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NEWFOUNDLAND REGION, SITE AND STAND MANAGEMENT RESEARCH PROGRAM: PROGRESS REPORT FOR 1969/70

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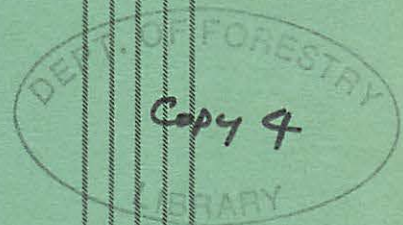
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FOREST RESEARCH LABORATORY
ST. JOHN'S, NEWFOUNDLAND
INFORMATION REPORT N-X-44

CANADIAN FORESTRY SERVICE
DEPARTMENT OF FISHERIES AND FORESTRY
MARCH, 1970



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Newfoundland Region, Site and Stand Management

Research Program: Progress Report for 1969

INTRODUCTION

A new, multi-disciplinary program in site and stand management research was initiated in the Newfoundland Region during the fall of 1968. It is one of four programs which are presently being developed within the region to carry out problem-oriented research on important forestry problems.

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

A more complete discussion of the reasons for the establishment of the program, together with an initial outline of proposed program development, has been given earlier (Page, 1969a). Since the preparation of the earlier report the program has become functional; discussions between group members have been in progress throughout 1969, study plans have been agreed upon in more detail than was possible at the time of program inception, and work has been in progress on a number of existing and new studies.

This report therefore serves two purposes. It is, firstly, a progress report for all studies that were active within the program during 1969. Secondly, more complete and more detailed plans for future study development are presented, together with items such as manpower requirements, and plans for trials and demonstrations, which could not be included in the earlier report.

Consideration is given in the first instance to the way in which the program, as a whole, has functioned and progressed during the year, and, subsequently, to the progress and future plans of the individual studies under each of the seven problems that were formulated earlier.

PROGRESS DURING 1969

OVERALL PROGRAM DEVELOPMENT

The site and stand management research program is the first of the problem-oriented programs established within the Newfoundland Region to become functional. It has therefore been necessary during 1969 for the program group not only to discuss and develop plans for the future conduct of research studies but also to evolve efficient ways of working together as a team to ensure the best use of talents available and to establish a group spirit which can give the program momentum for the future.

During the winter of 1968/69, discussions centered initially upon general concepts of the scope of the program, the problems that needed investigation, and the ways in which existing studies might be fitted into this framework. These early discussions culminated in the issue of a first program outline (Page, 1969a), giving the overall program objectives and a somewhat generalized account of the studies that were to be incorporated. Since the preparation of that report, work has been planned in greater detail, and the direction of program development over the next few years has been tentatively mapped out.

The problems identified in the earlier report remain the same. However, a number of changes in priorities and schedules have been made during 1969. Some of these appeared desirable as a result of more detailed planning; others have been necessitated through staff resignations and re-assignments. Details of these changes are discussed below under the individual problems.

In general, the group of researchers involved with the program have worked well together as a team. At the same time, there are, undoubtedly, further improvements in team organization and co-operation which can and will be made as all members become more familiar with the special requirements of group planning in research work. Group planning has been particularly effective with regard to new studies, where study methods, objectives, goals, and integration with other work (including other work outside of the program) have all benefited to a considerable extent. The group has discussed broad concepts of study development and detailed work plans and methods with equal effectiveness. Discussions during 1969 have made it possible to plan the extension of certain studies to the stage of trials and demonstrations and to prepare a full listing of manpower requirements, both of which were not possible when the earlier report was prepared.

In summary, therefore, it is clear that the program has made sound and worthwhile progress during 1969; reaction to the initial program report from industry and from other parts of the Canadian Forestry Service has been favourable. The establishment of the program has

resulted in effective and integrated planning of a series of allied studies designed to answer the most pressing problems of forest industry and government in the field of site and stand management. Within this framework every researcher involved with the program has his own goals and objectives to which he is firmly committed as his contribution to program development and problem solving.

THE PROBLEMS

Seven problems requiring immediate attention were identified and discussed in the earlier report (Page, 1969a). These problems have remained as the basis of the program during 1969, and all studies carried out during the year are designed to assist in solving one or more of them. The first two problems are concerned with obtaining more complete and more readily usable information on crop growth and yield and on the relationships between site conditions and growth. Problems three and four are concerned with stand manipulation and site amelioration to increase productivity, while problem five involves the effects of tree crops on soil conditions and is closely related to the problem of site amelioration. The testing of provenances of exotic and native species and the investigation of individual tree variability as a means to increase productivity constitutes problem six. The mensurational aspects of balsam woolly aphid impact on fir stands are being examined under problem seven. Reference should be made to the earlier report for a full discussion of these problems; only a brief reiteration of the major points is given below. The individual studies are, however, discussed in this report in greater detail than was possible earlier. Accounts of progress and future plans for individual studies are given by the researchers involved. Studies are referred to by establishment and, where possible, branch project numbers to facilitate cross-reference to the Newfoundland Region project statements.

Problem 1

Lack of growth and yield tables for even-aged crops

for the whole of the island of Newfoundland, by

R.S. van Nostrand, A.J. Robinson, and G. Page

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 species and ages. Growth tables are available for central Newfoundland, but no other parts of the island are covered at present by practically-applicable data. The solution of this problem constitutes one of the most important and immediate aims of the site and stand management program. Existing mensurational studies will be completed to provide additional data which will be used in the preparation of new and complete sets of growth and yield tables to cover the entire island.

Study 1011-3-1 (NO27): Growth tables for spruce and fir in central Newfoundland. Investigator: R.S. van Nostrand.

