



**A PROGRAM FOR THE
DEVELOPMENT OF SITE AND STAND
MANAGEMENT RESEARCH
IN NEWFOUNDLAND**

by
G. Page

**FOREST RESEARCH LABORATORY
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INTRODUCTION

The forthcoming establishment of a third pulp and paper mill on the island of Newfoundland has emphasized the need to ensure optimum use of the relatively limited land and forest resources that are available. Wood using industries will be required to satisfy progressively increasing demands for their products from a progressively smaller share of the forest lands.

The implications are clear. The forest industries will need an assured and regular supply of raw material of the right quality to maintain a high level of production and fulfil their role in the Canadian economy. This supply of material will have to be obtained under more restrictive economic and land-use circumstances, requiring the maintenance of fully-stocked crops of the most desirable species on the more productive sites, and the return to full production of those potentially productive sites which are currently in a non-forested or understocked condition.

More intensive management will be required to achieve these aims. It will be necessary to use the most productive species for the sites concerned and to achieve the maximum timber or fibre production that is economically worthwhile from every site. Detailed knowledge of growth, yield, and stand development of different species in relation to site conditions will become ever more necessary to assist management in making the right decision on such matters as choice of species, ideal stocking levels, and rotation lengths.

In order to provide answers to the problems involved in obtaining optimum production from crop and land resources and at the same time make the most effective use of available research manpower and facilities, a number of

interdisciplinary research teams will be set up in the Newfoundland Region. Each of these teams will be carrying out problem-oriented research on specific topics within its general area of concern. The development of problem-oriented programs is in keeping with Forestry Branch policy, and should enable much more rapid progress to be made in researching specific areas of concern to the wood-using industries. At present, three programs are being developed, concerned with reforestation and afforestation, peatlands, and site and stand management.

The development of the site and stand management research program can be expected to produce important practical benefits. From this program the forest manager should ultimately obtain answers, or the biological basis for answers, to such questions as what yield to expect from a given crop or site type, how best to recognize and delineate different sites as regards their forestry potential, how best to manipulate stands and carry out site amelioration so as to achieve maximum economically-worthwhile production, and what species or provenances to favour on a given site so as to obtain better yields.

The integration into this program of studies in growth and yield, stand development, site evaluation and classification in relation to tree growth, and of methods of increasing site and crop productivity, is necessary to achieve the maximum and most logical utilization of all the results that are obtained in these fields.

This report is, essentially, a preliminary account of the site and stand management research program, containing a brief review of past work in this field in Newfoundland, an outline of the overall purpose and scope of the program, and specific proposals for the future development of existing and new work, together with an approximate time schedule for the phasing of the studies. Such schedules for phasing and development will, of course, be subject to a continual process of review and re-assessment without which the program would rapidly become obsolete.

THE STATUS OF SITE AND STAND MANAGEMENT

RESEARCH IN NEWFOUNDLAND

Several studies on site and stand management have been or are currently being carried out in the region following the establishment of a forest research unit at St. John's in 1950. A majority of these studies are concerned with stand development and treatment and with growth and yield. File or mimeograph reports of establishment and final results have been prepared for those studies now closed, but relatively few of these have been carried through to publication.

Intermediate stand cutting experiments have included various large- and small-scale trials of different cutting methods under varying crop and site conditions. The majority are now closed, but a few areas are still being maintained for long-term remeasurement purposes. Most of the results have been written up in the form of file reports; none have been published to date.

Earlier studies on growth and yield were mostly of a reconnaissance nature, involving such work as the examination of provincial government plantations and of a variety of natural crop conditions in different parts of the island. Subsequent more detailed studies have included the collection of data from hardwood stands for the compilation of birch and poplar volume tables, and the testing of wedge prisms for use in forest inventory. Data collected from permanent sample plots by Price (Nfld.) Ltd. have been used by van Nostrand (1964) for the determination of growth and yield trends for spruce and fir in central Newfoundland. This is a continuing study, with succeeding 10-year remeasurements of the sample plots being used for continued revision of the growth tables.

Between 1960 and 1962 data on the mensurational characteristics of the important forest types (as defined by Damman 1964, 1967) were collected from the four main forest regions of the island. Results have been published for western Newfoundland (Bajzak, Bouzane, and Page, 1968) and compiled in an unpublished

report for central Newfoundland (Bajzak, 1962); material for northern and eastern regions is still in the process of compilation. General purpose site-index curves have also been prepared (Page, 1968) for the four forest regions from these data.

