A PROGRAM FOR THE DEVELOPMENT OF PEATLAND FORESTRY RESEARCH IN NEWFOUNDLAND

by
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FOREST RESEARCH LABORATORY
ST. JOHN'S, NEWFOUNDLAND
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INTRODUCTION

Peatland forestry research is a relatively new field in Newfoundland. Interest has been stimulated by developments in European countries where great strides have been made in the utilization of organic soils for forestry purposes. Finland is probably the leading country in this respect and has reclaimed some 2.5 million acres of bogland.

Newfoundland has 5 to 6 million acres of boglands and preliminary surveys (Heikurainen 1968) indicate that many have a high degree of ecological similarity with those in parts of Finland which have been reclaimed for forestry. However before commitments at the operational level can be justified intensive ecological and economic studies, as well as drainage and plantation trials, will be required to determine the feasibility of reclaiming various boglands. The Forestry Branch, Department of Fisheries and Forestry, is the most appropriate agency to undertake these investigations, a viewpoint which has been supported by the Regional Advisory Committee. Therefore in 1968 an interdisciplinary research team was formed to examine peatlands in Newfoundland and determine their probable economic uses (see Appendix I). Plans have not as yet been made for an economic input into the program. However, as soon as some of the preliminary ecological results become available economic aspects will be included.

This report outlines the preliminary program development while realizing that modifications will be required as results are obtained. Specific objectives and time involved to achieve stated goals are stressed (see Appendix II).

PEATLAND RESEARCH AND ITS RELEVANCE TO CANADA

Peatland research had its modest beginnings, more than 300 years ago, in Ireland, Germany and the Netherlands. Since then many countries have developed this resource and over the last fifty years the Scandinavian countries and the U.S.S.R. have forged ahead as world leaders. Peatland studies in the United States, although recently begun, are rapidly reaching the scientific level attained in western Europe.

A rough estimate places the area of peatland in the world at 350 million acres, distributed primarily over ten countries. The figures listed for both Canada and the United States are considered to be conservative.

Country	Area (Millions of Acres)
U.S.S.R.	146.5
Canada	90.0
Finland	24.0
U.S.A. (without Alaska)	20.0
Germany	8.5
Sweden	8.0
Great Britain	6.0
Poland	5.5
Ireland	2.5
Norway	2.0

One of the greatest uses of peatlands in Canada is for the production of peat moss. This industry operates in most parts of Canada (except Newfoundland) and its development has been brought about mainly because of the vast ready

markets in the United States. The peat production industry is economically sound and is expanding at a steady pace. Because of the abundance of fertile mineral soil in Canada peatland forestry and peatland agriculture (except in a few local areas) have not been developed to any extent. In Newfoundland mineral soils suitable for agricultural purposes are in short supply but there are some 5 to 6 million acres of peatlands. As a result an extensive research program has been underway in the province for a number of years to determine the feasibility of using peatlands for agriculture.

Responsible persons in industry and research are beginning to wonder if present forest and agricultural resources can effectively meet the increased demands of the future. One possibility to help alleviate anticipated shortages may be to increase the productivity of present marginal and non-productive lands. Looking at production from peatlands in Northern Europe and the United States it can be seen Canada's peatland is a valuable natural resource which has too long been neglected.

PEATLAND RESEARCH IN NEWFOUNDLAND

The first mention of using peatland for agriculture was noted in 1886 when James Howley, reporting on a Geological Survey, stated that "a large portion of the country hitherto looked upon as useless marsh and swamp could, by a judicious system of drainage, be converted into the very best hay growing lands" (Anon. 1955a). In the report of the Royal Commission on Agriculture (Anon. 1955a) the many problems involved in using peatland were discussed and recommendations presented. In 1956 Aasulv Loddesol, a director of the Norwegian Bog Association, was employed by the Newfoundland Government to report on the potential utilization of the bogs in the province. He recommended that 'services now provided by the Canada Experimental Farm be extended to include experiments on bog soils. Preferably, such

experiments should be concentrated at a substation which possibly could be placed at Colinet --'. This substation was established at Colinet and experimentation has now been conducted for more than ten years.

Investigations have shown that when properly drained, limed and fertilized, these lands can be very productive, especially when planted to forage crops and vegetables (Rayment and Chancey, 1966). Rayment and Chancey stated that 'if Newfoundland succeeds, the other provinces of Canada will look to their own peat resources. If there is failure or only partial success then peat soils will await a later day when pressure of world food requirements demand their utilization'.

Research into peat moss potential has been conducted by the Mines Branch, Department of Mines, Agriculture and Resources, Newfoundland. This work has now been completed and compiled in the publication 'The Peat Resources of Newfoundland' (Pollett, in press). This study shows that peat deposits on the island have the physical requirement to support the industry, and with favorable transportation costs the peat moss industry should become viable.

The Royal Commission on Forestry (Anon. 1955b) discussed the possibilities of using peatland for forestry purposes. The report stated that this was not economically feasible at the time but that population increases and rising pressure of land use would eventually make bog drainage for forestry an economic proposition. In 1966 Bowaters employed Mr. J.A.B. MacDonald, a former conservator for S. Scotland in the U.K. Forestry Commission, to investigate the potential use of peatland for forestry. As a result of MacDonald's recommendations five acres of open blanket bog were ploughed in 1966 for various fertilizing and ditching trials, and the following summer another 25-30 acres were ploughed on a similar bog. In the autumn of 1967, Dr. Leo Heikurainen, Director of Peatland Forestry,

Helsinki, Finland, was engaged by the Canadian Department of Forestry for six weeks to establish a preliminary peatland classification which would be applicable to forestry and to report on the potential of Newfoundland's peatlands for forestry use. Dr. Heikurainen cautioned that while potentially good peatland sites are available in Newfoundland, more information is required on many biological silvicultural and technical questions before forest drainage activity can be put into practice.