The purpose of this study is to update the central Newfoundland growth tables, originally prepared in 1964, on the basis of the 1967-68 remeasurement of the Price (Nfld.) Pulp & Paper Ltd. permanent sample plots. During 1969, growth trends have been derived by graphical methods, using data from 350 sample plots taken over a period of 20 years. Separate graphs of growth in merchantable volume per acre have been prepared for stands where spruce or fir comprises more than half of the softwood component. These two graphs are contained in a report (van Nostrand, 1970), together with a table of mean volume per square foot of basal area, thus providing a means for estimating present merchantable softwood volumes, and for predicting future volume increment of large forested areas in central Newfoundland. Regression analyses of the permanent plot data are also being carried out, and will be reported during 1970. The study will then be closed.

Goals: To complete regression analyses and prepare report giving results by winter, 1970,

Study 1011-3-2 (NO28): Mensurational characteristics of the major forest types of Newfoundland. Investigator: D. Bajzak (to August, 1969); G. Page (September, 1969 onwards).

The purpose of this study is to determine the mensurational characteristics of typical mature or semi-mature stands of the major softwood forest types as defined earlier by Damman, in the four main forest regions of Newfoundland. Results provide useful information on such features as volume yields and rotation lengths for application in

practical forest management. The study will also provide a large amount of mensurational data for use within the site and stand management program in the compilation of growth and yield tables. Reports for two regions of the island (central and western) were completed prior to 1969. During the year under review analyses have been completed and a report prepared for northern Newfoundland (Page, Bouzane, Bajzak and van Nostrand, 1970). Data for five productive forest types, consisting mainly of balsam fir, and with pulpwood volumes ranging from 1500 to 3500 cubic feet per acre, were presented. The data for eastern Newfoundland have not been analyzed and reported as planned owing to the resignation of the original investigator. This material will now be analyzed and reported during 1970/71, and the study will then be closed.

Goal: Completion of analyses and preparation of report for eastern Newfoundland by 31 March, 1971.

Study 1011-3-3(N025): King's Cove managed woodlot. Investigators: D.T. Sharpe (to October 1969), C.H. Evans.

This study has been maintained as part of the site and stand management program as a source of growth and yield data over an extended period. Original program plans called for the preparation of a report during 1969 on the current status of the woodlot. This was not carried out owing to the resignation of the investigator. No further work on this project will be carried out until 1971 at which time there will be a final 20-year remeasurement of the complete woodlot and a report on the growth and development of the stands over 20 years.

Goals: Remeasurement of woodlot in 1971.

Preparation of report on stand development over 20 years by 31 March, 1972.

Study 1011-3-4: Growth and yield tables for even-aged stands of native species in Newfoundland. Investigators: D. Bajzak (to August, 1969), A.J. Robinson (from September, 1969), R.S. van Nostrand, G. Page.

This is a new study, started in 1969, to prepare (i) total and merchantable tree volume tables for the most important native tree species, and (ii) variable density yield tables for even-aged stands in the main Forest Sections of the island. There is at present a lack of any consistent and comprehensive body of tree volume and growth and yield data for Newfoundland which can be utilized by the forest manager; this study is designed to fill part of that need. Tables will be derived by mathematical methods and based on crop performance (tables based on physiographic site will be derived in a later study).

All suitable individual tree data already available were collected together during the year. A number of additional trees were cut to fill gaps in existing data. During 1970/71, it is planned to commence

the yield table compilation and to complete the analysis and publication of the volume tables. The yield tables are to be completed during 1971/72.

Goals: Analysis of data and publication of tree volume tables by 31 March, 1971.

Commencement of yield table compilation during winter 1970/71.

Completion and publication of yield tables by 31 March, 1972.

Study 1011-3-5(N024): (previously numbered 1011-5-1) Intermediate commercial cuttings in black spruce and balsam fir. Investigators: D.E. Nickerson (to March, 1969), R.S. van Nostrand.

This experiment involving clearcutting, partial cutting, and uncut controls, was established in two productive stands, of pure fir and pure spruce, between 1954 and 1956. The major original objectives of the study were to compare the costs of partial cutting and clearcutting and to determine whether or not partial cutting could increase pulpwood production. An unpublished report was prepared during the past year (Nickerson, 1969), showing that ten-year increment in the control plots has been greater than in the partial cut plots. Partial cutting is no longer considered an economically-feasible practice, but the experiment retains value for long-term growth and yield studies. It has therefore been retained under the growth and yield problem, and is to be maintained for a further remeasurement.

Goal: To replace plot marker stakes during summer of 1970.

Future Study Development - Problem 1

The central Newfoundland growth and yield study and the mensurational characteristics studies will be completed and closed during 1970/71, and the King's Cove woodlot study will be completed during 1971/72. Data from these and other sources will be used in compiling the volume and growth and yield tables for the whole island. These tables will be based on crop performance, and related to capability classes as used in the Newfoundland Forest Inventory. Completion date for the project is 1972.

Starting in 1971, data from site evaluation, land classification, and growth and yield studies will be brought together, along with necessary additional photo-interpretation and ground checking, to produce growth and yield tables based on practically-applicable physiographic sites. Tables produced by this means should ultimately provide a logical, site-oriented basis of growth prediction for use by the forest manager. Completion of this latter study is expected to bring to an end the present major effort in growth and yield. However, remeasurements of some permanent plots, and more detailed examinations of particular aspects of stand growth, may be needed at a later date.

Problem 2

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

G. Page and R.E. Wells

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. Land classification and site evaluation techniques can provide the means to obtain this information. At present little is known of the relative importance of the various environmental factors controlling tree growth in Newfoundland. Such knowledge is, however, of vital importance in developing sound techniques of site evaluation and land classification which will then in turn, be applied in practical forest management. Two studies are now in progress in this field. The first is designed to test a method of forest and associated wildland classification for use in practical forest management; the second aims to determine factors controlling tree growth and to use this knowledge in refining land classification techniques, in determining site potential, and in evolving improved methods of stand management and site amelioration.

