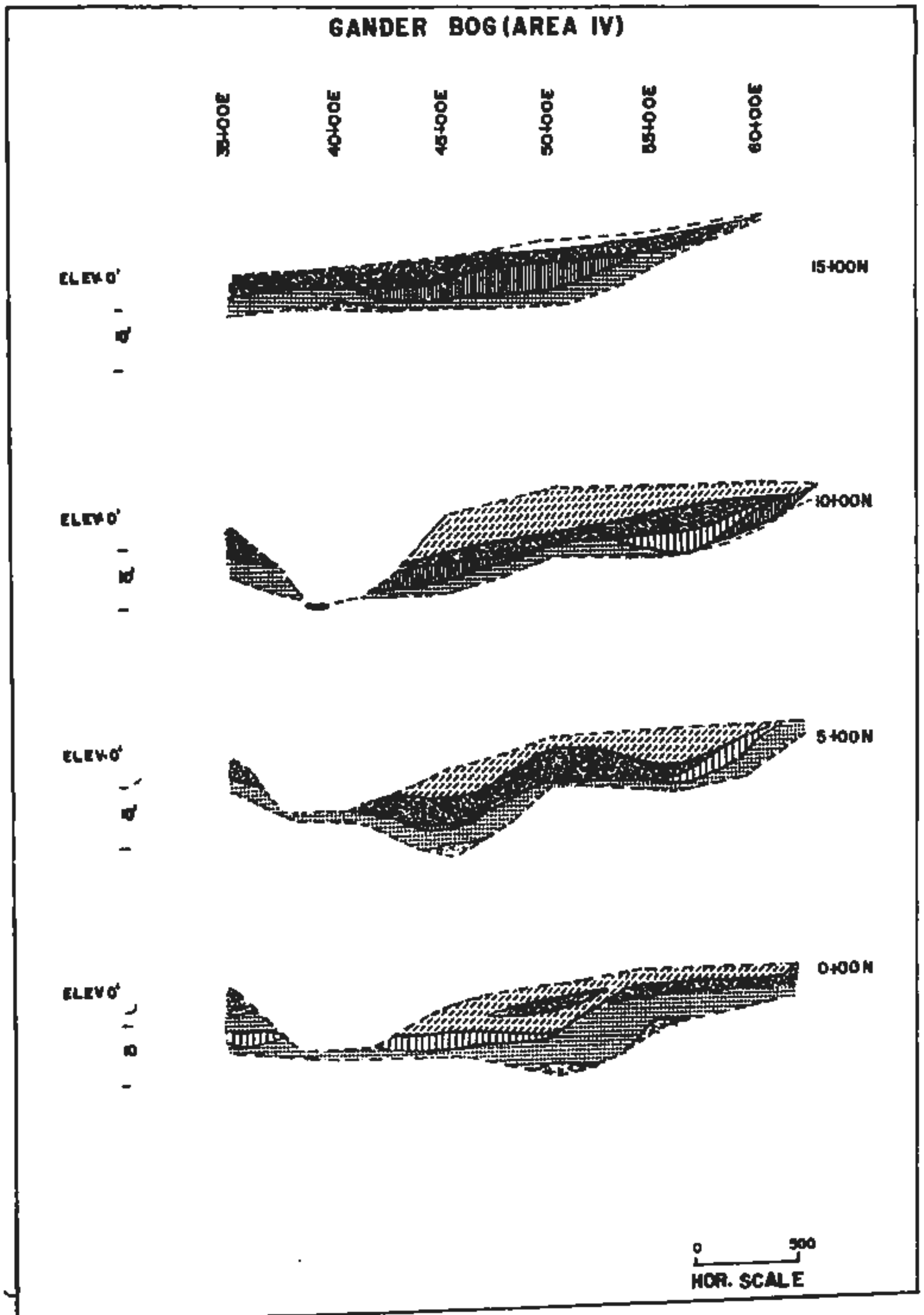

Figure xxii. Sections of Gander Bog (139), with six varities of peat shown. There are thick deposits of transition peat (H3-5) and sedge peat; woody peat is also found near the bottom.