FUTURE PEATLAND FORESTRY RESEARCH IN NEWFOUNDLAND

The feasibility of peatland afforestation in Newfoundland and its potential benefit to the economy can only be determined by a long-term and detailed research program. To this purpose this multidisciplinary research team has been set up with a study program extending over a period of 5-10 years through a progression of interrelated steps. To attempt any afforestation of peatlands without knowledge of site suitability or the best methods of site preparation would constitute only a 'hit or miss' approach with little understanding of the significance of the end results. Before attempting a planting program it is essential to learn as much as possible about those environmental factors that might influence the growth of particular tree species. Factors which constitute the most important characteristics of the sites must be examined and measured. Computer programming can then relate the data to site and hopefully trends will establish the significance of particular characteristics.

Once significant characteristics have been determined practical means must be developed for using them to delineate and classify potentially good areas. Drainage work and plantation trials can then proceed. Along with this work ecological studies must be maintained and developed to obtain an understanding of and to explain developments.

The program will follow a sequence similar to that in the flow chart (Figure 1).

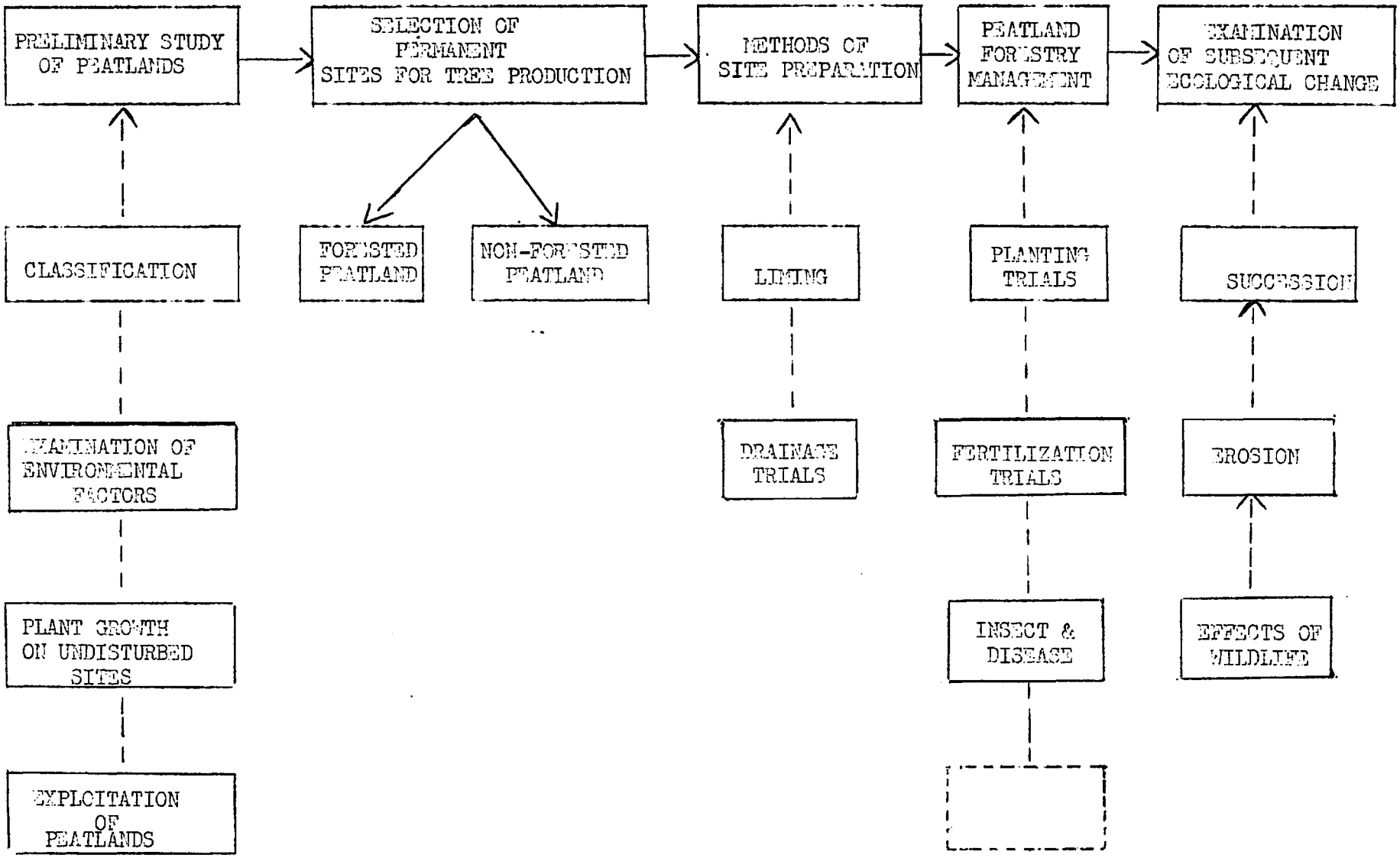

Figure 1. Sequence of steps for peatland research in Newfoundland.