Study 1011-4-1 (NO23): Reconnaissance land classification system, Newfoundland. Investigator: D. Bajzak (to August, 1969); R.E. Wells (from March, 1970),

This project was initiated to develop and test a wildland and associated forest land classification system recommended by the National Committee on Forest Land in 1967. The project is based essentially upon airphoto interpretation and aims to delineate areas of land which are recognizable and meaningful in terms of their potential for forestry. All field sampling in the 500 square mile trial area near Corner Brook (Anon., 1968) was completed during 1969. Soil, vegetation, and forest stand data have been collected for all the land units that have been mapped. Results of this project will not be reported by the original deadline of March 1970 owing to the resignation of the original investigator. It is now planned to have this report prepared by fall, 1971.

Goal: Preparation of final report by fall, 1971.

Study 1011-4-2 (N026): Site conditions and the growth of fir and spruce in Newfoundland. Investigator: G. Page.

The objectives of this project are to elucidate basic interrelationships between site conditions and the growth of fir and spruce in eastern and western Newfoundland to provide a means of predicting growth from soil or topographic factors for research and management purposes, and to indicate potentially useful site amelioration techniques for increasing productivity. Results should tie-in with the land classification work, thus ensuring that the features which are classified and mapped are those of greatest significance to tree growth. This study should also provide basic information needed for the logical development on a site basis of studies in growth and yield, regeneration, stand manipulation, and site amelioration.

Field sampling was completed in western Newfoundland during 1969 and laboratory analyses of the western Newfoundland soil samples are in progress. A preliminary examination of some topographic and basic soil factors has shown that those indicative of soil drainage conditions are most closely related to tree growth in western Newfoundland (Page, 1970a); measures of exposure are of lesser importance. Analyses of the Avalon Peninsula samples have been completed, and three reports prepared dealing with the effects of topographic, soil physical, and soil chemical factors on tree growth (Page, 1969b, 1969c, 1970b). Soil drainage and associated moisture relationships appear to be of major importance to tree growth on the Avalon Peninsula. Exposure and soil nutrient status are of somewhat lesser importance. Sample plot data collected in 1968 and 1969 have been used in reports on the variation of site-index and basal area within the "Dixman" forest types of eastern and western Newfoundland (Page, 1970c, 1970d). Data on the effects of tree crops on soil properties will be collected during 1970, and the entire study will be completed during 1971.

Goals: Completion of field work on the effects of tree crops on soil properties during summer 1970.

Completion of laboratory analyses (1969 samples), and preparation of reports on physical and chemical soil factors in relation to tree growth in western Newfoundland, and on the properties of Newfoundland forest soils, by 31 March, 1971.

Completion of laboratory analyses (1970 samples) and preparation of report on the effects of tree crops on soil properties by 31 December, 1971.

Commencement of final report on study during summer, 1971.

Future Study Development - Problem 2

The pilot-scale land classification project is scheduled for completion by 1971. The mapping units and associated descriptions of site and crop conditions that have been obtained from this project are considered a useful basis for the development of a management plan for the Corner Brook watershed area. The feasibility of preparing such a plan is currently being investigated; it might be carried out independently of any problem-oriented program but would, in any case, require a considerable input from various regional projects including many of the site and stand management program studies. The techniques tested in the pilot-scale land classification project can also be used to derive a practical framework of land classification units in any part of the island where required for management or research purposes.

The quantitative site evaluation project will be completed during 1971. Results will assist in the refinement of land classification data, and the two studies will together facilitate the classification, mapping, and detailed evaluation of forest lands for management or research purposes. Application of these studies is expected to be a continuing process from now onwards. In research, one immediate use will be in providing a basic framework of site information to which many other studies concerned with fertilization, young stand development, stand treatment, and other topics can be related. The development of growth and yield tables on a physiographic site basis (Problem 1) will require a considerable input of site evaluation and land classification data.

The site evaluation project is also designed to reveal factors 'limiting' to tree growth, and thus to indicate potentially useful approaches to site amelioration. Trials to test the effects of site amelioration techniques such as draining will need to be established by the Development and Services section as part of the site and stand management program (under Problem 4) possibly starting in 1971.

Later, it will be necessary to commence investigations of significant site factors in more detail, in order to derive a more complete understanding of the mode of action of such factors as exposure and soil moisture status upon growth and to work towards more basic means of mitigating their limiting effects. Exposure presents a special problem, particularly on the Avalon Peninsula. Continued liaison with the regeneration program will be necessary with regard to studies on the use of tatter flags as exposure guides and on shelterbelts for use in assisting the establishment and early growth of artificially-established stands. Shelterbelt trials may be established as a joint undertaking of the two programs and would also require the involvement of the Development and Services section.

Problem 3

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

R.S. van Nostrand and A.J. Robinson

One potentially important approach for obtaining economically-worthwhile increases in productivity is through stand manipulation. Treatments may be mechanical or chemical, but in almost all cases their purpose is to control the number and spacing of stems so as to obtain increased total volumes or increment rates. Large areas of forest land in Newfoundland are occupied by stands with stocking levels not near the optima. It is therefore important that studies be carried out to determine the normal course of early stand development and the most effective and economical methods of stand manipulation, particularly with regard to young stands where the greatest response to treatment is to be expected.

Study 1011-5-1 (NO24): Intermediate commercial cuttings in black spruce and balsam fir. Investigator: R.S. van Nostrand.

This study has been transferred to Problem 1 (loc cit).

Study 1011-5-2: An assessment of the distribution and nature of dense softwood stands in central Newfoundland. Investigator: J.S. Yorke.

The objectives of this study were to determine the distribution, extent, and degree of association with physiographic features, of dense softwood stands in central Newfoundland. The study was completed and a file report (Yorke, 1969) prepared during 1969 as planned. Plot tally data from the provincial forest inventory were supplied through the courtesy of the Newfoundland Forest Service. Between two and three percent of the merchantable stands that were sampled were considered to be overstocked. There were indications of an association between overstocked stands and dry, infertile sites, but the number of plots involved was too small to permit statistical analysis. Visual observation has also indicated that there are considerable areas in various parts of Newfoundland occupied by dense stands which have not reached merchantable size and which are not included in the two to three percent total referred to above. These results provide evidence of a sufficient problem to merit further studies into stand development and treatment, especially in regard to young stands.