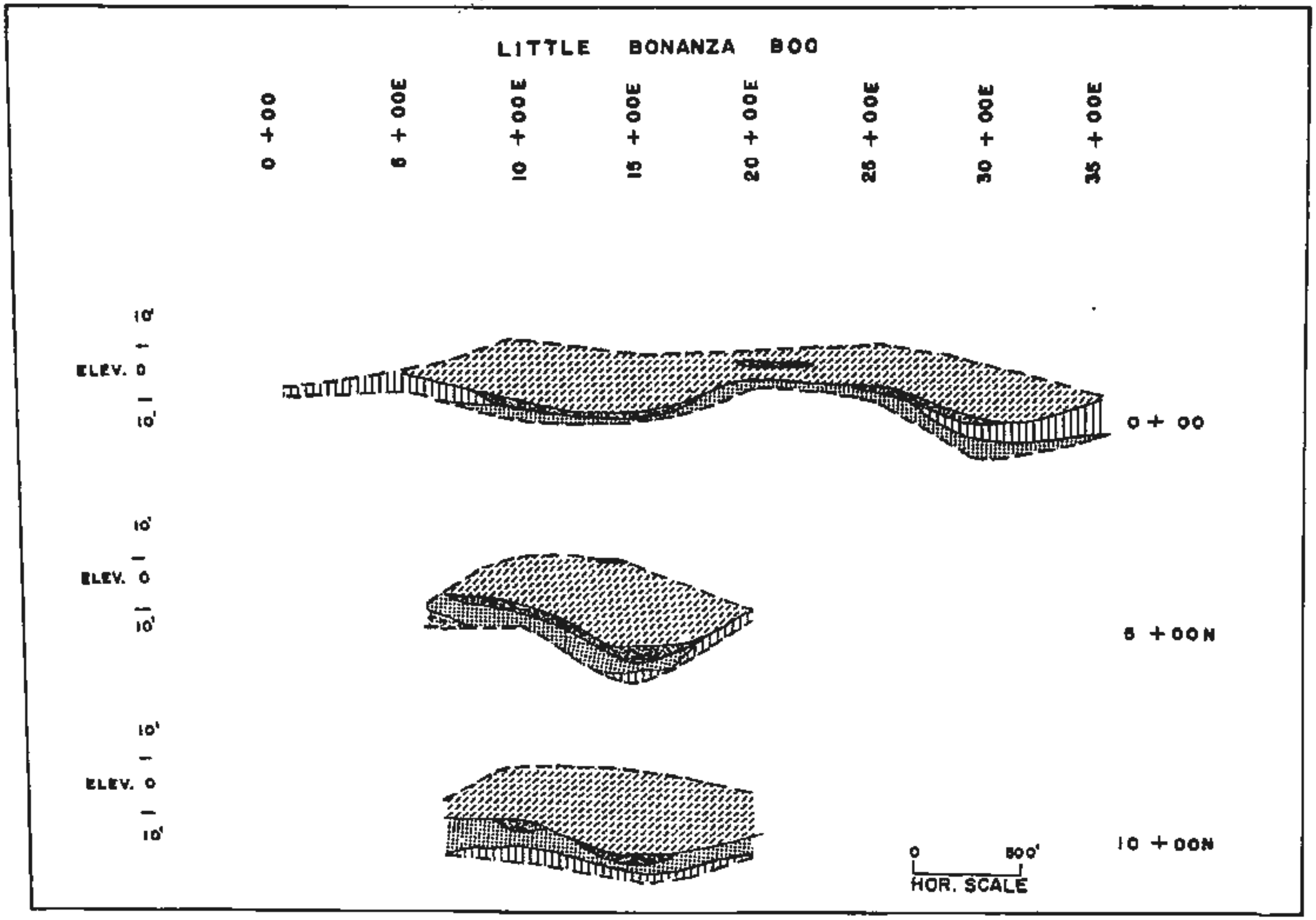

Figure xxiii. Sections of a raised bog near Gander (Little Bonanza Bog, 140). The convexity of the surface is easily seen. Near the bottom and edges is sedge peat (H2-3).