Phase I:

Phase one involves the preliminary study of peatlands through investigation of selected factors leading to site assessment. There is a need for a capability classification and mapping approach in peatland research which is applicable to multiple use, involving the fields of forestry, agriculture and peat moss production. Such a classification should have the flexibility of use by the industrialist as well as the academic.

Much of the information required for development of such a classification will be derived from ecological investigations presently being conducted. Criteria must be established to enable identification of broad capability classes. The primary criteria are vegetative composition of both the current growth and peat, and the nutrient status of the peat. Based on these factors a number of peatland types have already been identified and placed in a framework of a preliminary classification (Heikurainen 1968). This work requires strengthening because of the small number of plots examined and the few peat samples analysed. Also, yet to be examined are a number of environmental factors which appear to be closely related to floristic composition and nutrient status and comprise an integral part of a detailed site assessment. For example, the nutrient supply of a peat deposit, as well as the degree of decomposition, are greatly influenced by the hydrological characteristics which are in turn functions of topography, morphology, climate, surrounding soil, and bedrock geology. Emphasis is placed on both total and available nutrients stressing nitrogen, potassium, phosphorus, calcium and magnesium content. Also the plant communities; pH; thickness, humification and botanical constituents of the peat types as well as surface elevations, total peat depth; water table, field capacity and evapotranspiration will be examined.

These site factors will be then related, where possible, to capacity for forestry. Plots of one-tenth acre will be chosen on various peat types and the four dominant trees of a species measured for height, diameter, breast height and age at breast height. The height attained by the dominant trees of a single species at age 50 years will be used as an index of site quality. These indices will indicate the relationship between productivity and the environmental factors influencing the ecosystem. This aspect of the programme will be associated with closely related projects being conducted presently on site productivity of forest soils.

These site factors will also be related to agriculture and peat moss industries. From a survey of literature peatland characteristics generally considered favorable for each mode of utilization were obtained. Some of these are depth, decomposition, vegetative cover, open water, slope, nutrient status and water table. Also climatic factors, especially wind, precipitation and lengths of growing season are important. Accessibility is also necessary especially for agricultural or peat moss use. The requirements for peat moss exploitation are clearly defined. The peat layer should average more than six feet deep over an area of 75 acres or greater. The peat layer must be relatively undecomposed consisting almost wholly of Sphagnum moss to an average of four feet. This peat should be uniform in texture and surface. The deposit should have a slope to facilitate drainage as well as a vegetative cover which can be easily removed from the underlying peat. To be economically viable the peat deposit should be accessible and near main transportation routes. If possible areas chosen for the industry should not be in areas with high rainfall which will hinder air drying. Only raised bogs or deep blanket bogs could possibly support peat moss utilization.

Characteristics of peatland which may favor forestry and agriculture are radically different. The more flexible of these is agriculture which, because of the required heavy fertilization, can be established on almost any large fairly level accessible bog. Such bogs should slope toward the sides, have little open water and a uniform low vegetation. Factors believed to be important in peatland forestry are shallowness of the peat, state of decomposition, level of N, P, K, protection from direct winds, especially in eastern regions, and length of growing season.

Associated with these ecological studies will be a determination of the application of photo-interpretation in identifying the peatland types. Physical features such as morphology, pond and vegetational patterns and drainage can be determined through photo-interpretation. In many cases it may be possible to associate these characteristics with the nutrient status, depth and subsurface characteristics of various peatland types.

Also related to the preliminary study of peatlands is the examination of the growth and development of plants on undisturbed sites. This work will primarily involve the development of roots of trees on a number of peatland sites ranging from extremely poor to rich in nutrients. The study will attempt to relate this development with site factors obtained.

The scope of this program will require investigation of many plots distributed throughout the island. In addition permanent study plots will be chosen which are relatively free from disturbance by fire or previous drainage, accessible, and exhibiting large and abrupt variations in site. Such an area is termed 'peatland complex', that is, a continuous tract of peatland consisting of a number of types throughout the continuum from nutrient poor to nutrient rich, from open to forested and from deep peat to shallow peat over mineral soil.

The main advantage of such sites is that comparable studies can be conducted on a number of variable sites within one area under similar climatic conditions. These 'complexes' should be chosen in different parts of the island under different climatic conditions which would enable comparisons to be made with similar sites within various environments. This season (1968) one peatland complex near Badger, in central Newfoundland, will be examined thoroughly, and a second area to be located on the Avalon Peninsula will be used for continuous studies on temperature, nutrition, macro-climatic conditions and hydrology.

A comprehensive classification should be established within three years, however, with the acquisition of ecological data, as the program progresses, certain revisions or additions may be necessary. This initial phase of the project should be beneficial to planned multiple use of Newfoundland peat resources. Progress reports and a publication should be completed at the end of this phase.

Phase II:

The selection of permanent sites for tree production is not necessarily a long term project but is important enough to be an individual step within the overall program. These sites will be chosen from the peatland complexes and other bogs and fens which have been examined and classified during phase one. This selection will include both forested and non-forested peatlands as well as peatlands ranging from poor to rich in available nutrients. The areas should be readily accessible and large enough for expanded trials if required. This selection will be made in the summer of 1970 so that site preparation can begin on a small scale during the fall season. The responsibility of site selection will be a function of those members of the team actively involved with classification following consultation with other members involved with practical trials.

