**Not for publication**

# Regeneration of Spruce/Alpine Fir Types in British Columbia

## A REVIEW OF THE PROBLEM AND A PROPOSAL FOR REGENERATION RESEARCH IN THE NORTH CENTRAL INTERIOR



by
R.C. Dobbs and R.G. McMinn

FOREST RESEARCH LABORATORY
CANADIAN FORESTRY SERVICE
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INTERNAL REPORT BC-24

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# REGENERATION OF SPRUCE/ALPINE FIR TYPES IN BRITISH COLUMBIA

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# INTRODUCTION

According to the sustained-yield principle, the basis of British Columbia's forest policy, annual cut can be maintained at maximum levels only if restocking is prompt and maximum growth is sustained. The present large acreage of potentially productive but insufficiently stocked forest land attests to the difficulty of attaining satisfactory stocking in spruce/alpine fir forest types. Considerable resources are currently devoted to reforestation programs. Advances through silvicultural research would help to optimize expenditures and realize the potential for fiber production and other benefits that derive from well-managed forest lands.

The apparent need for further silvicultural research on forest regeneration in the British Columbia Interior prompted the Canadian Forestry Service to initiate a problem analysis in the spring of 1970. The improved definition of the problem which resulted and the priorities which emerged form the basis for this silvicultural research proposal.

Preliminary terms of reference were established after management-level discussions with the Research Division of the British Columbia Forest Service. To avoid duplication of effort, it was decided that the Canadian Forestry Service would direct its attention to regeneration research in the spruce/alpine fir forests of the Interior Subalpine Section (SA2) and the more moist portions of the Montane Transition Section (M4) (20) in the North Central Interior of British Columbia.

Within these terms of reference, the problem analysis was advanced primarily through field observations and the conduct of exploratory field and laboratory experiments. Further focus was given by numerous background discussions, correspondence, literature reviews, and the feedback resulting from preliminary reports (6, 7, 15).

Field activities and observations were undertaken over the North Central Interior but, through the courtesy of Northwood Pulp Ltd., attention was concentrated on T. F. L. 30, to the east of Prince George. Extended discussions with representatives of Northwood Pulp Ltd. and the British Columbia Forest Service were most informative. The analysis was facilitated by recommendations put forward by the District Forester, Prince George Forest District, and his staff. Significant discussions were also held with other industrial representatives, with members of the Faculty of Forestry and the Department of Botany of the University of British Columbia, and with management, scientists and economists in the Regional Forest Research Laboratories in Victoria and Edmonton, and the Forest Products Laboratory, Vancouver.

This report outlines the program that will be undertaken in the immediate future and the reasons for adopting this course. It is intended also to indicate that the priority problems requiring reduction by research are not yet adequately defined. Further evaluation is required of the results of work already done. Therefore, in addition to experiments designed to resolve specific questions already formulated, it is proposed to devote some immediate effort to a field survey of a range of plantations and natural regeneration in the North Central Interior. This survey will be undertaken to refine and sharpen the focus of the analysis of the problem by identifying and quantifying climate, soil and vegetation conditions that affect the establishment and growth of seedlings and outplanted stock.

## THE NORTH CENTRAL INTERIOR

This proposal for regeneration research concerns the spruce/alpine fir forests of the North Central Interior of British Columbia. The area considered is included in Rowe's (20) Interior Subalpine Section SA2 of the Subalpine Forest Region and the more moist portions of the Montane Transition Section M4 of the Montane Forest Region. These sections are approximately coincident with Krajina's (14) Subboreal and the northerly portion of the Interior Subalpine Biogeoclimatic Zones. Administratively, the region is more or less delineated by Forest Inventory Zone No. 4, in the Prince George and Interior portions of the Prince Rupert Forest Districts (19).

The North Central Interior encompasses a variety of physiographic units. Included are portions of the Central and Southern Plateaus and associated mountain areas, the Rocky Mountain Trench and portions of the Rocky Mountains (Muskwa, Hart and Park Ranges)(11).