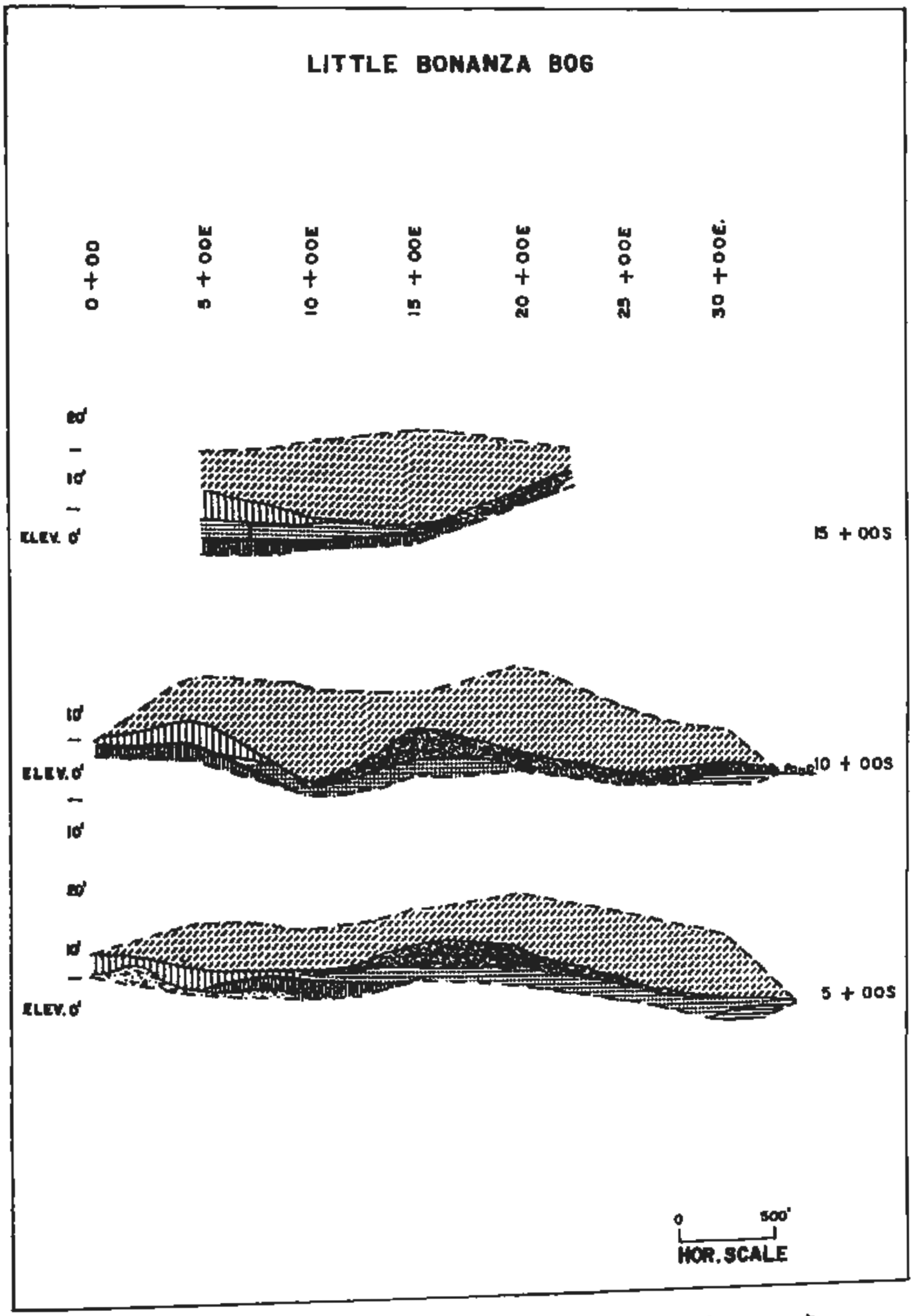

Figure xxiv. Sections through a raised bog (140) showing great thicknesses of Sphagnum (Hi-3).

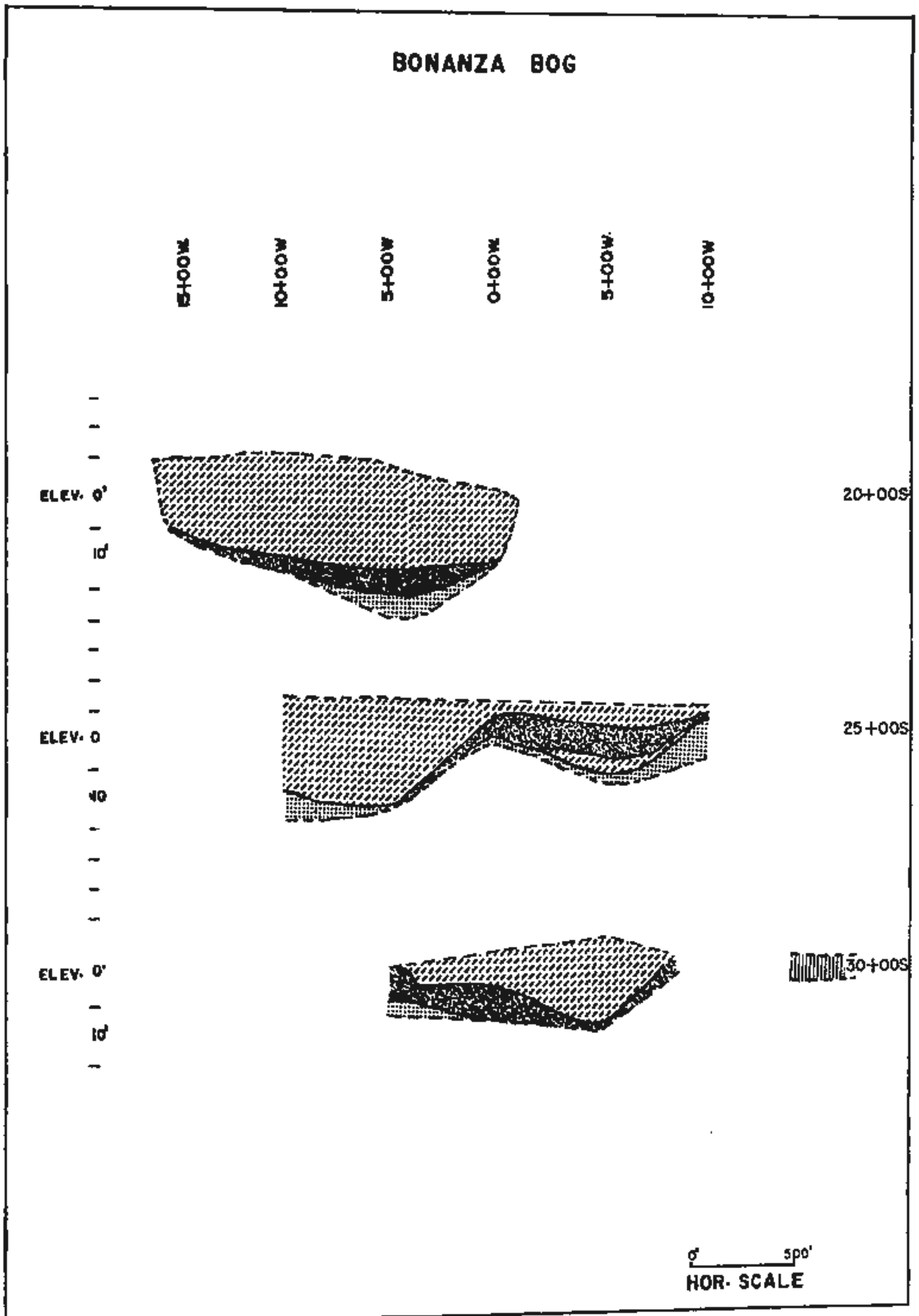

Figure xxv. Sections of Bonanza Bog (141), a raised bog near Gander. In 25+00S Sphagnum (H1-3) is found in the lower layers.