Phase III:

Site preparation will begin in the fall of 1970 on a small scale. This will involve drainage of peatland areas already forested, but with growth impaired by water-logging of the soil caused by a shallow peat layer. Generally these areas are often composed of old stands past their most rapid growth stage. Some areas do, however, have large stands capable of showing increased growth rates with proper drainage.

Partially or non-forested peatland will require liming the year previous to drainage. In general peat soils are acidic, water-logged, and poor in nutrients. The latter will be examined through proper analysis and improved with appropriate fertilization trials. Acidity and water-logging are to be tackled first. The more oligotrophic peatland sites have a pH of 3.5 - 4.0 and to improve this condition liming is required which will hopefully raise the pH and increase the amount of exchangeable calcium. This liming preparation will be mainly restricted to these nutrient poor sites; however, one or two richer areas will also be treated for comparative results.

Before planting peatland must be drained. Drainage is necessary to increase aeration of the soil, which in turn will accelerate microbiological activity and rate of decomposition. These trials will depend largely on data obtained on hydrology, morphology, and topography in and about the peatland complex. The rate of drainage will be effected by ditch spacing, ditch depth, slope and type of peat. Drains will be constructed according to patterns suggested by Heikurainen (see Appendix III). He stated that the ditch spacing has a greater influence on the water economy of the soil than does ditch depth. According to Heikurainen's recommendations a series of ditches at 30, 60 and 120 feet spacing would yield most informative results. From these trials the water economy of various peat

types may be ascertained within the peat complex, and comparisons between peat types under different climatic conditions can also be made. This involves a detailed study of peatland hydrology including field capacity, evapotranspiration and run-off from both virgin and drained peats. The inclusion of many peatland sites in various parts of the island will increase complexity of correlating data. An attempt will be made to keep the number of sites drained at a workable number.

Drainage trials on non-forested peatland will begin in the spring following site preparation (liming). This will include plots on oligotrophic and mesotrophic bog as well as mesotrophic fen. Further areas will be drained in the following year at Badger and in subsequent years in western and eastern Newfoundland. The types of peatland to be ploughed and the appropriate areas will be ascertained from data obtained over the next two field seasons in western and eastern regions.

Equipment required to carry out this drainage will have to be procured. This aspect of the projects would be a function of the Liaison and Service Section of this department. Ditching on open deep peat can be accomplished using the disc-ditcher designed by J.V. Healy, specialist in peat bog engineering now with the Provincial Department of Agriculture. This plough has been used extensively throughout Newfoundland. At present the plough used is the one-furrow Parkgate plough. There is also a possibility that a Cuthbertson plough could also be obtained from the Federal Department of Agriculture. Heikurainen recommends that the Cuthbertson plough be mounted to a double furrow plough. For shallow peats backhoes such as the Wain-Roy by International and Hyster by Caterpillar are recommended. The important factors are durability, speed and a power arm with a swing through 180°. According to Heikurainen the scoop

required for forest ditches could be made or bought from Finland. This equipment should be quite suitable for the initial pilot plots. For large scale forest drainage a heavy ditching plough such as the Finnish Lokomo plough should be valuable.

Phase IV:

Both fertilizing and planting trials should begin immediately following drainage of a particular site (see Appendix IV).

Peatlands are often low in nutrient content especially in the major elements N, P, and K. It is proposed that layouts using the proven method of factorial N, P, K applications should provide the necessary information on optimal application rates. This will be conducted in consultation with Dr. N. Bhure. These applications will begin on a small scale at Badger, 1970, with larger layouts in years up to 1973. These treatments will be applied to three principal trial areas - open peatland drained, forested areas drained, open peatland undrained. Both selection and concentrations of fertilizers will be determined after careful review of results from other countries and in consultation with local researchers experimenting with fertilizers on peatland.

Planting trials will follow recommendations by Heikurainen emphasizing the turf planting method. The technique used is simple. It involves a network of open drains with peat spread to provide mounds 6-9" high in which seedlings are planted. The seedlings are set in notches cut from the sides of the mounds. This procedure has been carried out in Bowaters' drainage experiments on the west coast. For comparable data seedlings should also be planted in unprepared surfaces and in both high and shallow mounds using other planting methods and positions. The number of possible combinations is large and proper trial selection will require additional planning.

The species of tree best suited to treated peatland in Newfoundland is not known. In natural wet sites throughout the island black spruce is most abundant, but other tree spp. will also be used in the trials. The Tree Biology section of the department will supply the necessary seedlings of sitka spruce (Picea sitchensis) and black spruce (Picea mariana); this work will be associated with provenance studies presently being conducted by J. Nicholson. From the Silviculture Section seedlings of Norway spruce (Picea abies), Japanese spruce (Picea jezoensis), red spruce (Picea rubens) and Scots pine (Pinus sylvestris) will be provided. Also lodgepole pine (Pinus contorta) will be used if seedlings are available. Certain hardwood species such as poplar may also be used in the trials. Initially, in 1971, the areas planted will be restricted to small pilot plots at Crooked Bog (Badger). In 1972-75 additional plots will be planted including areas in west-central and eastern Newfoundland.

With the establishment of these plantations management will require services of the Insect and Disease Survey to assess related entomological and pathological problems, and to examine these factors with relation to site. This may lead to discovery of problems which will require services of the Entomology and Pathology section of the department.