The climate is characterized by long, moderately cold winters with heavy snowfall and short, cool and humid summers (19). Precipitation during the growing season, though varying throughout the region, is generally relatively high and drought periods are usually of short duration.

Soils developed from coarse-textured glacial till and postglacial sands and gravels are podzolized. On finer textured parent materials, which are common, grey-wooded profiles predominate. Organic soils occur throughout the region.

Five principal site types have been described by Illingworth and Arlidge (12). In descending order of site quality, these are: Oplopanax (O), Disporum (D), Aralia-Dryopteris (A-D), Cornus-Moss (C-M) and Equisetum-Sphagnum (E-S). At maturity, the average height of dominant spruce ranges from 130 feet on O sites to 95 feet on E-S sites. The range for mature alpine fir is from 108 to 80 feet. Severe competition from brush is a forest regeneration problem on virtually all site types.

## THE DEVELOPMENT OF FORESTRY PRACTICES

In 1914, the Prince George Forest District executed its first timber sale which provided that all trees over 10 inches d.b.h. and with more than 50% sound wood were to be cut (2). For several decades thereafter, diameter limit cutting (generally to a 12-inch d.b.h.) was carried out in the mature uneven-aged spruce/alpine fir stands of the British Columbia Interior. It was intended that the residual stand and advance growth would make up the second cut and that the third cut would depend on regeneration following the initial cutting. Griffith (10) drew attention to the difficulties inherent in this approach when he showed that, although spruce dominated the overstory (generally comprising over 60% of the basal area), it ran a poor second (about 18%) to alpine fir in the understory. Moreover, the anticipated spruce regeneration did not materialize due to the intact layers of moss and herbaceous growth on the forest floor.

Initially, trees were bucked into logs and skidded by horse. Following the Second World War, heavy logging machinery was introduced and further deterioration of the residual stands resulted from heavy logging damage (2). Because of logging damage and windfall, the spruce poles forming the residual stand were of little value as a subsequent crop (21).

In 1949, Pogue (17) reported that cutover areas were poorly stocked, and recommended that the 12-inch diameter limit be replaced by a single tree selection system that would provide for a more uniform residual stand. This system was generally unsuccessful due to continued logging damage (9) and windfall problems (16). Moreover, such regeneration as did occur was generally alpine fir (16).

Alternate strip clear-cutting was introduced in 1954 (2). The initial hope that advanced regeneration would provide an acceptable new crop was not fulfilled due to heavy logging damage. Moreover, natural regeneration did not materialize because winter logging left the forest floor virtually undisturbed. Thus, in 1956, scarification of logged areas was introduced (2). This technique was moderately successful when a good seed crop followed seedbed preparation by a year or two. However, scarified seedbeds generally become unreceptive within 2 or 3 years due to reinvasion of brush (3), while good seed crops are generally separated by several years (18). This sets one limitation on the effectiveness of scarification for natural regeneration.

Alternate strip clear-cutting also produces the problem of regenerating the leave strips when they are eventually cut. This problem has been approached by scarifying leave strips (pre-scarification), usually at the same time as adjacent cut strips are being scarified. The same difficulties of seed crop periodicity and brush reinvasion are encountered in pre-scarification, as well as several additional problems. Standing trees make it more difficult to obtain good coverage, and damage to root systems is thought to increase windthrow (19). There is also the problem of eventually harvesting the leave strips without excessively damaging the regeneration that has been obtained.

Alternate strip clear-cutting is still the principal cutting method although there is currently a trend toward large clear-cuts of several hundred acres. Since these clear-cuts are too large for natural seeding and direct seeding has not been perfected in the North Central Interior, they will require site preparation followed by planting.