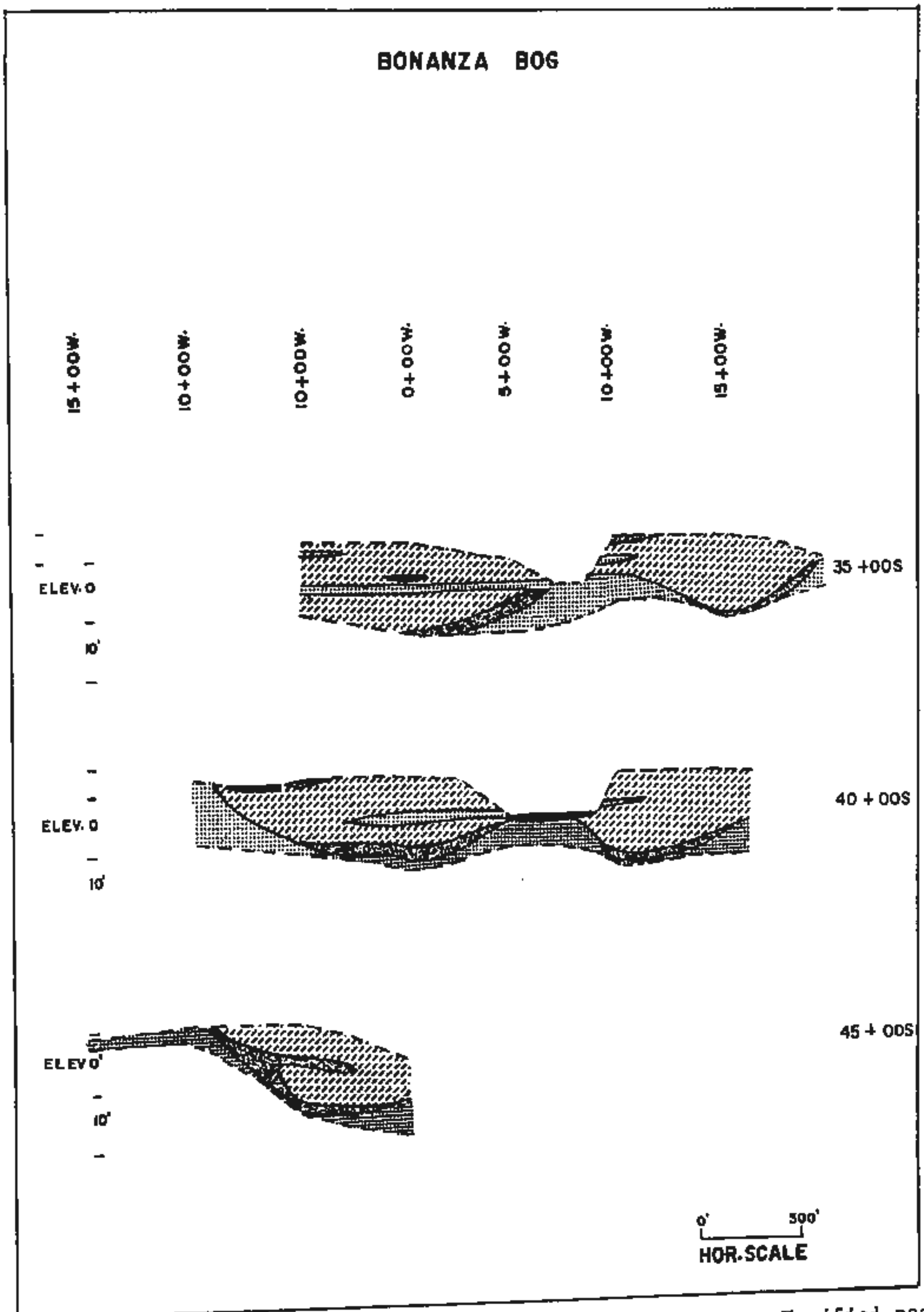

Figure xxvi. Sections of a raised bog (141) near Gander. Humified peat lenses (H6+) extend inward from the mineral water influence and interrupt the uniformity of the Sphagnum (H1-3) layers.