The forest types of the island have been classified by Damman (1964, 1967), and this classification is currently being used (together with additional soil data) as a basis for the land capability for forestry program being carried out, concurrently with the forest inventory program, by the Newfoundland Forest Service. A pilot land classification project involving the recognition and description from aerial photographs and ground surveys of the major features of soil, geology, topography, and vegetation cover is now in progress in western Newfoundland.

More detailed soil and site studies have included investigations of the causes and possible cures for chlorosis in balsam fir, the effects of burning and of different types of vegetation cover on soil properties and profile development, investigations of the nature of seepage soils and podzols, and studies into the characteristics of the so-called acid brown wooded soils (currently in progress). Work is also in progress on the effects of different soil types and fertilizers on seedling growth under greenhouse conditions and on incubation experiments with forest humus. The latter investigations are closely related to trials of the effect of fertilizers on the growth of semi-mature stands which have recently been established (van Nostrand and Bhure, 1968).

Experiments in the use of exposure flags for indicating suitable afforestation sites are fairly well advanced (Nickerson, 1968) although these flags have not as yet been used for indicating the potential productivity of such sites. Work designed to elucidate the interrelationships between soil and topographic conditions and tree growth has recently been started in eastern and western

Newfoundland. This work is designed to provide a means whereby the potential of non-forested sites can be determined, to indicate potentially useful means of site amelioration, and to provide a considerable amount of basic data of use to various other studies. A study has also been carried out on the influence of environmental factors on the development of the root systems of sitka spruce seedlings (Yorke, 1968).

Relatively small-scale provenance trials with species of potential value for increasing productivity were established between 1961 and 1964. Species involved are balsam fir, white spruce, and red spruce. More extensive provenance experiments for black spruce and sitka spruce are due to be established in field trials during the next two years.

FUTURE PROGRAM DEVELOPMENT

GENERAL CONSIDERATIONS

The overall objective of the program will be to develop economically-worthwhile methods of increasing productivity on productive or potentially-productive forest sites in Newfoundland. To fulfil this objective it will be necessary to develop and integrate our knowledge of site and stand conditions and of stand development, and to include in the program studies of techniques in site and stand manipulation.

Initial program development in this area will involve the co-ordination and completion of a number of existing studies and the integrated development of new work to provide answers to specific problems. Some of these problems are already apparent and have been included in the form of specific proposals in this report. Some others are included only as very tentative suggestions for future work, while in some cases a clear understanding of problems and priorities is not yet possible. In this latter case one of the main aims in co-ordinating the completion of existing studies is to provide firm information for the future

allocation of priorities.

As the site and stand management research program develops, the nature of the studies it contains is expected to change. During the first two or three years much of the work will be of a preliminary nature, involving the completion of existing studies and maximum utilization of their data. Later, most of the program can be expected to consist of problem-oriented studies of an interdisciplinary nature.

A number of considerations are of general importance to the development of the complete program. These involve the presentation and publication of results, the use of sound experimental designs and methods of analysis, the integration of the various topics and fields of investigation which together constitute this research program, and the integration of this program with allied programs which involve some of the same research personnel and a number of closely related topics of investigation.

Maximum utilization and publication of research results has not always been achieved in the past, and there is a clear need for reviews of past work or position papers in a number of topics and in some cases for an amalgamation and re-analysis of all pertinent data collected up to the present time. Several such reviews are included in the program for urgent attention prior to the further development of research in the appropriate fields.

The design and analysis of experiments will require careful examination in future. In this program each individual research investigation will be producing results related and of immediate significance to all other parts of the program. It is therefore essential that all investigations be statistically sound and designed to ensure the attainment of objectives. Co-operation and consultation between members of the research team involved with this program and with statisticians from Biometrics Research Services or, ultimately, on

the regional staff, will be necessary to fulfil this requirement. All new projects established as part of this program must be thoroughly examined from this point of view. In addition, in order to commence the program on the most sound basis it will be necessary to review statistical designs and analyses being used in existing studies to ensure that maximum utilization of existing data is achieved.

The need for integration and logical development of allied research projects is obvious and, indeed, constitutes one of the major reasons for the establishment of this research program. Equally necessary, however, is full co-operation and liaison between this program and related programs or other fields of investigation which do not presently form part of any such program. Thus continued liaison will be required with the afforestation and reforestation and peatland programs currently being developed and with the management and liaison, forest insect and disease survey, and possibly later, entomology and pathology sections. Such liaison will mainly be the responsibility of the program leader, with assistance from individual research officers directly involved where necessary.