## THE RESOURCE MANAGEMENT PROBLEM

The magnitude of the problem of regenerating spruce/alpine fir forests is underscored by some recent statistics. In the Prince George Forest District alone, there are presently over one-million acres of "plantable", that is essentially N.S.R., forest land, the majority of which have received no site preparation (13). By contrast, 12,000 acres were planted in the entire Interior in 1969 (4).

This sizeable acreage of unproductive land is being increased year by year. In recent years, over 75,000 acres of spruce forest have been clear-cut each year, and by 1975 (only 4 years hence), the area logged annually is expected to exceed 100,000 acres; while planting stock will be produced in numbers sufficient to plant 25,000 acres annually (19). The requisite stock will be provided by rapid expansion of forest nursery output, most notably at the Redrock Forest Nursery, south of Prince George, and possibly by progress toward the production of container-grown seedlings on an operational scale. A substantial increase in site preparation will be necessary to utilize properly this stock.

Thus the regeneration portion of the resource management problem takes on two aspects: 1) the need to deal effectively with the logistics of an expanding planting program and to protect a substantial investment by maximizing survival and growth, and 2) the need to find effective alternative methods of regenerating the vast majority of the logged-over area not destined for planting in the foreseeable future.

The regeneration problem confronting the resource manager is basically an economic one with an operational and a biological component. That is to say, both operational and biological constraints exist because of economic limitations. For example, existing knowledge of regeneration ecology, though rudimentary, would be adequate to the task of forest regeneration if unlimited funds were available. Thus it is emphasized that the operational and biological problems to be discussed must be considered in an economic context. The relatively low productivity of sites in the North Central Interior, by intensifying economic limitations, increases the operational and biological constraints.

Both climate and ground conditions in the North Central Interior provide particular operational constraints to practices that may be successful elsewhere. For example, in many seasons, weather for adequate prescribed burning is very restricted. By mid-summer, rainfall amount and distribution are such that fuels are not dry enough to permit an adequate burn. Although fuels may carry a fire in the spring, surface layers are usually too wet to allow much duff reduction or control of competing vegetation. The infrequency of sites with sufficiently firm ground for summer logging restricts the area scarified by normal logging operations. Increasing use of rubber-tired skidders is now reducing the proportion of ground formerly scarified by summer logging. Sites with relatively high water tables and fine-textured soils must be logged in winter when the ground is frozen. Such areas may be accessible only with difficulty during summer months for either scarification or planting. Only during exceptionally dry summers can such areas, which predominate the landscape, be easily and economically blade scarified. The necessity to time scarification for natural regeneration to coincide with good seed crops, moreover, means that work loads for site preparation are uneven and poor weather may well hamper operations during such peak years. Economic considerations have led to the increasing frequency of clear-cut areas that are too large to be naturally regenerated.

## THE BIOLOGICAL COMPONENT

Several biological components of the resource management problem pertain to seed production and the production of stock for outplanting. However, our concern in this discussion is with the fate of seed or seedlings after arrival at the site to be regenerated. The essentially universal problem is that, following logging, the site is invariably inhospitable to seed and seedling alike, and current methods of site preparation only partially overcome this difficulty.

### Natural Regeneration and Direct Seeding

Surface organic layers and competing vegetation generally remain intact after winter logging when the ground is covered by snow. Even in summer, disturbance is only partial. The usual fate of a white spruce or lodgepole pine seed germinating on such a surface is death due to drought. Organic material moistens and dries readily, with the usual consequence that the growing radicle desiccates before it can reach a more stable moisture supply in the underlying mineral soil. Numerous studies (e.g. 1,5,8,10,18) have shown the necessity of a mineral soil (or rotten wood) seedbed for the successful establishment of white spruce or lodgepole pine germinants. Some form of site preparation is therefore necessary. In the spruce/alpine fir forests of the North Central Interior, blade scarification is the only current method feasible under present economic and operational constraints. Unfortunately, while this operation enhances the establishment of germinants, it leaves an austere environment for their further development. Heavy mortality, due to drought and high surface temperatures, follows germination and fertile upper soil horizons are removed beyond the reach of newly germinated seedlings. Moreover, rodent populations, which flourish on cutover areas, consume large quantities of seed (5,18). Seed and germinant losses might be compensated for by a heavy innoculum of seed following seedbed preparation, but economics preclude the provision of sufficiently large quantities by direct seeding and adequate spruce seed crops occur only spasmodically at two- to six-year intervals. Lodgepole pine occurs too infrequently in most overmature spruce/alpine fir forests for natural regeneration of that species to be feasible. The irregularity of spruce seed crops introduces the operational problem of preparing large acreages of cutover lands when a good seedcrop is forecast, since the effectiveness of site preparation is largely negated within three years by regrowth of vegetation (3).