Phase V:

Research in ecological change will be conducted both during and after drainage and planting trials. The mineral regime in the peat is expected to change with drainage and fertilization. The rate of decomposition should be increased and the structure of the upper layers altered through drying and compaction. The species composition of the vegetational communities as well as insect and animal population is also expected to be affected resulting in new successions. Changes in hydrology and its effect on nutrient cycling will be also examined.

Such an ecological study would continue for a number of years with detailed examination of the interrelationships between peat deposit, tree growth and the surrounding environment. For example, the changes in water economy will affect the natural processes of paludification (peatland expansion) and this breakdown over a long period may lead to the encroachment of trees from the edge of the peat deposit. Peat erosion also may result from these changes.

Included with this change in the ecosystem new habitats will be made through subsequent plant succession. Accompanying this plant succession will be a change in wildlife populations. An attempt will be made to involve researchers in this field to examine this aspect and to note the effects on the plantations.

The data obtained from this research will be presented in the form of preliminary reports, available on an annual basis. Detailed annual plans will also be given. It is hoped that a number of joint publications will result from this work, with the material being applicable to other peatland areas and to the large areas of forest on water-logged soils. On completion of this project enough data on the feasibility of peatland afforestation should be available for industry and provincial authorities who may be interested in continuation of the work on a large scale.

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APPENDIX 1

Members of Peatland Research Team

F.C. POLLETT - Peatland ecologist, co-ordinator of the peatland research problem and involved primarily in examining ecological factors in peatlands leading to their classification and probable utilization.

DR. D. BAJZAK - Photogrammetrist, primarily involved with interpretation of peatlands through aerial photography.

DR. J.S. YORKE - Physiologist, examination of growth and development of trees on natural peatland sites as well as consultant on tree species selection.

J. NICHOLSON - Forest genetist, involved in selection and procurement of trial species; also will conduct provenance testing on peatlands.

P. HALL - Silviculturist, selection of tree species for trials, determination of planting methods and plantation management.

DR. N. BHURE - Soil chemist, consultant with site preparation and fertilization layout; may also be involved with particular aspects of peatland chemistry.

D. SHARPE - Management and Liaison, involved with establishment of drainage trials; procurement of afforestation equipment.

L. WARREN - Consultant with Insect and Disease Survey.

Also required will be a pedologist to examine soils in relation to peat type and to study morphology of peats, this study may be conducted by R. Wells of the Soils Section of this department. Consultants will also be sought from the Federal and Provincial Departments of Agriculture and the Federal Department of Wildlife. Other fields in which aid will be requested are economics and statistics. Hopefully this aid will be provided by federal services in Ottawa.

APPENDIX II

Tentative schedule of events in development of a multi-disciplinary program of research in peatlands in Newfoundland.

1968-1970

Work will be mainly confined to the examination of environmental factors with relation to the classification of peatlands for industrial purposes. This will involve ecological examination of hydrology, morphology, physiographic processes, -------. By 1970 sufficient information will be available for publication (investigator - F.C. Pollett).

Work will also begin to determine the applicability of aerial interpretation to peatlands and its possible use for large scale classification. A report and publication should be available on this aspect by 1970, (investigator - D. Bajzak).

Examination of trees with particular reference to their growth and development on natural peatlands will be started. This work will subsequently be related to data obtained from later examination of plantations. A preliminary report is expected in 1968 with further reports and a publication to follow (investigator - J.S. Yorke).

Once plans have tentative approval, other agencies, such as the Federal Department of Agriculture who are actively concerned with peatlands, will be invited to participate. This should prevent overlap of effort and also lay ground work for possible inter-agency co-operation and participation. Other disciplines not currently involved in the problem will be kept informed so they may participate as needed at some later date.

1970-1971

During this period work will begin on a small scale on the manipulation of peatlands.

(i) Open Peatlands:

This will be chosen in 1970 and small areas prepared by liming (Investigator - Pollett with consultant - Bhure).

In 1971 drainage will begin in chosen area (Co-operator - Sharpe with consultants - Hall and Pollett). To accomplish this arrangement an acquisition of equipment will have to be made and estimates of cost put in 1970-71 budget.

In 1971 small afforestation trials will be initiated on drained and undrained sites. (Investigators - Hall, Nicholson and Yorke).

In 1971 accompanying the afforestation trials will be fertilization trials carried out in consultation with N. Bhure and co-operation of D. Sharpe. (Investigator - F.C. Pollett).

(ii) Forested Peatlands:

By 1970 or 1971 areas of forested peatland will be obtained and possibly fertilized. (Investigators - P. Hall, F. Pollett; co-operator - D. Sharpe). Over these areas the study of ecological changes (Pollett) and tree growth (Hall) will be studied.

1972-1975

During this period a series of operational trials will be established to determine effectiveness of different drainage trials, equipment, planting trials, etc., in various sites. The performance of plantations and effect of various fertilizers will be examined. This will result in a number of projects involving all members of the research team. Also throughout the program the Insect and

Disease Survey (consultant - Warren) will be responsible for survey to determine presence of any pests and to recommend remedial action.