This program will be dealing primarily with moderate and good sites where wood fibre production has a more assured future than on the waterlogged sites under investigation in the peatland program. Some consideration of the poorer sites, more particularly in regard to site evaluation, is necessary, however, in order to develop a complete picture of stand and site interrelationships. The program will be related both to present management practices and to probable future more intensive management and shorter rotations.

PROBLEMS

Seven problems have so far been recognized and a number of studies are required in each. All the studies listed are considered necessary and of

definite practical value in the light of present information; priorities presently attached to them are listed in a subsequent section of this report (page 23). These priorities will determine work to be carried out during 1969. Beyond that date, schedules are tentative and continued re-examination of the program in the light of new needs and circumstances will be required to confirm or modify schedules as necessary.

Problem 1

Lack of growth and yield tables for even-age crops for the whole of the island of Newfoundland.

One of the most basic requirements of good forest management is a knowledge of the growth trends and expected productivity from existing stands of various ages. Information of this type is available for central Newfoundland, but no other parts of the island are covered at present by practically-applicable data. However, a large amount of data are, or will shortly become, available for most parts of the island, and a major review and analysis of all data on the growth and yield of even-aged crops in Newfoundland will then be possible. The overall purpose of this analysis will be to produce a series of growth and yield tables of direct practical application to all, or each, of the major forest regions of the island. Data will be analyzed mathematically, and tables produced will be of general application within the geographic framework to which they apply. Data presently available are not adequate to permit the construction of refined growth tables for specific site conditions, but later developments in this field are expected to include detailed work on the growth of individual trees and stands in relation to various site and crop factors.

The studies will be carried out in three phases. The first phase will consist of the completion of four existing studies so as to provide data which, together with those already available, will be used in phase two. The four

studies are the central Newfoundland growth and yield study, the study of mensurational characteristics of the major forest types of northern and eastern Newfoundland, a review of the status of the King's Cove woodlot, and the collection of crop data during site evaluation work in eastern and western Newfoundland (see Problem 2, Study 2). Phase two will involve a review and complete mathematical analysis of all suitable data for developing general growth and yield tables for practical application in the major forest types over the whole of the island of Newfoundland. This analysis will also provide an opportunity to re-assess the significance of the forest regions of Newfoundland in relation to crop performance; present boundaries will be recognized only if they are found to coincide with meaningful differences in crop performance. The third phase, which is only tentatively proposed at present, will consist of more detailed investigations of tree and crop growth in relation to site conditions, to develop knowledge of the effects of various vegetation and site factors on stand development and, ultimately, to produce growth data for individual site and/or crop types. This work will require close co-operation with the site evaluation and land classification studies listed under Problem 2 and with the study of superior black spruce trees (Problem 6, Study 6).

Studies in progress or to be undertaken soon are listed below.

Study 1: Brief revision of growth and yield tables for central Newfoundland and publication of report. Detailed revision is not required in view of the later inclusion of the data in the major analysis. (Goal: Completion by fall, 1969). Investigator: R.S. van Nostrand.

Study 2: Completion of analyses and publication of results on the mensurational characteristics of the major forest types of northern and eastern Newfoundland. (Goal: Completion by fall, 1969). Investigator: D. Bajzak.

Study 3: Continuation of thinning and remeasurement cycle and publication of report on the present status of the King's Cove woodlot. (Goal: Completion of report by June, 1969; continuation of thinning cycle until 1971).
Investigator: D. Sharpe.

Study 4: Review and major analysis of all available growth and yield data for even-aged crops in Newfoundland. (Goal: To commence in winter 1969/70).
Investigators: D. Bajzak, R.S. van Nostrand, G. Page.

Study 5: Detailed investigations of interrelationships between tree and stand development and site conditions. (Proposed to commence in 1970).

Problem 2

Lack of information on site factors influencing crop productivity in various parts of Newfoundland.

Many areas of Newfoundland are devoid of any tree growth or carry only scrub or severely understocked crops. Practical forest management has need of some means whereby the potential of these areas as well as of forested areas, can be determined in relation to properly-managed crops of native species. Our aim will be to develop practically-applicable methods of land classification, to determine specific site factors limiting growth, and, ultimately, to investigate significant factors in a more detailed manner so that forest owners can manage their lands to the best advantage.