Goal: Examine material contained in file report and prepare Internal Report by 31 December 1970.

Study 1011-5-3: Effectiveness of Dybar fenuron soil sterilant for killing dense softwood regeneration. Investigator: R.S. van Nostrand.

The purpose of this study is to determine the effectiveness of Dybar fenuron brush killer for killing dense softwood regeneration, and to indicate the potential use of this chemical as a thinning tool. Two replicated experiments were established during 1969 in stands of balsam fir and black spruce regeneration; both areas contained between 30,000 and 50,000 stems per acre. Dybar was applied broadcast, and in spots on grid patterns at four different intervals, at four different rates of application. A preliminary examination in the fall of 1969 showed that even the heaviest broadcast application (48 lbs Dybar per acre) had not produced 100 percent kill in either species. Broadcast dosages of 6 and 12 lbs per acre showed little kill. Spot application appears to have the greatest potential as a thinning treatment. Even at 6 lbs per acre it produced some kill at almost every spot. The experiments will be remeasured in 1970, and if the treatments appear promising they will be maintained to follow future stand development.

Goals: To carry out a full-scale remeasurement during summer 1970.

Prepare report on results of remeasurement by 31 March 1971.

Study 1011-5-5: Spacing trials of native and exotic species. Investigators: R.S. van Nostrand, J. Nicholson.

This study is designed to determine the spacings which will give optimum fibre and lumber production per acre for commercial softwoods, and the effects of fertilization at time of planting on the development of trees at different spacings. Three sites, in central and western Newfoundland and on the Avalon Peninsula, were selected during 1969. In each area four 'Nelder' circular plots are to be established in 1970. Black spruce, balsam fir, and two provenances of sitka spruce will be planted at spacings ranging from two to twelve feet. Half of each Nelder plot will receive a fertilizer treatment at the time of planting.

Goals: Nelder plots are to be established at the three selected areas during summer 1970.

Remeasurements will be carried out at two-year intervals during the stage of early stand development, commencing in summer 1972.

Study 1011-5-6: The development of young stands resulting from artificial seeding. Investigator: A.J. Robinson.

This is a new study designed to trace in detail the development from regeneration to merchantable tree size of stands of native species established by direct seeding. During 1969 existing data on young stand

development were examined and reported (Page and Robinson, 1969). The data showed that where large numbers of seedlings are present following cutting a very rapid reduction in numbers per acre occurs during the first five years of stand development, with later reductions being slower until at 20 years the number of stems on balsam fir cutovers is commonly between 5,000 and 10,000 per acre. Where the initial density is below 5,000, the number of stems commonly increases during the first five years. Different seeding treatments were found to result in differences in the rate of height growth which were maintained for at least ten years. Existing data are not adequate to provide detailed information on stand development over the whole of the period up to the attainment of merchantable size. A detailed re-measurement of an existing, artificially-seeded stand of black spruce (old project NF-10/NF-45) is therefore to be carried out in 1970 to provide some of the required information. Other artificially-seeded stands of native species are to be re-measured in subsequent years so as to build up a comprehensive and detailed picture of young stand development in terms of height, diameter and volume increment, crown development, and fibre and dry matter production.

Goals: Re-measure seeded black spruce plantation (old NF-10/NF-45) during summer 1970.

Locate and examine during 1970 other potentially useful areas for future re-measurement.

Prepare report on 1970 re-measurement by 31 March 1971.

Future Study Development - Problem 3

It is planned that several young, artificially-seeded stands at various stages of development will be re-measured during the next few years to provide complete and detailed information on the early development of this type of stand. By 1972 it is hoped to commence similar studies in young natural stands. Ultimately, data from these studies will provide important information on the long-term effects of various techniques of establishment and of various site conditions on early stand growth, and should indicate the potential value of short rotation management for maximum fibre production.

Stand treatment studies presently being carried out are also of importance in relation to possible future short rotation management; all studies of this type are designed to increase yields and/or shorten rotations. The Dybar experiment will be re-measured during 1970 and the experimental areas will be retained to record future stand development if some of the treatments appear promising. Another possible method of thinning dense young stands involves the clearing of alternate strips by mechanical means. A trial of this type was established by the Development and Services section during 1969 in western Newfoundland. This will be examined during 1970 to determine

whether it might be of value within the Site and Stand Management Program. By 1971 it is planned to commence trials on the use of fertilizers, applied broadcast or in spots, for increasing growth and relieving stagnation in dense young stands. The present spacing study will be established during 1970. No new spacing studies will be commenced at least until recommendations have been received from the cross-Canada study that is underway to evaluate the usefulness of present methods for establishing spacing trials.

Problem 4

Lack of information on suitable methods of site
amelioration for increasing productivity, by

N.D. Dhure and R.S. van Nostrand

Stand productivity can be increased by site amelioration as well as by treatments to the stands themselves. Amelioration may be designed to improve the nutrient status, the moisture status, or the aeration conditions of the soil. Little is known at present of the possible value of the various ameliorative practices under Newfoundland conditions. However, the effects of fertilization, which is possibly the most promising of the ameliorative techniques, are already being tested in field trials. In addition, various techniques of site preparation are presently being investigated under the regeneration and peatland programs; results from these trials should ultimately be of value to the site and stand management program. The basic site studies being carried out under problem 2 should reveal the most important of the factors that are limiting to forest growth, and hence indicate further promising approaches to site amelioration.

Study 1011-6-1 (NO32): Forest fertilization trials. Investigators: R.S. van Nostrand and N. Bhure.