1971 -----

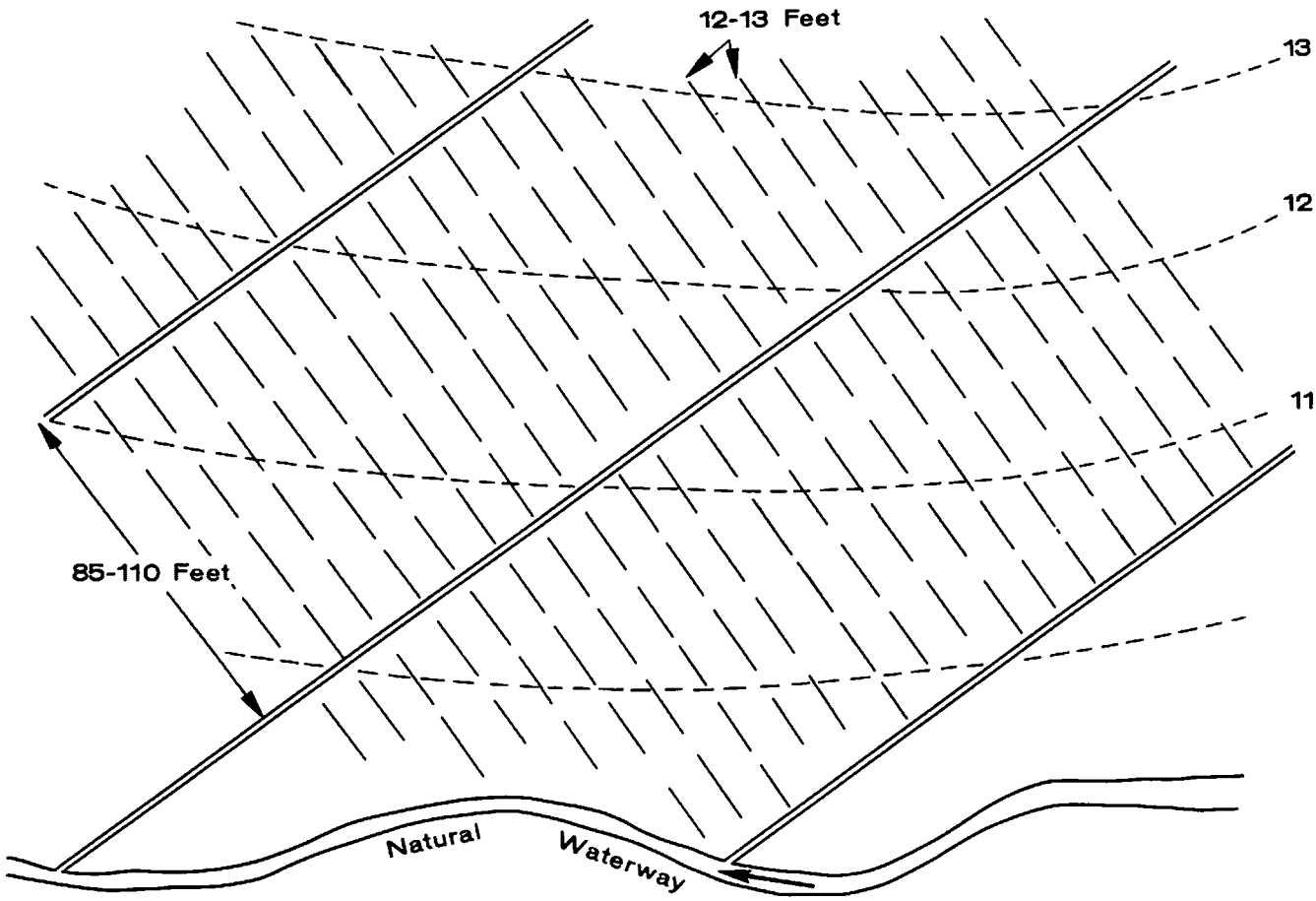
A study of subsequent ecological change due to afforestation trials will be undertaken and plant succession, peat erosion, mineral regime as well as energy flow will be examined.

It should be noted that the above schedule is tentative and may be changed depending upon findings as the program develops.

APPENDIX III

Proposed ditching systems for drainage of Newfoundland peat deposits for forestry (Heikurainen, 1968)