Three studies are presently in progress. The first, a pilot-scale land classification project in western Newfoundland has, as one of its aims, that of delineating areas each of which is sufficiently homogenous in terms of site and forest conditions as to form a single, recognizable unit. When the basic classification has been drawn up it could, ultimately, be developed one step further into a form of basic management plan for the area, treating each mapped unit as a separate entity requiring certain specific forms of

treatment, and detailing crops, site treatments, rotations, etc. most suitable, on a biological basis, for each unit. Results from growth and yield, stand treatment, and afforestation and reforestation projects would need to be studied in order to achieve this objective. Such a plan could serve as the first step in the development of a more detailed management plan for the Corner Brook watershed (Bowaters Ltd.) or as a blueprint for similar developments by provincial government or company agencies in other parts of the island.

The second study, an investigation of how various soil and topographic factors influence growth, will indicate basic interrelationships between tree growth and site conditions for the development of more detailed studies, provide a means of predicting the growth of native tree species for management or research purposes where this information is required as a reference point against which other treatments or courses of action can be assessed, and indicate site amelioration techniques most likely to be successful in increasing productivity. Site evaluation is, in many ways, basic to almost all branches of forest research. This study should provide a means of interrelating numerous other studies under circumstances which would otherwise prevent their comparison, and is complementary to the land classification project.

Development of a forest soil classification for Newfoundland may be necessary to provide data to tie in with land classification. However, clarification of information available from the agricultural soil survey already in progress and of the special needs of forest soil classification is necessary before any definite proposals can be made in this regard.

The third study has been undertaken to determine whether exposure flags can be used for detecting sites suitable for afforestation purposes. If, as

seems probable, exposure proves to be one of the major factors influencing growth rates in Newfoundland, then further, more detailed work will be necessary to elucidate which of the climatic factors are most directly concerned and how they affect growth, and to develop means whereby their effects might be mitigated.

Any detailed work which may be undertaken to determine the effects of climatic factors on growth will not be started until firm evidence is available from site evaluation studies on the part played by exposure, as compared to soil factors, in limiting tree growth. However, flag data already available need to be correlated with detailed meteorological observations by establishing flags at official meteorological recording sites, such as airports, so as to provide a firmer base for their use. This work will at present be carried out as part of the afforestation and reforestation program.

Studies in progress or to be undertaken soon are listed below.

Study 1: Completion of pilot-scale land classification project and publication of results. (Goal: Completion by March, 1970). Investigator: D. Bajzak.

Study 2: Quantitative site evaluation in eastern and western Newfoundland. (Goal: Completion by fall, 1971; possible later extension to central Newfoundland). Investigator: G. Page.

Study 3: Application of land classification and other data in the development of a basic management plan for the Corner Brook watershed. (Tentative proposal only).

Study 4: Detailed investigations of exposure in relation to tree growth. (Tentative proposal only).

Problem 3

Lack of information for defining and controlling stocking levels to optimise stand productivity.

Studies already discussed are concerned with deriving an understanding of growth trends and of the effects of site conditions on potential for forestry. These are areas of direct concern to practical forest management in the utilization of existing crop and land resources to the best advantage. However, it is also of immediate economic importance to know how existing stands can be treated to obtain economically-worthwhile increases in production. Treatments considered potentially useful at the present time are concerned with defining stocking levels appropriate for various purposes under given site conditions, and with controlling stocking in those stands where it is not currently near the optimum level.

Studies already carried out have been mainly concerned with the effects of various cutting methods on stocking levels and subsequent growth rates. While the studies concerned are now mostly completed, results have not yet been published. Completion of analyses and presentation of results is therefore required as soon as possible. High priority will be given to a study to determine the importance of overstocked stands. This investigation will utilize available forest inventory data for determining the extent and distribution of such stands in Newfoundland.

If, as seems most probable, these initial investigations show the need for further studies and trials, work will be developed along the following, closely interrelated lines. The growth and yield of under-, fully-, and over-stocked mature and semi-mature stands of various ages will be studied as part of the growth and yield investigations (Problem 1). Stocking and stand development in young crops below measurable size may also be studied

for the ultimate development of standards for assessing adequacy of regeneration (this is a tentative proposal at present).

Small-scale trials of potentially useful treatments for overdense stands will be initiated if the survey of dense stands shows them to be a significant problem, and will probably include thinning, fertilizing, and herbicide treatments, together with appropriate cost figures. Physiological investigations will also be carried out simultaneously with these trials to determine how and why stagnation develops in overstocked stands, to obtain information on morphological and physiological characteristics of trees in dense stands, and to derive more basic means whereby the situation might be remedied. Trials in fully- and somewhat under-stocked stands may also be required at a later date if the review of earlier results indicates gaps in our knowledge. If required, and if considered economically worthwhile, the treatments should be closely interrelated with those on overstocked crops, and should also have cost data applied to them.