A series of Nitrogen and NPK fertilizer trials were established during 1967 and 1968 in even-aged semi-mature stands in central and western Newfoundland. The objectives of the study are to determine the fertility status of some common, well-drained forest soils, the increased wood yield to be gained by fertilization, and the dosages and frequency of fertilizer application necessary for optimum growth response. In the fall of 1969 a preliminary examination was made of the response in radial growth at breast height of a number of stems in the plots fertilized in 1967. Trees from the NPK plots were the only ones to show a consistent increase in radial growth relative to the untreated controls. Since response to fertilizer application has so far been small and generally inconsistent, dosages in the NPK trials were increased in 1969 to the equivalent of 180 lbs. N, 50 lbs. P and, 100 lbs. K per acre. Soil and foliar analyses on samples collected from the fertilization plots have continued during the past year. Additional fertilization trials are to be established in a semi-mature softwood stand on the Avalon Peninsula during 1970 and in a mixedwood stand in central or western Newfoundland during 1971. Remeasurements of crop response and soil and foliar nutrient levels will subsequently be carried out at regular intervals in all trial areas until 1979.

Goals: Establish NPK fertilizer trial in a softwood stand on the Avalon Peninsula, and collect soil and foliage samples for analysis, during summer 1970.

Establish NPK fertilizer trial in a mixedwood stand, and collect soil and foliage samples for analysis, during summer 1971.

Summer 1971, commence cycle of remeasurements of the trial areas and reports on growth response (to continue until 1979).

Study 1011-6-2 (NO33): Evaluation of fertilizer requirements of some typical forest soils of Newfoundland. Investigator: N.D. Bhure.

This study was commenced in 1968, in close association with the fertilizer trials, to determine the effects of nitrogen, phosphorus, and potassium in different fertilizers on the growth of tree seedlings in greenhouse pot trials using soil from the fertilizer trial areas. Seedlings grown in soils from the fertilizer trials established in 1967 and 1968 were harvested during 1969. Analyses of seedling nutrient contents will be completed during the summer of 1970, and reports on dry matter production and nutrient uptake prepared by spring 1971. Similar greenhouse experiments will be carried out using soil from the Avalon Peninsula and mixedwood fertilizer trial areas between 1970 and 1973.

Preliminary data on the nutrient status of forest soils have suggested that much of the nitrogen in forest soils is unavailable to trees. Incubation experiments to test the effects of various treatments on nitrogen mineralization and volatilization in humus from certain of the fertilizer trial areas were completed during the past year. Balsam fir humus has been found to be richer in available nitrogen than black spruce humus (Bhure, 1970a). Higher incubation temperatures increase the rate of nitrogen mineralization, indicating the desirability of silvicultural techniques that favour increased forest floor temperatures. When urea fertilizer is applied more nitrogen becomes available on richer sites with low carbon-nitrogen ratios than on nutrient-poor sites. Losses of nitrogen from urea fertilizer through volatilization have been low under laboratory conditions when using acid humus samples (Bhure, 1970b).

Goals: Commence greenhouse pot trials using Avalon Peninsula soil samples during summer 1970.

Complete analyses of seedlings from completed greenhouse trials during summer 1970, and prepare report on seedling dry matter production by 30 June 1970.

Prepare report on seedling nutrient uptake in the completed greenhouse trials by 31 March 1971.

Commence greenhouse pot trials using soil from the mixed-wood area during summer 1971.

Complete analyses and prepare report on the Avalon Peninsula pot trials by summer 1972, and on the mixedwood pot trials by summer 1973.

Future Study Development -- Problem A.

The present series of fertilizer trials in semi-mature stands will be completed with the establishment of the two trials planned for 1970 and 1971. Each of these trials will be remeasured at appropriate intervals up to 1979 to follow the effects of the fertilizer applications on soil and foliar nutrient levels and crop response. Results should eventually indicate the degree of crop response that can be expected from the application of various kinds and dosages of fertilizer on some of the common, freely-drained soil types of the island. Methods will also be developed for identifying and correcting nutrient deficiencies through a knowledge of the interrelationships between foliar nutrient levels and tree growth. Greenhouse pot trials will continue until 1973 to provide more detailed information under controlled conditions on the response of soils from the fertilizer trial areas to the application of various types of fertilizer.

Trials (to be established by the Development and Services section) are planned for 1971 to test the potential value of various methods of site amelioration on the basis of results from the site evaluation study. Present indications are that drainage and fertilizer treatments will be required; trials of windbreaks may also be closely associated with this work. Other fertilization trials will be needed by 1971 in young stands to evaluate possible increases in growth rate in stands at this early stage of development and to determine the value of fertilization for preventing stagnation in dense young stands.

A major study is planned to commence in 1971 to investigate some important and detailed aspects of nutrient cycling in forest stands. It will be necessary to examine the balance between uptake and release of nutrients, the availability of nutrients in humus and soil, relationships between foliar and soil nutrient levels, and factors that influence nutrient cycling in softwood and hardwood stands. The ultimate purpose will be to devise methods by which a greater proportion of the nutrients already present on the various sites can be made available for tree growth.

Problem 5

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

E.R. Nawe and R.E. Wells

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. This problem is closely allied to the problem of site amelioration, particularly as regards organic matter buildup and the retention of nutrients in an unavailable form. Original plans called for new work to start on this problem during 1970. However, staff re-assignments have necessitated the temporary postponement of any new studies on this topic at least until 1971.

Study 1011-7-1(N034): Study of some poorly characterized slope soils.
Investigator: R.E. Wells.

During 1967 samples of an acid brown wooded sequence of soils were collected from a slope area near Gander. Laboratory analyses of these samples were not completed due to the illness of the investigator. No further work was carried out on the project during 1968 and 1969 due to the absence of the investigator on educational leave. Data collected are insufficient for a report, and the project is now closed. Work on this, or an allied topic may, however, be re-activated at a later date as part of more detailed land classification studies; more detailed work of this nature will not be initiated at least until 1971 owing to present commitments to the bio-physical land classification program.