Research directed to the solution of these biological constraints should be concerned with improving methods of seedbed preparation ameliorating microclimate by shading (e.g. by shelterwood cuts), alternative methods of vegetation control, control of rodent populations, and improved forecasting of seed crops.

Planting

Many of the problems associated with natural and artificial seeding are averted by planting nursery-grown or container-grown stock. Nevertheless, an important dilemma faces the silviculturist who will plant a cutover area. Mortality of seedlings due to competing vegetation is generally appreciable on untreated cutovers and operational methods of site treatment generally reduce, at least temporarily, the productivity of the site with a consequent loss of seedling growth. Generally, the aggressiveness of competing vegetation has been met by scalping; that is, by removing and casting aside the more fertile upper soil horizons. Satisfactory survival must seemingly be purchased at the cost, at least initially, of reduced seedling growth.

Field observations amply support the contentions that, with current production stock, seedling survival on undisturbed sites is frequently unacceptably low and that growth on scalped sites is retarded. Experimental evidence that scalping reduces seedling growth was obtained last winter in a growth chamber experiment. Following various site treatments, intact blocks of soil were placed in containers and transferred to the laboratory. White spruce germinants were transplanted to the various soils and grown for several months in a growth chamber. At the end of the experiment, the seedlings that grew on undisturbed soils were dramatically larger than those that grew on scalped soils. Growth on mixed and burned soils was intermediate.

Research devoted to the solution of this problem must be approached from two directions: 1) Methods of reducing competition, which are less deleterious to the site, must be found within the constraints imposed by economics, and 2) methods must be developed of producing and planting seedlings that render them better able to withstand competition on fertile sites and to develop subsequently at acceptable rates.

## PROPOSED RESEARCH

After the first phase of the problem analysis, it was decided that the initial research effort should be directed to regeneration by planting - specifically, to assessing and reducing causes of mortality and growth stagnation, and finding ways of improving site preparation, planting stock quality, and planting methods. This decision is justified in view of plans for increased planting acreages by the large investment associated with planting coupled with the high potential for improving methods and thus protecting the investment.

Two complementary five-year projects are proposed:

1) BC-914 Artificial regeneration of Interior spruce/alpine fir types (R. C. Dobbs).

   Objective: To develop successful artificial regeneration procedures by a) identifying the microsite and physiological parameters limiting survival and growth in the field, and b) developing establishment procedures and methods of producing seedlings that exhibit maximum survival and growth in the field.

2) BC-916 Ecology of site preparation in Interior spruce/alpine fir types (R. G. McMinn).

   Objectives: a) To determine site characteristics, necessary for the establishment and early growth to acceptable standards of tree species suitable for reforestation, which may be created by site preparation.

   b) To test and recommend procedures for site preparation that meet the silvical requirements of species suitable for reforestation.

The two projects are complementary in that BC-914 seeks to relate seedling performance to specific environmental parameters such as soil temperature, moisture and fertility, while BC-916 seeks to determine how site treatment methods may modify such environmental parameters.

GENERALIZED PLAN OF ATTACK

An immediate goal of both projects is to refine the problem analysis by surveying the performance of artificial and natural regeneration on a variety of sites. The establishment, survival and growth of white spruce and lodgepole pine (species considered suitable for reforestation of spruce/alpine fir sites in the North Central Interior) will be assessed in relation to geographic locality, site type, logging intensity, site preparation, competing vegetation, age and type of stock and time of planting.