In view of the fact that most stands will be harvested for pulping all the above studies will be oriented towards relatively short rotation management and high production of wood fibre as well as to current management practices. The effects of the various stand treatments on wood quality will also require investigation as part of harvesting and utilization studies which may be developed in the region at a later date.

Stocking levels and associated productivity in artificially-established stands will become of more importance to forest management as the proportion of such crops increases. Studies in natural crops and in plantations already established will provide partial answers when required. However, in order to obtain representation of a range of stocking levels it is now necessary to establish a limited number of plantation spacing trials. These can most

conveniently be set up as dual purpose trials in conjunction with the second phase of the sitka spruce provenance trials (problem 6).

Studies to be undertaken are listed below.

Study 1: Review and summary of results of intermediate cutting experiments carried out in Newfoundland to date. (Goal: Completion by summer 1969).

Investigators: D.E. Nickerson, R.S. van Nostrand.

Study 2: Survey, assessment of significance, and report on dense stands. (Goal: To commence in summer, 1969; Completion by winter, 1969/70).

Investigator: J.S. Yorke.

Study 3: Trials of treatments for over-dense stands. (Goal: Preliminary work to commence in 1969 - dependent on results of study 2). Investigator: R.S. van Nostrand.

Study 4: Physiological investigations of causes and possible cures for over-dense stands. (Proposed to commence in summer, 1970 - dependent on results of study 2). Investigator: J.S. Yorke.

Study 5: Establishment of joint spacing and provenance trials in various parts of Newfoundland. (Goal: Selection and preparation of planting sites in summer, 1969; Planting in 1970). Investigators: R.S. van Nostrand, J. Nicholson.

Study 6: Studies of stocking and development in regeneration and young stands. (Tentative proposal only).

Problem 4

Lack of information on suitable methods of site amelioration for increasing productivity.

Stand productivity can be increased by site amelioration as well as by treatments to the stands themselves. As the intensity of forest management

increases, site amelioration is likely to become of greater significance and economically more worthwhile. It is therefore necessary to determine methods of site amelioration that can be applied successfully in practice and the levels of response that can be expected.

Site evaluation studies listed under problem two will be of assistance in giving some indication of those factors limiting growth and thereby indicating site conditions most likely to benefit and show increased potential as a result of site amelioration. Many ameliorative practices (e.g. plowing, draining) are carried out to assist in the establishment of tree crops. As such they are of direct concern to the peatland and afforestation and reforestation programs. Their ultimate effects on site potential are also of concern to this program, however, and liaison will be maintained as necessary to ensure that maximum use is made of results from such studies.

The only site amelioration practice which appears to have any economic potential at present under stand conditions involves the improvement of nutrient status by fertilization and other techniques. A series of experimental fertilization plots have already been established under semi-mature crops on freely-drained soils in several parts of Newfoundland. An extension of these trials to cover further parts of the island and different site and crop conditions may be carried out during 1970 or later. Decisions in this regard will be made at a later date according to preliminary results obtained during 1969 from existing trials and greenhouse and laboratory experiments (see below), and in keeping with national plans for fertilization research and development. The ultimate aim will be to provide a comprehensive picture of crop response to various types and concentrations of fertilizers and of the costs involved.

In addition to fertilizer trials, more detailed and basic investigations of nutrient relationships on fertilized and unfertilized areas under various site conditions will be required. Studies of the effects of various soil and fertilizer combinations on seedling growth, and humus incubation studies, both of which are already in progress, will form a satisfactory starting point for more elaborate studies into the nutrient relationships of forest stands. Various crop and soil types under fertilized and unfertilized conditions will be investigated to determine the distribution of nutrients within the crop and the soil, the ways in which nutrients are retained in the ecosystem (in particular in the humus layer), to derive a fuller understanding of results obtained in the fertilizer trials and of the reasons for the availability or otherwise of the nutrients present, and to develop and test means whereby additional amounts of nutrients may be made available to increase productivity. The co-operation of a mycologist or physiologist may be required to determine the part played by mycorrhizae in the processes of nutrient cycling.

Studies in progress or to be undertaken soon are listed below.

Study 1: Continuation of fertilization trials and ultimate assessment of response. (Goal: Completion by 1977). Investigators: N. Bhure, R.S. van Nostrand.