Study 1011-7-2: Effects of certain vegetation types on soil nutrient status. Investigators: A.W.F. Damman (to 1967), E.R. Dawe.

This study was undertaken primarily to investigate the relative effects of balsam fir, black spruce, and Kalmia on the fertility of three closely similar sites in western Newfoundland. Most of the analyses were completed by 1967, and a report, which shows marked differences in nutrient contents and cycling within the three ecosystems, is currently in preparation (Damman, personal communication). A secondary objective of this study was to derive quantitative information on the effects of fire on soil nutrient status and to relate these data to changes in vegetative cover. Analyses of the lysimeter samples that were collected in 1967 and 1968 were delayed until 1969. Results of these analyses proved inconsistent and of doubtful reliability owing to the length of time they had been stored. No further reports on this study can therefore be prepared, and the project is now closed.

Future study development - Problem 5

No further studies on this problem will be initiated before 1971. At present, plans for future study development are very tentative; more detailed study proposals will be examined during 1970/71 winter. Data on soil properties presently being collected as part of the site evaluation, land classification, and fertilization studies should provide much basic information of value in planning the course of future studies into the effects of cover type on soil properties. In addition, future work on this topic will need to be closely allied with studies of nutrient availability in progress or planned under the problem of site amelioration (problem four).

Future studies might usefully examine the effects of various cover types, of disturbance such as cutting, and of quantitatively-defined moisture regimes on soil nutrient balance and nutrient loss, soil profile development, and present and long-term future site productivity. Basic mineralogical parameters might also be examined to provide information on the ability with which various sites can maintain their fertility levels over long periods of time and thus prevent site degradation.

Problem 6

Lack of information on the increase in productivity that may be achieved by use of stock with increased genetic potential, by

J. Nicholson

Economically-worthwhile increases in site productivity may be achieved by the use in seeding or planting programs of superior provenances and/or individuals of both native and exotic species. This method of obtaining increases in productivity is likely to assume greater importance as forest management becomes more intensive and the proportion of artificially-established crops increases. A small number of exotic species have already shown some promise under Newfoundland climatic conditions and are now being tested in provenance trials. Other exotics are still in an introduction phase (as part of the regeneration program) but may need to be tested under plantation conditions at a later date. Of the native species, black spruce is currently receiving major attention because of its commercial importance, relative freedom from serious pests, and adaptability to artificial regeneration practices.

Study 1011-8-1 (NO31): The genetic improvement of black spruce (Picea mariana (Mill.) B.S.P) in Newfoundland. Investigator: J. Nicholson.

The purpose of this study is to determine the amount, pattern, and possible causes of genetic variation in black spruce in Newfoundland.

A nursery experiment was established during 1968, and a report on the establishment and progress was prepared during the past year (Nicholson and Tricco, 1969). Preliminary observations were made during the fall of 1969 on the progress towards dormancy and the height growth of seedlings of the various provenances (Nicholson and Tricco, 1970). The northernmost provenances (from Labrador and the Northern Peninsula) were the first to become dormant and had grown less in height than those from other parts of the island. It is concluded that the Northern Peninsula black spruce represents a distinct ecotype adapted to the more severe climatic conditions. Differences in seedling performance between other parts of the island were also observed but more precise measurements are required before conclusions can be made.

Goals: Prepare reports based on 1969 data on (i) correlation of cone length, cone width, and seed weight, and (ii) dormancy observations, by 31 March, 1970.

During summer 1970, detailed phenological observations are to be made on the seedlings in the nursery experiment, and seed is to be sown in preparation for the outplanting phase of the study.

Prepare report on 1970 phenological observations by 31 March, 1971.

Carry out a further series of phenological observations during summer 1971.

Prepare final report on the nursery phase of the study by 31 March, 1972.

Study 1011-8-2 (NO29): Provenance experiment with sitka spruce (Picea sitchensis (Bong.) Carr.) in Newfoundland. Investigator: J. Nicholson.

Twelve sitka spruce provenances are being tested in this study to determine whether any are suitable for Newfoundland site and climatic conditions. Seven plantations were established in various parts of the island during 1969 and mortality counts made in the fall. Two more plantations will be established in 1970. All outplantings will subsequently be cleaned and maintained as necessary, and remeasured at ten-year intervals. Results so far indicate that survival and growth is best on the more fertile sites where moisture supply is constant but not excessive. The local black spruce that has been included in each plantation as a control has performed as well as the sitka spruce in most locations.

Goals: Establish two more plantations during summer 1970.

Replace dead seedlings and clean plantations as necessary during summers of 1970 and 1971.

Prepare an establishment report by 31 March, 1971.

Study 1011-8-3 (NO30): A provenance experiment with Lake States - St. Lawrence Region white spruce (Picea glauca (Moench.) Voss) in Newfoundland. Investigator: J. Nicholson.

This study is designed to test the suitability of 31 mainland white spruce provenances for Newfoundland conditions. The plantation at North Pond, which was established in 1964, was remeasured in 1968 (10 years old from seed) and a report is to be prepared during spring 1970.

Goals: Prepare report on 1968 remeasurement during spring 1970.

Remeasure plantation (15 years from seed) during summer 1972.

Prepare report on 1972 remeasurement by 31 March, 1973.

Study 1011-8-4: Provenance experiment with red spruce in Newfoundland.
Investigator: J. Nicholson.

The purpose of this study is to determine the suitability of 30 provenances of red spruce for conditions in central Newfoundland. The plantation was set out at North Pond in 1965, but has not yet been remeasured.

Goals: Remeasure plantation during summer 1972.

Prepare report on 1972 remeasurement by 31 March, 1973.

Study 1011-8-5: Provenance experiment with balsam fir from the Avalon Peninsula, central Newfoundland and two locations in New Brunswick.
Investigator: J. Nicholson.