PROPOSAL FOR DITCHING SYSTEM IN OPEN BOGS AND FENS

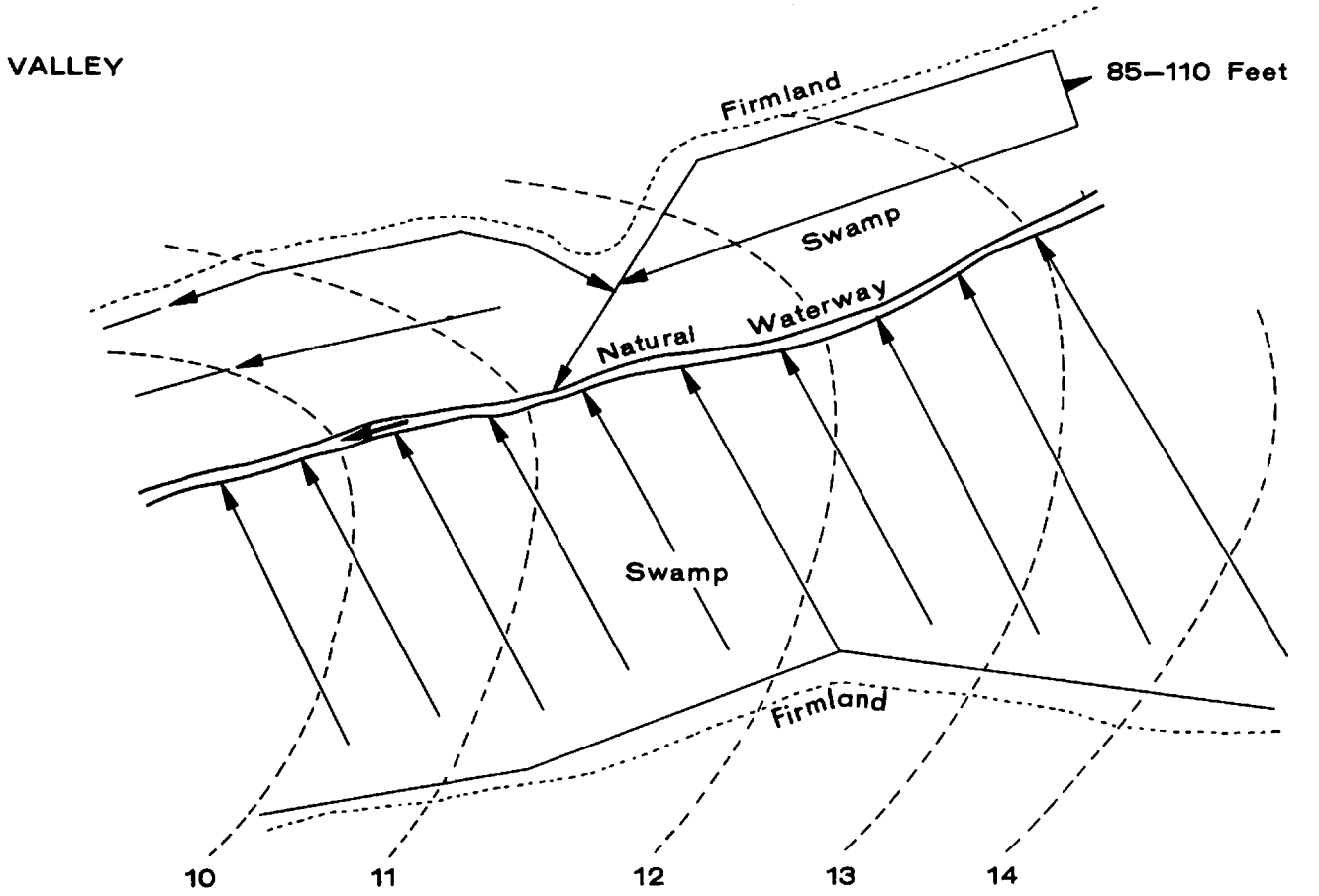


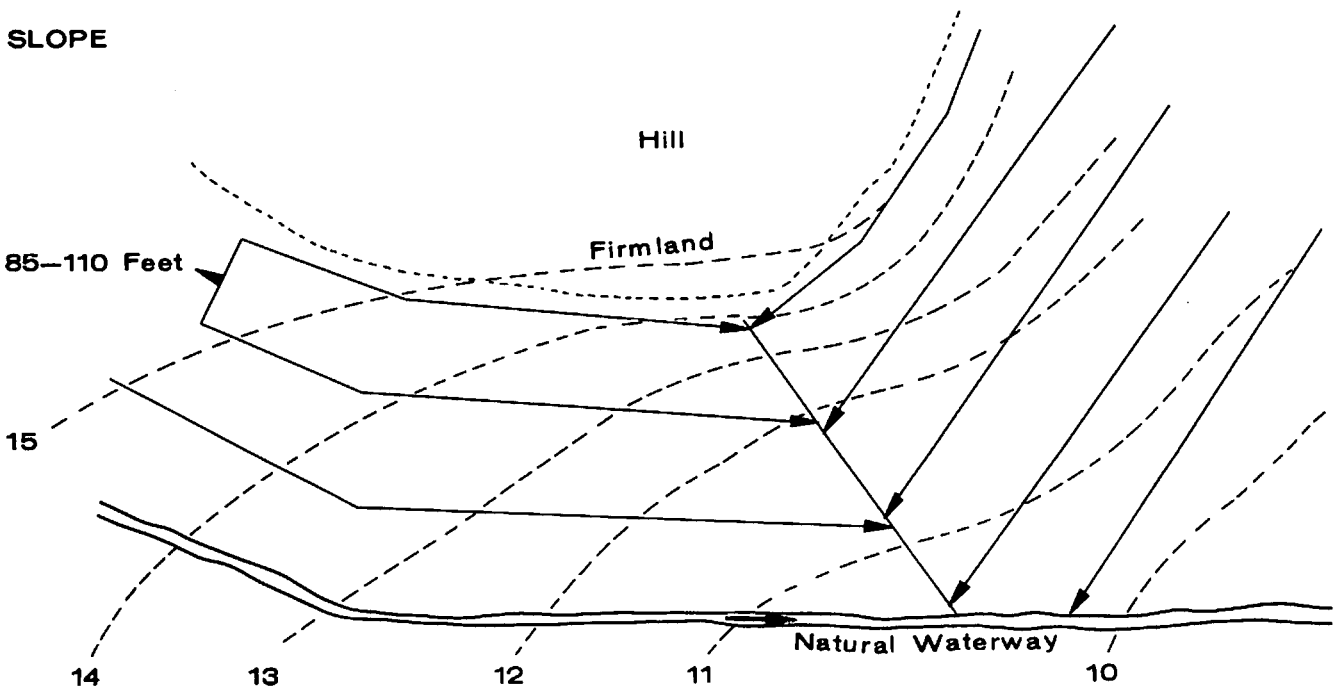
- - - - - - - - - 10 Contour line

—— —— —— Shallow ditch made by planting plough, depth in feet on both sides planting turfs.