Study 2: Continuation and expansion of detailed studies on nutrient relationships in fertilized and unfertilized stands. (Goal: To expand scope of study from 1970 onwards. Completion of present study by 1973). Investigator: N. Bhure.

Problem 5

Lack of information on the effects of different cover types on soil development and long-term site productivity.

Visual observation in Newfoundland and experience in other parts of the world has suggested that certain vegetation types and in particular successive rotations of certain coniferous species may cause site degradation and a loss of productivity in subsequent rotations. If these effects are of sufficient magnitude they will seriously affect forest management over a period of time by reducing the allowable cut from certain areas. Work now nearing completion on the characteristics of so-called acid brown wooded soils and on the effects of certain vegetation types on soil nutrient status will form a useful starting point from which to develop a further study of this problem. Soil physical and chemical properties will require examination under a variety of cover conditions, and close co-operation with the nutrient investigations and site evaluation studies will be necessary. The ultimate aim of the study will be to determine in detail the effects of the various cover types on soil conditions, to develop methods for recognizing sites which are currently in a degraded condition, and to indicate methods whereby a continued process of site degradation and loss of productivity can be avoided.

Studies in progress or to be undertaken soon are listed below.

Study 1: Completion and report on results of study on so-called acid brown wooded soils (Goal: Completion by winter, 1969/70). Investigator: R. Wells.

Study 2: Completion of analyses and report on results of study on the effects of certain vegetation types on soil nutrient status. (Goal: Completion by winter, 1969/70). Investigator: E. Dawe.

Study 3: Detailed study of the effects of various cover types on soil physical and chemical properties and on long-term site productivity. (Proposed to

commence in summer, 1970).

Problem 6

Lack of information on the increase in productivity that may be achieved by the introduction of superior exotic species and provenances.

A further method of increasing productivity and one which is likely to assume increasing importance as the proportion of artificially-established crops increases involves the introduction to Newfoundland of exotic species and superior provenances of both exotic and native species. Any species and provenances which show sufficient promise to merit the establishment of trial plantations are of interest to this program with regard to their ultimate productivity under stand conditions. Liaison will therefore be maintained with the afforestation and reforestation program with regard to trials that have been established, and at a later date full investigations of the resultant stands will be carried out as part of this program.

Small provenance trials of white spruce, red spruce, and balsam fir have already been established in Newfoundland and larger trials of black spruce and sitka spruce provenances will shortly be planted. The most immediate need is for a review of the establishment and, where possible, early results of these trials. The establishment of the sitka spruce trials also provides a useful opportunity to initiate some plantation spacing trials to provide growth and yield information at a later date (see problem 3). Results of the provenance trials will ultimately be used for determining the increase in production that can be obtained through the use of superior strains. The trials of black spruce provenances will also be of value in indicating what proportions of the observed differences in growth patterns between crops from different parts of the island are due to genetic causes and this in turn will assist in the explanation of mensurational differences between crops from these

regions.

An increase in the productivity of black spruce may also be obtained by extending the trials to incorporate progeny from a number of 'plus' trees or stands with desirable characteristics, obtained from different regions of the island. Selection of suitable trees and stands will be necessary as the first step in this process, and certain of those chosen can usefully also be investigated as regards detailed interrelationships between the site conditions and crop growth (see problem 1). For selected areas there would then be data on site, crop, and genetic potential from which valuable information on the relative influence of these three factors should be available.

Studies in progress or to be undertaken soon are listed below.

Study 1: Continuation of black spruce provenance trials, including review of establishment and progress. (Goal: Completion of review by spring 1969).

Investigator: J. Nicholson.

Study 2: Continuation of sitka spruce provenance trials, including review of establishment and progress. (Goal: Completion of review by winter 1969/70).

Investigator: J. Nicholson.

Study 3: Continuation and periodic remeasurement of white spruce provenance trial. (Goal: Completion of report on 1968 remeasurement by winter 1969/70).

Investigator: J. Nicholson.

Study 4: Continuation and periodic remeasurement of red spruce provenance trial. Investigator: J. Nicholson.

Study 5: Continuation and periodic remeasurement of balsam fir provenance trial. Investigator: J. Nicholson.

Study 6: Development of criteria for selecting superior black spruce trees. (Goal: To commence in summer, 1969). Investigator: J. Nicholson.

Problem 7

Lack of information on the impact of insects and diseases on productivity in relation to site and stand conditions.