The purpose of this study is to determine whether balsam fir from the Avalon Peninsula is genetically different from that in central Newfoundland and whether New Brunswick fir is suitable for Newfoundland conditions. Results of this study should ultimately help to explain the different growth pattern of Avalon Peninsula fir. Two plantations were established in 1961, in western Newfoundland and on the Avalon Peninsula. The latter has been partially destroyed but will be examined again in 1970 to determine whether it can still be of some use.

Goals: Remeasure plantation(s) (15 years from seed) during summer 1972.

Prepare report on 1972 remeasurement by 31 March, 1973.

Study 1011-8-6:

Phenotypic variation and interrelationships of stem, branch and foliage characteristics of black spruce in central Newfoundland.
Investigator: J. Nicholson.

The objective of this study is to determine, from a knowledge of the interrelationships and variation of phenotypic characteristics, the best criteria for the identification and testing of black spruce trees with superior volume growth. It is hoped that this will ultimately lead to methods for selecting genetically superior trees for use as future seed sources. During 1969, three types of stands were selected in central Newfoundland and preliminary observations and measurements made. Data were collected on crown shape and size, height, and diameter increment of a number of trees in each stand. Data are to be analyzed and a report prepared during the 1969/70 winter.

Goals: Analyze preliminary data and prepare file report during spring 1970.

During summer 1970, obtain more extensive data of the type obtained in 1969.

Analyze 1970 data and prepare report by 31 March, 1971.

Carry out detailed analyses of foliage, stem, and branch characteristics during summer 1971.

Analyze 1971 data and prepare final report by 31 March, 1972.

Future Study Development - Problem 6

The provenance studies of sitka spruce, white spruce, red spruce, and balsam fir are straightforward, relatively long-term trials which will require remeasurements at appropriate intervals over a period of years. Later, other exotics that appear promising in the introduction phase may require testing in a similar manner. However at present there are no immediate candidates for testing, and no plans to expand work on the exotics already under test. Some of these trials may ultimately evolve into plantation development studies where the species concerned have adapted sufficiently well to Newfoundland conditions.

Black spruce will continue to receive major emphasis, at least for the next 3 or 4 years. The nursery provenance experiment will be completed by 1971 and should provide the basis for an understanding of the pattern of variation in Newfoundland and for the delineation of seed zones. However, early results suggest that the pattern of variation is quite complex, and it will probably be necessary (possibly in 1972) to carry out a supplementary greenhouse study using bulked seedlots from perhaps 50 to 60 locations on the island in order to adequately define the variation and to permit a more accurate delineation of seed zones. In 1974 the black spruce study will enter a long-term outplanting phase. This work is necessary to confirm results of the nursery experiment and to follow later development of the various provenances in different locations. The study of phenotypic variation in black spruce will continue until 1972. Results should reveal those characteristics that are indicators of superior volume growth and thus permit the selection of phenotypically superior stems. Subsequently, progeny of selected stems will need to be tested to provide information on parent-progeny correlations and inheritance of important characteristics. A co-operative all-range black spruce provenance experiment is scheduled to be sown in the nursery in 1970 or 1971. This study will provide valuable information to complement that already being collected for the native provenances, and will identify possible mainland provenances for introduction and provide a gene pool for future breeding work.

Further plans are at present only tentative. Larch species have shown very rapid growth when established on good sites in the Maritime Provinces, and there is considered to be potential for provenance and hybridization studies on these species in Newfoundland. Hybridization work involving the superior black spruce provenances may also be necessary at a later date.

Problem 7

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

H.O. Schooley

The balsam woolly aphid is one of the most serious pests of balsam fir in Newfoundland. Control of this insect is of concern to the Protection Program. However, the impact of this insect upon stand development and productivity, a topic about which relatively little is yet known, is of concern to both the Protection Program and the Site and Stand Management Program. Studies of this problem are being carried out as a joint undertaking of the two programs, with special attention being given by the Site and Stand Management Program to the mensurational aspects of aphid impact.

Study 1011-9-1 (NO35): *Adelges piceae* impact and *Abies balsamea* stands. Investigator: H.O. Schooley.

The purpose of this study is to examine the impact of balsam woolly aphid damage on balsam fir stands of various ages, with particular reference to reproductive characteristics, development of young stands, and changes in the productivity of merchantable stands. It has been determined that cone production is not affected by the aphid unless there is extensive swelling and distortion of nodes and more than a 5% decrease in current shoot growth. Cone size, number of seeds produced, and seed viability are not affected by aphid injury. Since all trees in a stand are not affected to the same degree, and since periodic recovery of the fir may occur following a decline in aphid numbers, it is concluded that stand replacement under the influence of the aphid is not a problem. Three sampling procedures have been used to examine the distribution and intensity of aphid damage in young stands. Aphid-infected trees occur in distinct groups in lightly and moderately damaged stands. Tree mortality is not common in young stands; instead, severely affected trees fail to grow competitively, lose their place in the stand canopy, and die from suppression. During the past year an extensive survey was carried out to determine the extent and amount of aphid damage in young fir stands in western Newfoundland. Analyses of this work are in progress. These analyses will be completed and reported by 1971. Reports presently in preparation on sampling methods and on the impact of the aphid on reproductive characteristics and young stand development will be completed during 1970.

Goals: Completion of reports on sampling methods, regeneration characteristics, and young stand development by 31 December, 1970.

Preparation of plans for future study development by spring 1970.

Completion of analyses and preparation of report on aphid damage survey by 31 March 1971.

Future Study Development - Problem 7

As indicated above, plans for future study development are not yet finalized. A comprehensive review of balsam woolly aphid research in Newfoundland is to be carried out by the Protection Program during the spring of 1970, and the future conduct of the aphid impact study will be decided at that time. However, preliminary work has already started to determine the effects of the aphid on the volume production of individual balsam fir trees, and it is hoped to use this information in a major study (to commence by 1971) to determine the present impact of the aphid on the volume production of infested fir stands.