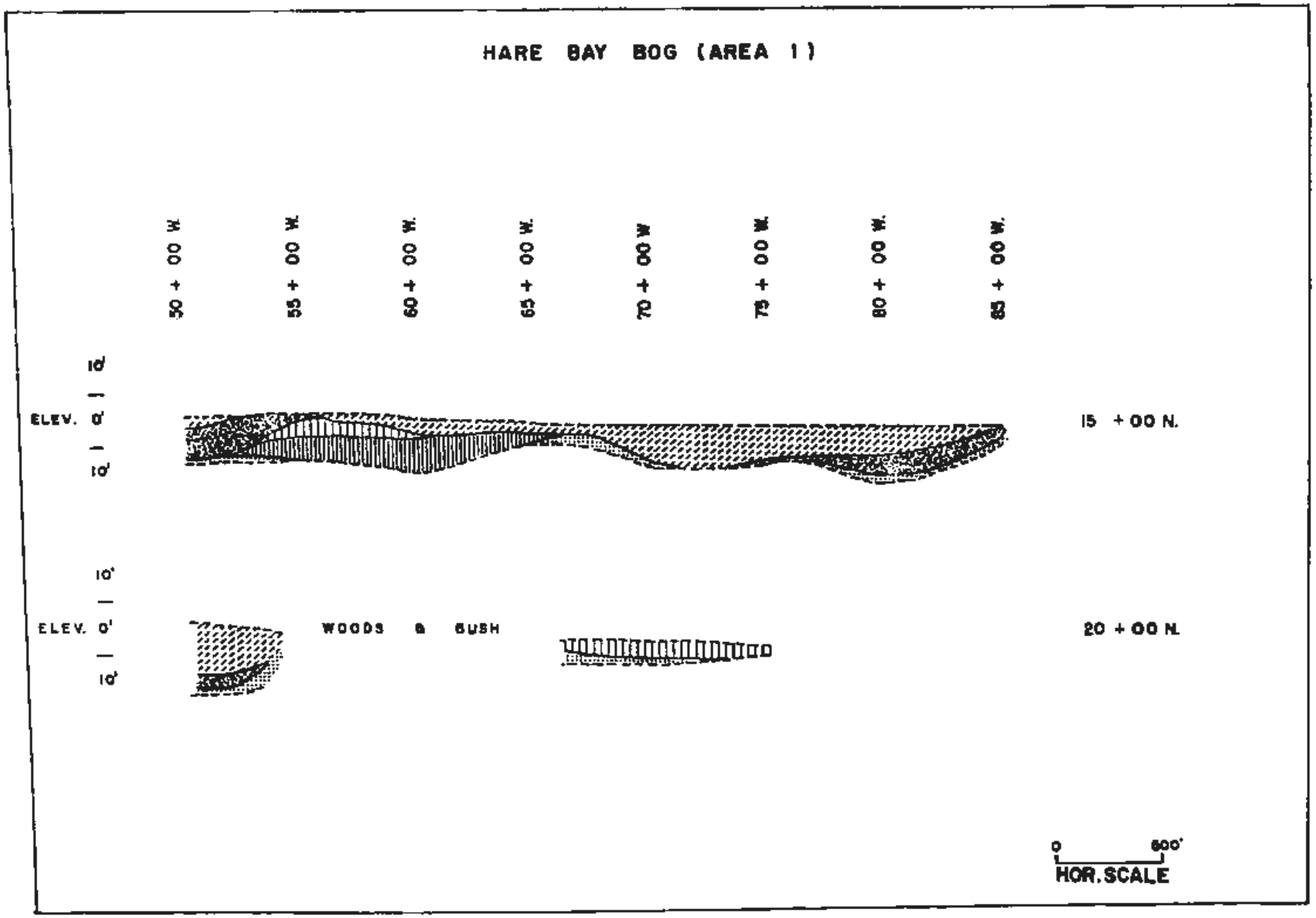

Figure xxvii. Cross-section of Hare Bay Bog (138).

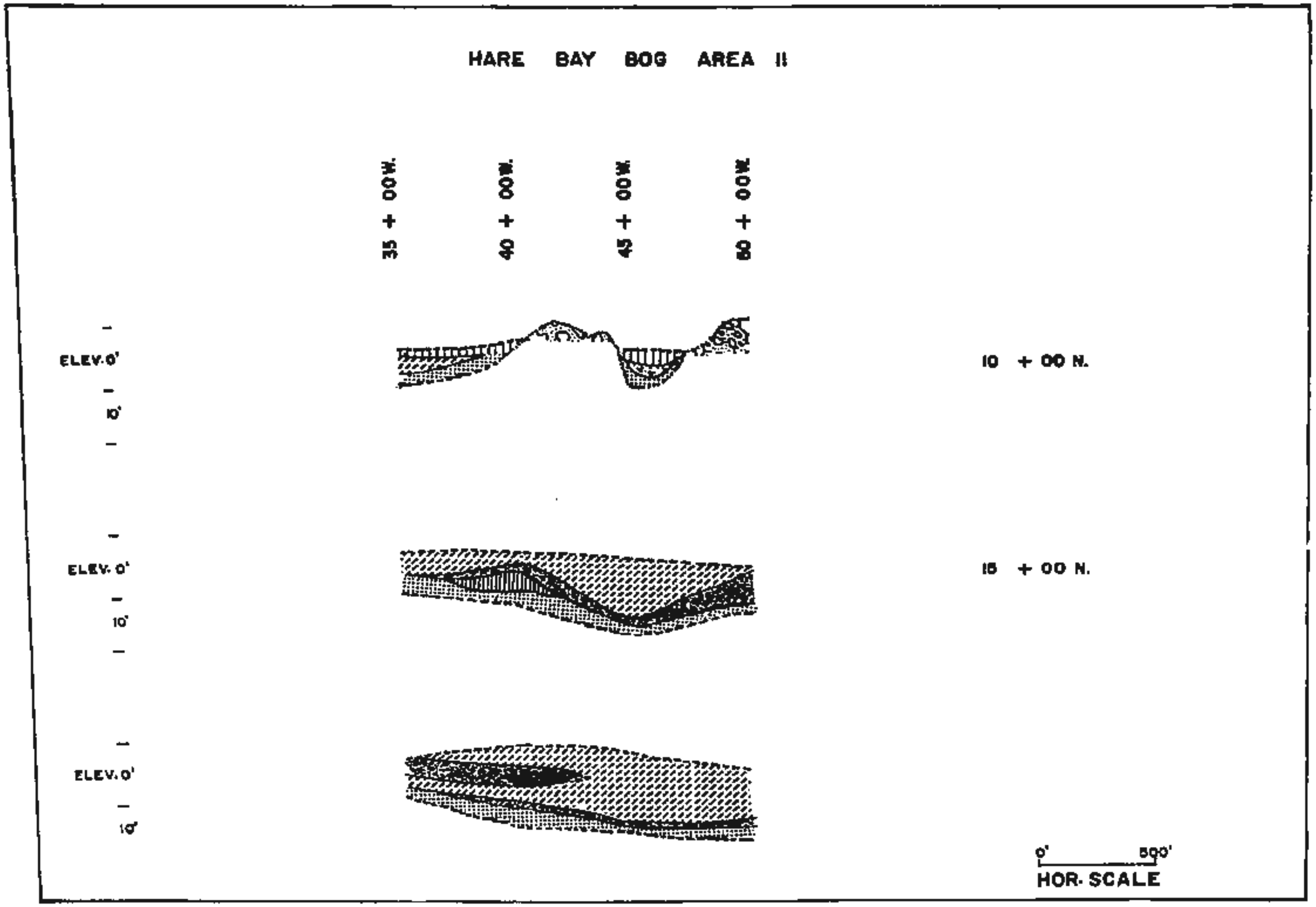

Figure xxviii. Cross section of Hare Bay Bog (138). In 10+00N there is some woody peat. Also <u>Sphagnum</u> (H1-3) is found beneath sedge peat.