The reduction of losses due to insects and diseases is of obvious significance to practical forest management. The effects of attack on growth rates and ultimate productivity and the incidence of attack in relation to site and crop conditions are aspects of the problem of direct concern to the site and stand management program. Almost all entomological and pathological studies are ultimately, concerned with the effects of the various organisms on stand development, and much of the work in this problem area is likely to be in the form of liaison or co-operative studies between this program and the insect and disease survey and entomology and pathology projects. Both site and growth and yield data are likely to be required as part of the insect and disease survey and entomology and pathology programs for developing a more complete knowledge of the interrelationships between the incidence of attack (especially of the hemlock looper and balsam woolly aphid) and site and crop conditions. Equally, a knowledge of the effects of the various insects and diseases on stand development and productivity will form a valuable addition to our knowledge and management of forest stands.

One study already in progress which is greatly involved with site conditions and stand development concerns the impact of the balsam woolly aphid on balsam fir stands. This study requires to be developed as part of this program to permit the optimum application of site and stand data in evaluating the impact of the aphid on stand productivity under various site and stand conditions, and to assist in the formulation of management techniques which will prevent stands or sites from reaching a condition favourable to serious aphid infestation.

Studies in progress or to be undertaken soon are listed below.

Study 1: Impact of the balsam woolly aphid on fir stands and its incidence in relation to site and stand conditions. (In progress. To be interrelated with site evaluation data by 1971). Investigator: H.O. Schooley.

OTHER REQUIREMENTS FOR PROGRAM DEVELOPMENT

Most of the general requirements for program development have already been discussed. One, more specific, item requires attention, however, to assist in obtaining maximum utilization of data in the future development of the site and stand management research program.

In the more distant future, stand development and treatment studies will need to be oriented towards stands of native and exotic species established by artificial means. Establishment of such stands has only fairly recently been started in Newfoundland and only young crops are presently in existence. Their growth and yield characteristics will ultimately become of considerable importance, however, and periodic remeasurements (as have already been carried out for a number of these areas) should be continued until such time as the crops are of sufficient size to be incorporated into more active growth and yield and stand treatment studies. Areas of potential value for this purpose are included in a number of projects either closed or on an infrequent re-measurement cycle only. Most of these projects are very limited in extent and only seem likely to be of future value when considered in the context of other similar studies. It is therefore proposed that a thorough examination of all past and present projects which might fall into this category be carried out by personnel from this program and the Management and Liaison and Silviculture sections. Those projects of obvious future value in their own right (i.e. classed as "active") should be maintained as such. The value of those now maintained for remeasurement should be assessed; any which have now

served all possible useful purpose should be finally closed, while those whose original purpose has now been fulfilled but which retain value for stand development purposes should be closed as separate projects and placed, together with any useful experimental areas which remain from projects already closed, into one holding project. The areas listed will then be maintained until such time as results from other studies or the development of the areas themselves indicate that they should be withdrawn from the holding project and investigated more intensively as part of a new growth and yield or stand treatment study. The holding project will be under the overall charge of D. Sharpe.

PHASING OF PROGRAM DEVELOPMENT

Priority 1

Including existing and new studies which require immediate attention and which are listed in the program as specific recommendations for action during 1969.

- (1) Brief revision of growth and yield data for central Newfoundland (1969). Problem 1. Study 1.
- (2) Completion of analyses and reports on mensurational characteristics of the major forest types of Newfoundland (1969). Problem 1. Study 2.
- (3) Report on status of King's Cove woodlot (1969). Problem 1. Study 3.
- (4) Review and major analysis of all available growth and yield data (1969-1971). Problem 1. Study 4.
- (5) Quantitative site evaluation studies in eastern and western Newfoundland (1969-1971), possible extension to central Newfoundland (1971-1972). Problem 2. Study 2.
- (6) Completion of pilot-scale land classification project (1969-1970). Problem 2. Study 1.

- (7) Review of intermediate stand cutting experiments in Newfoundland (1969). Problem 3. Study 1.
- (8) Preliminary survey and assessment of significance of overstocked stands (1969). Problem 3. Study 2.
- (9) Trials of treatments for dense stands (1969-). Problem 3. Study 3.
- (10) Establishment of spacing trials (1969-). Problem 3. Study 5.
- (11) Continuation of fertilizer trials (1969-1977). Problem 4. Study 1.
- (12) Continuation and further expansion of studies on nutrient relationships in fertilized and unfertilized stands (1969-1973). Problem 4. Study 2.
- (13) Continuation of establishment and maintenance of provenance trials including review of their establishment and early results (1969-). Problem 6. Studies 1-5.
- (14) Study of criteria for selecting superior black spruce trees. (1969-1971). Problem 6. Study 6.
- (15) Completion of studies on acid brown wooded soils and on the effects of certain cover types on soil nutrient status (1969-1970). Problem 5. Studies 1 and 2.
- (16) Impact of balsam woolly aphid on fir stands and its incidence in relation to site and stand conditions (1969-). Problem 7. Study 1.
- (17) Establishment and maintenance of holding project (1969-).