REVISED LIST OF PROGRAM GOALS AND
PRIORITIES

- (A) Studies listed as 'Priority 1' in 1969 (Page, 1969a, page 23) which have been completed.
- (1) Revision of growth and yield tables for central Newfoundland (Study 1011-3-1).
 - (2) Report on partial cutting experiments (Study 1011-5-1/1011-3-5).
 - (3) Preliminary survey and assessment of significance of overstocked stands (Study 1011-5-2).
 - (4) Study of the characteristics of acid brown wooded soils (Study 1011-7-1).
 - (5) Study of the effects of certain cover types on soil nutrient status (Study 1011-7-2).
- (B) 'Priority 1' studies which will be under investigation during 1970/71.
- (1) Completion of analyses and reports on mensurational characteristics of the major forest types of Newfoundland (Study 1011-3-2) 1970-71.
 - (2) Analysis of available growth and yield data and preparation of tables (Study 1011-3-4) 1970-72.
 - (3) Quantitative site evaluation studies in eastern and western Newfoundland (Study 1011-4-2) 1970-71.
 - (4) Completion of final report on pilot-scale land classification study, Corner Brook (Study 1011-4-1) 1970.
 - (5) Dybar experiment (Study 1011-5-3) 1970-71.
 - (6) Spacing trials, establishment and maintenance (Study 1011-5-5) 1970-
 - (7) Development of young stands established by artificial seeding (Study 1011-5-6) 1970-
 - (8) Continuation of fertilizer trials (Study 1011-6-1) 1970-80.
 - (9) Continuation of detailed nutrient studies (Study 1011-6-2) 1970-

- (10) Continuation of provenance trials with bS, sS, wS, rS, and bF (Studies 1011-8-1, 1011-8-2, 1011-8-3, 1011-8-4, 1011-8-5) 1970-
 - (11) Study of criteria for selecting superior bS trees (Study 1011-8-6) 1970-72.
 - (12) Impact of balsam woolly aphid on fir stands (Study 1011-9-1) 1970-
- (C) 'Priority 2' studies on which work is tentatively planned for 1971 or later.
- (1) Remeasurement, report, and closure of King's Cove woodlot study (Study 1011-3-3) 1971-72.
 - (2) Preparation of growth and yield tables on a physiographic site basis. Tentatively planned for commencement in 1971.
 - (3) Studies of the development of young, naturally-established stands of fir and spruce. Tentatively planned to commence by 1972.
 - (4) Detailed investigations of exposure in relation to tree growth, and co-operation with regeneration program in trials of windbreaks.
 - (5) Drainage, possibly combined with fertilizer, trials under forest stands to improve growth.
 - (6) Stripcutting to control stocking in dense young stands.
 - (7) Use of fertilizers to prevent and relieve stagnation in dense young stands.
 - (8) Development of basic management plan for Corner Brook watershed.
 - (9) Studies on effects of cover type on soil development and site productivity.

SUMMARY OF ANNUAL MAN-MONTH REQUIREMENTS

Study	Time used: 1969-70		Estimated time requirements: 1970-71	
	Professional	Other	Professional	Other
1011-3-1	3.0	3.0	2.0	2.0
1011-3-2	1.5	2.0	1.5	3.0
1011-3-3	0	0	0	0
1011-3-4	2.5	2.0	8.5	8.5
1011-3-5	2.0	1.0	0.2	0.8
1011-4-1	1.5	7.0	3.0	6.0
1011-4-2	8.0	19.0	8.0	20.0
1011-5-2	2.0	1.0	0.5	0
1011-5-3	2.0	6.0	3.0	6.0
1011-5-5	0.3	5.0	1.5	5.0
1011-5-6	1.5	0.2	3.0	11.0
1011-6-1	1.5	1.5	5.5	14.5
1011-6-2	10.0	7.0	8.0	12.0
1011-7-1	0	0	0	0
1011-7-2	0	1.0	0	0
1011-8-1	4.0	3.0	2.5	9.0
1011-8-2	1.5	11.5	1.5	5.5
1011-8-3	1.5	3.0	0	0
1011-8-4	0	0	0	0
1011-8-5	0.1	1.5	0.2	0.2
1011-8-6	1.5	3.0	2.0	2.5
1011-9-1	12.0	16.0	12.0	21.0
Totals:	56.4	93.7	62.9.	127.0

REVISED LIST OF GROUP PERSONNEL

- G. Page : Program leader; concerned with co-ordination and overall development of program, quantitative site evaluation, mensurational characteristics of forest types, growth and yield studies.
- N.D. Bhure : Fertilization trials, detailed soil and foliar nutrient studies.
- E.R. Dawe : Soils laboratory supervisor, responsible for laboratory analyses of soil samples collected in various studies.
- J. Nicholson : Provenance trials and other genetics studies, spacing trials.
- R.S. van Nostrand : Growth and yield studies, partial cutting experiment, fertilization trials, dybar experiment, spacing trials.
- A.J. Robinson : Growth and yield studies, young stand development studies.
- H.O. Schooley : Aphid impact studies (jointly with protection program).
- R.E. Wells : Land classification studies.

Also associated with the program for liaison or advisory purposes are:-

- J.M. Jarvis (Associate Director and Acting Program Manager, Resources Research)
- F.C. Pollett (Peatland Program leader)
- J. Richardson (Regeneration Program leader)
- G.L. Warren (Program Manager, Protection Research, and Protection Program leader)
- W.C. Wilton (Head, Development and Services Section)
- J.P. Bouzane (Research technician; photo-interpretation for land classification and physiographic growth and yield studies)

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*...Copies of most of these reports may be obtained from the author or from the Information Officer, Canadian Forestry Service, P.O. Box 5430, St. John's, Newfoundland.