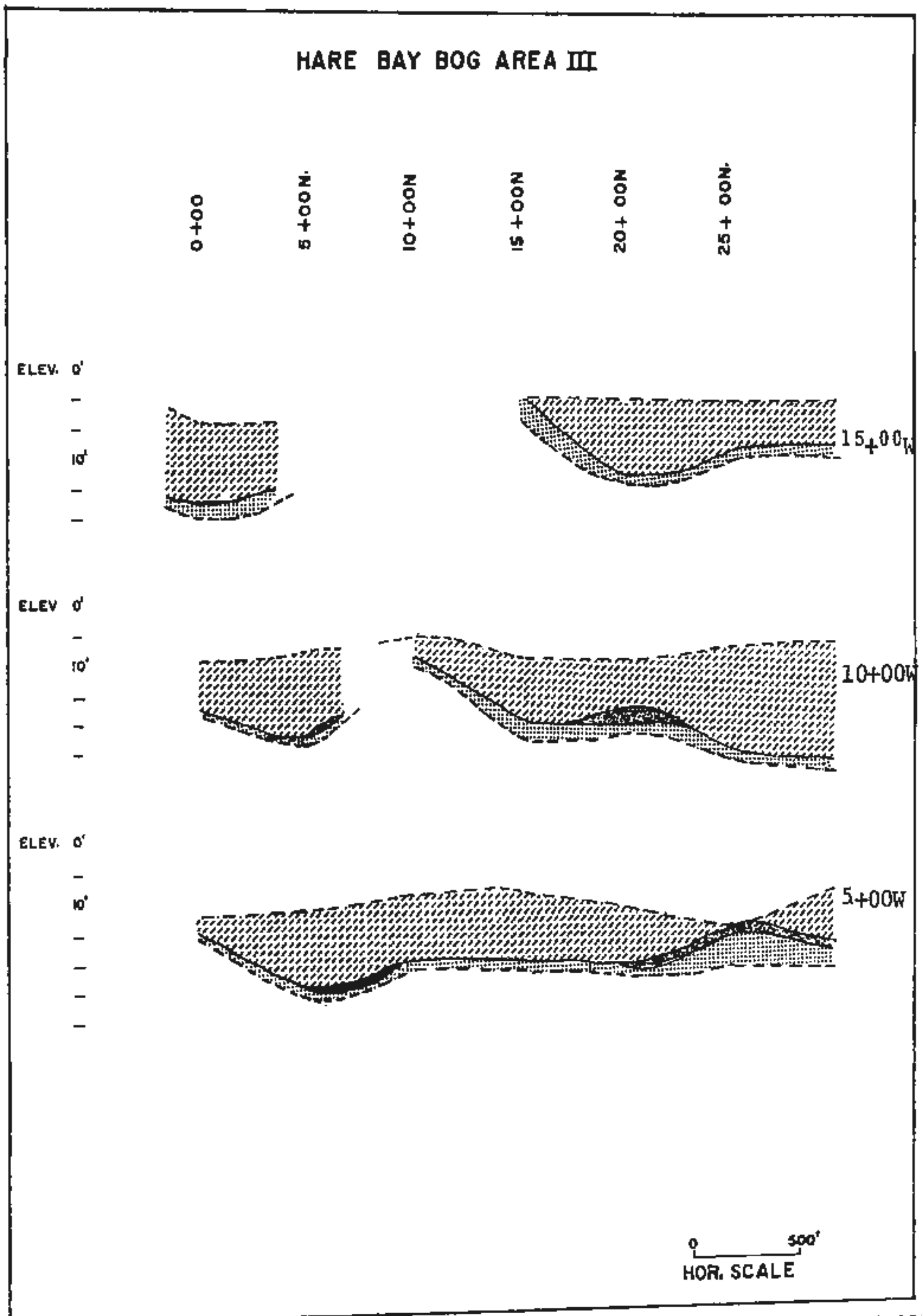

Figure xxix. Cross-section through raised centers on Hare Bay Bog (138). There are substantial thicknesses of Sphagnum (H1-3).