═══════ Ordinary drainage ditch (lateral-ditch), made by ditchingplough, type of Lokomo, or by power excavator (back hoe) with special designal scoop, depth 2, 5-3, 0 Feet, with almost semicircle as a cross section.

PROPOSAL FOR DITCHING SYSTEM IN TREE SWAMPS





All ditches are made by ditchingplough, type of Lokomo, or by power excavator (back hoe), depth 2, 5 feet, with almost semicircle as a cross section.

APPENDIX IV

Peatlands and afforestation site in Newfoundland

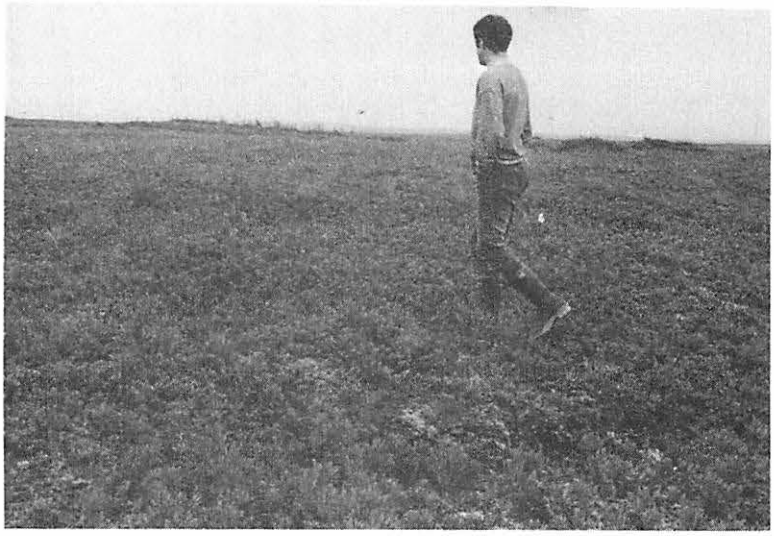


Fig. 1. Large ombrotrophic dwarf shrub bog on west coast of Newfoundland. Some bogs are more than 10 miles long.

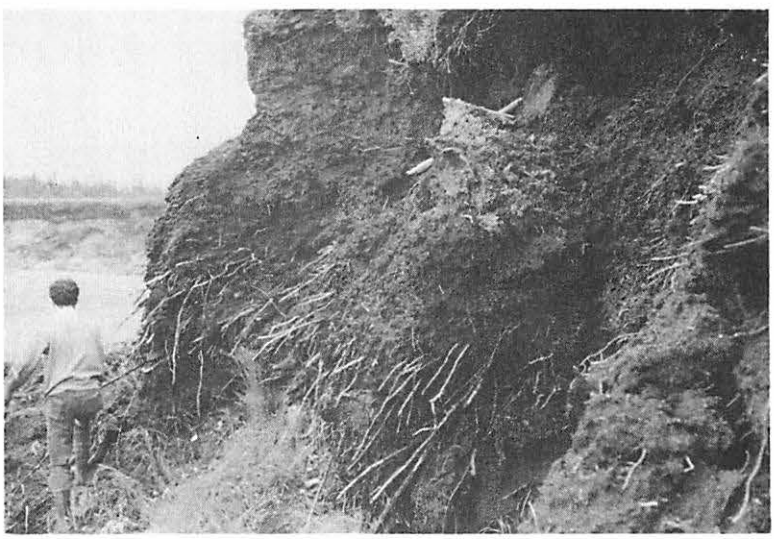


Fig. 2. Section cut through ombrotrophic bog. Note the lower woody layer which indicates that the bog succeeded earlier fen conditions.

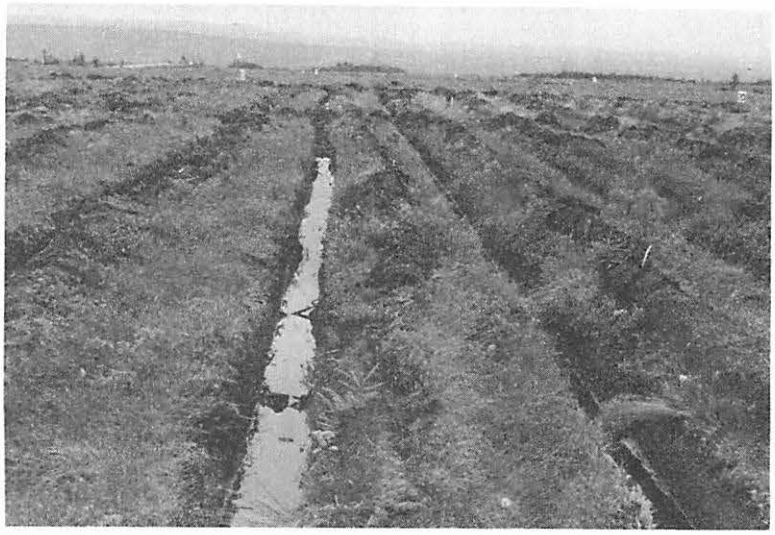


Fig. 3. Afforestation site established by Bowaters on the west coast in 1966.

Fig. 4. Seedlings from above site. On the left a birch seedling has become established along with the initially planted conifer.

Fig. 5. Study plot in Central Newfoundland is clearly marked along the T.C.H.