Priority 2

Including studies listed in the program as specific recommendations for commencement during 1970 or later, and studies only tentatively proposed at present whose inclusion in the program will depend on the results of preliminary work.

- (1) Detailed physiological studies in overstocked stands (1970-).
Problem 3. Study 4.
- (2) Detailed studies on interrelationships between tree and stand development and site conditions (1970-). Problem 1. Study 5.
- (3) Studies on effects of different cover types on soil development and site productivity (1970-). Problem 5. Study 3.
- (4) Detailed investigations of exposure in relation to tree growth.
Problem 2. Study 4. (Tentative proposal only.)
- (5) Development of basic management plan for Corner Brook watershed.
Problem 2. Study 3. (Tentative proposal only.)
- (6) Studies of stocking and development in regeneration and young stands.
Problem 3. Study 6. (Tentative proposal only.)

Priority 3

Including (i) studies of a continuing and long-term nature, and (ii) studies that will require development in the more distant future. This is only a partial list which will be amended and added to by the continual process of program review.

- (1) Continuation of trials of provenances, stocking levels, fertilization and other site amelioration practices, and stand treatment.
- (2) Initiation of studies on the growth and development of plantations.
- (3) Possible further development of studies into intensive, short rotation management.
- (4) Co-operation with studies on entomological and pathological problems of forest stands.

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APPENDIX I

Research Personnel Involved in Site and
Stand Management Research Program

- G. Page : Program leader; concerned with quantitative site evaluation, reviews of past work, and co-operation with analysis of growth and yield data, determination of the effects of tree crops on soil conditions, detailed studies of the effects of site conditions on stand development, and detailed exposure studies.
- D. Bajzak : Pilot-scale land classification project and its development for management purposes, mensurational characteristics of forest types, co-operation with review and analysis of growth and yield data and with detailed studies of tree development in relation to site conditions.
- N. Bhure : Fertilization trials, development of detailed studies of nutrient status and cycling and the effects of fertilizers under various stand and site conditions.
- E.R. Dawe : Soils laboratory supervisor; assistance with chemical aspects of studies on the effects of various cover types on soil and site productivity.
- J. Nicholson : Provenance trials of black, sitka, white, and red spruces and balsam fir, including review of their establishment and progress; co-operation with plantation spacing trials.

- R.S. van Nostrand : Central Newfoundland growth and yield study; fertilization trials; trials of methods for dealing with dense stands; co-operation with review and analysis of growth and yield data, and with plantation spacing trials.
- A. Robinson : Development of regeneration and young stands; co-operation with studies of stand development and yield in relation to site conditions.
- H.O. Schooley : Impact of balsam woolly aphid on balsam fir stands, and incidence of aphid attack in relation to site and stand conditions.
- R. Wells : Completion of study of acid brown wooded soils; development of studies into the effects of cover type, etc. on soil development and properties and long-term site productivity.
- D.T. Sharpe : Assistance in the establishment and maintenance of holding project; liaison for the transfer of data from site and stand management research to field trials, and vice versa.
- J.S. Yorke : Physiological investigations into the causes and possible cures for overstocked stands; detailed examination of exposure in relation to tree growth; possible co-operation with study of development of trees and stands in relation to site conditions.

Also associated with the program for liaison or advisory purposes will be:

D.E. Nickerson (Afforestation and Reforestation program leader)

F.C. Pollett (Peatland program leader)

G.L. Warren (Head, Insect and Disease Survey)

Statistical advice will be requested when necessary from Biometrics Research Services, and ultimately from statistician on regional staff.

Assistance with the economic assessments of various trials will also be required from suitably qualified personnel.

Liaison will be maintained with personnel from the Newfoundland Forest Service engaged on the forest inventory and forest land capability projects, with staff of the Canada Dept. of Agriculture, and with Woods Division staff of Price (Nfld.) Ltd. and Bowaters Ltd.

Appendix 2

SCHEMATIC DIAGRAM ILLUSTRATING THE SITE AND STAND MANAGEMENT RESEARCH PROGRAM