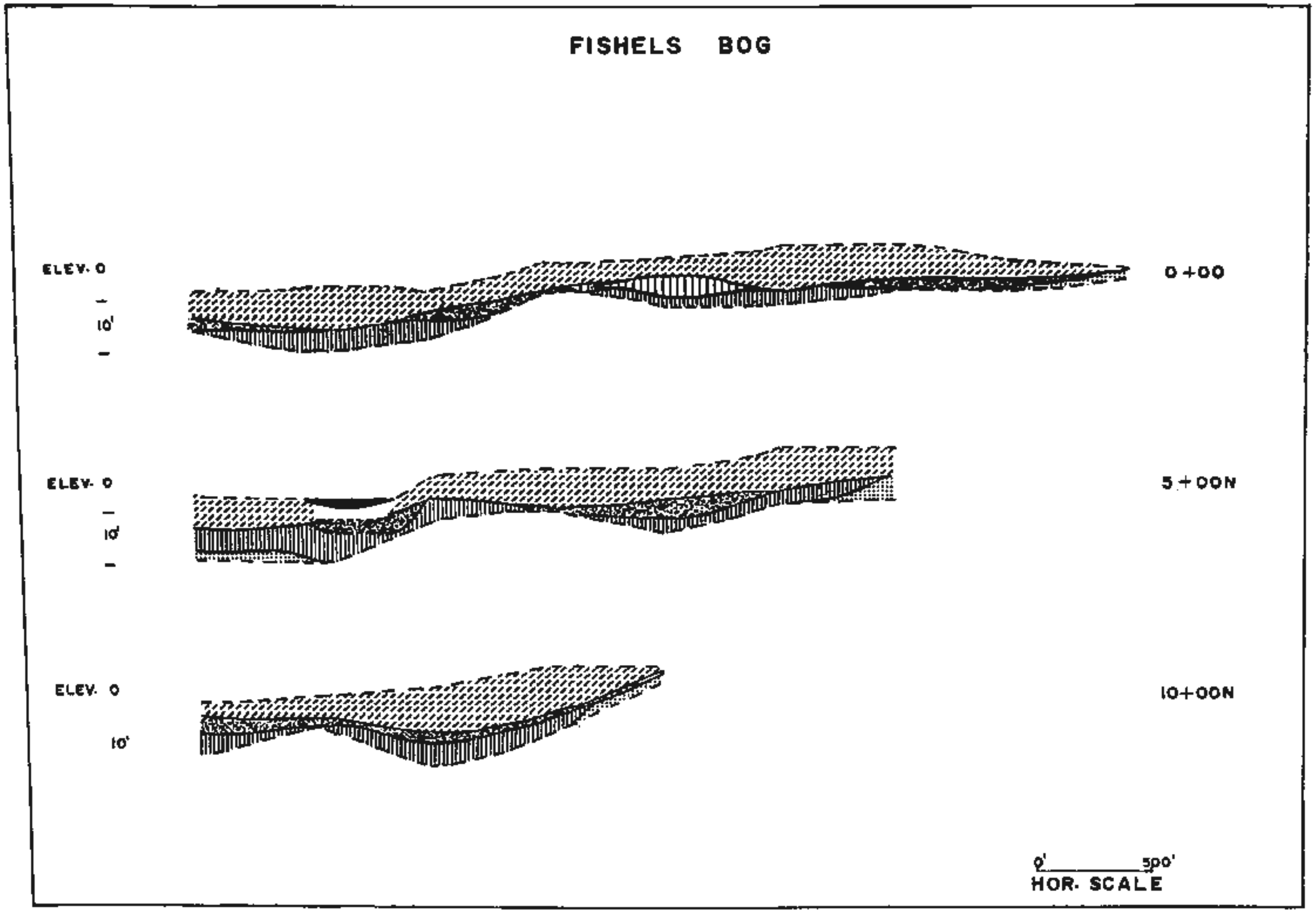

Figure xxx. Profiles of a blanket bog (158) found on the west coast. It can be seen that the surface and bottom contours are similar.

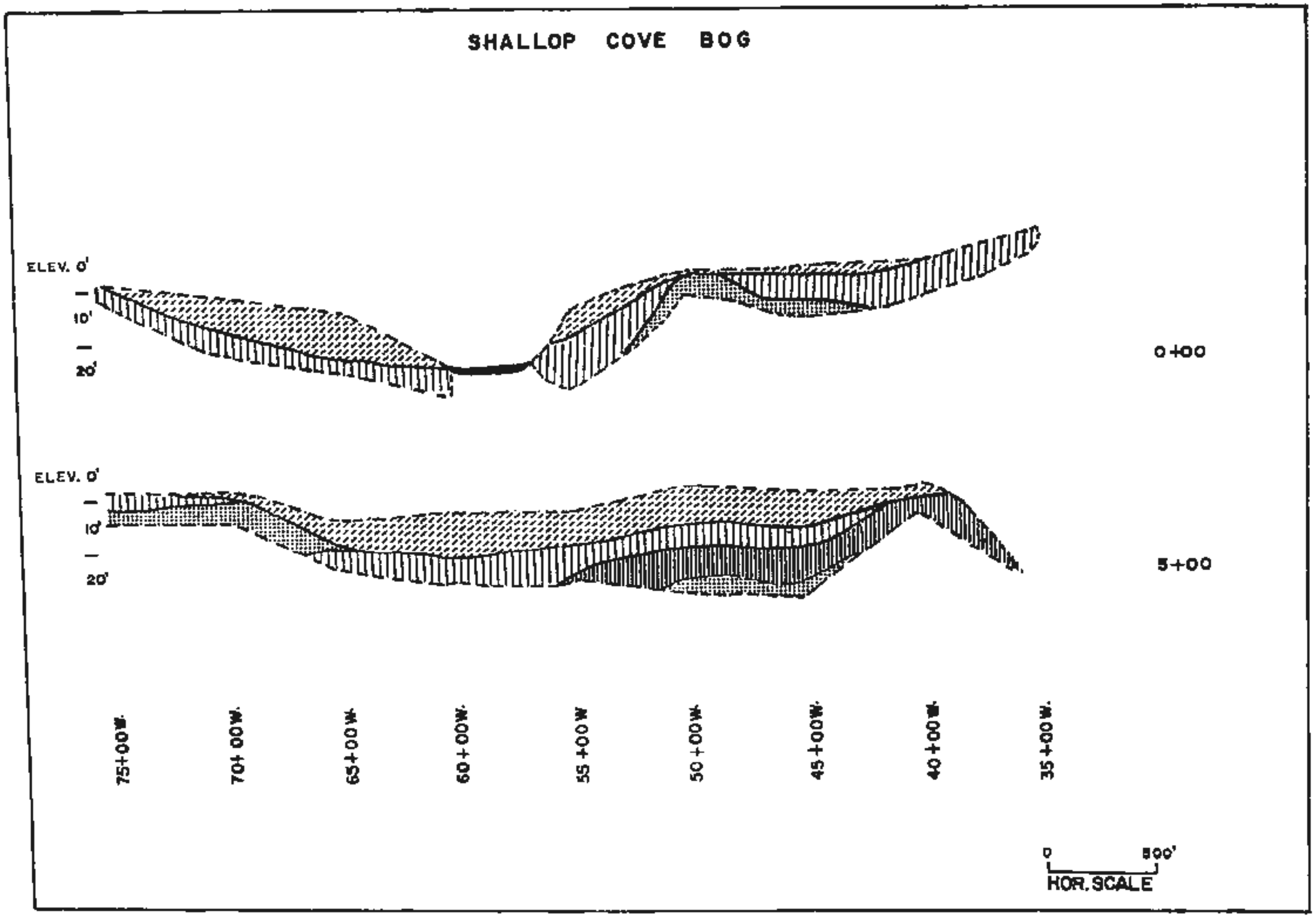

Figure xxxi. Sections of an ombrotrophic blanket bog (150) near St. George's. The thicknesses of sedge peat are much greater than those found in bogs of Region IV.

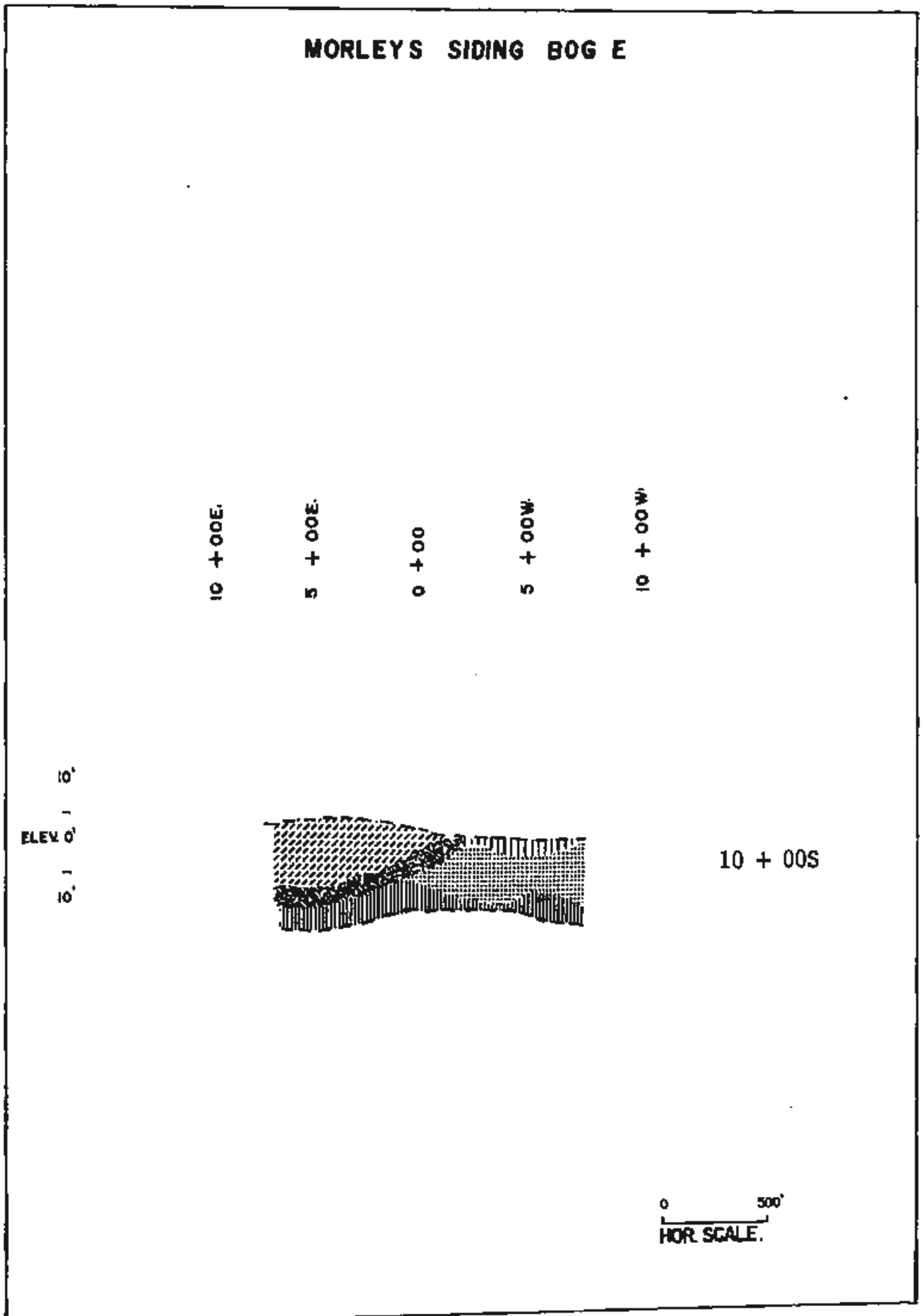

Figure xxxii. Section of Morley's Siding Bog E (130). There is a raised Sphagnum surface, with sedges and humified peat (H6+) dominating toward the mineral soil.