BC-914 Specific short term experiments will be designed and implemented to identify the microsite and physiological parameters limiting survival and growth in the field. Microsite parameters to be examined include species, proximity and density of competing plants as well as soil temperature and soil moisture tension. Physiological parameters include seedling water stress, inorganic chemical content and, perhaps, carbohydrate content. The effect of seedling stature on survival and growth will also be examined. Interpretation of data thus obtained, together with information from complementary growth chamber and greenhouse experiments, will provide the basis for the specifications of seedlings that will exhibit maximum survival and growth in specific field environments. Attention will then be given to methods of producing and outplanting such stock.

BC-916 Experimental and operational site preparation procedures will be assessed in terms of their effect in modifying specific environmental parameters such as soil temperature, moisture and fertility, and in terms of their effects on lesser vegetation. The ecology of lesser vegetation will be stressed because control of competing plants is a prime objective of site preparation in spruce/alpine fir site types. The type of propagule that reestablishes plants as competitors of outplanted stock following site preparation will be determined, as a guide to establishing the kind, intensity and timing of site preparation required. Native and introduced lesser vegetation species will be tested to ascertain their effectiveness as cover crops to moderate any adverse effect of large clearcut openings and to ameliorate any soil fertility reduction resulting from site preparation. Initially, major emphasis will be on mechanical and chemical site preparation methods, although the effectiveness of prescribed fire for site preparation will also be investigated. The results of experiments will provide the basis for testing and recommending modified or new site preparation practices and equipment.

FIELD EXPERIMENTS, 1971

Field experiments directed to the goals of both projects are being established and are briefly described below.

Four site treatment plots - undisturbed, scalped, mixed and herbicide - will be established on each of six study areas on Northwood Pulp Ltd's T.F.L. 30. A fifth treatment - prescribed fire - will also be assessed on one of the areas. Three of the study areas will be located near McGregor and three will be near Pass Lake, an area of higher elevation and rainfall. The three study areas in each location will be established in different site types - O, A-D and C-M (12). The treatment plots on the O and A-D site types will be planted with 2-0 white spruce and those on the A-D and C-M site types will be planted with 2-0 lodgepole pine.

The effects of site treatments on lesser vegetation, soil properties including temperature and moisture, and seedling performance will be assessed. Seedling increment, foliage nutrient content and moisture stress will be monitored. Results will be interpreted in the light of weather patterns, site type and soil characteristics.

In a separate though related experiment, 2-0 spruce and pine seedlings will be planted on undisturbed, scalped and burned portions of the McGregor study areas. The effects of initial seedling stature on seedling performance will be assessed.

## SUPPORTING RESEARCH NEEDS

This proposal for silvicultural and ecological research to improve forest regeneration practices might profitably be augmented by information gained through research by other disciplines. Land classification research is required to improve delineation of landforms and site types, and differentiate them into a priority stratification according to site preparation and regeneration method. To improve site preparation through the use of fire, burning prescriptions to meet the silvical requirements of species suitable for reforestation should be developed. If exploratory site preparation procedures indicate a favorable response from herbicide treatment, intensive research should be conducted to determine how herbicides might be used effectively and economically, and in accordance with the necessity to limit environmental hazard. Additional economic and growth and yield information is also necessary for optimal decisions concerning choice of species and degree of site preparation. Further information from such disciplines as tree physiology, genetics, forest products, forest pathology, soil microbiology and soil zoology, as well as ecological and silvicultural research to solve problems not covered by this proposal could help to reduce regeneration problems prevailing in the spruce/alpine fir forests of the North Central Interior.

## ACKNOWLEDGMENTS

We are indebted to numerous persons in our own and other organizations for advancing our understanding of the regeneration problem in the British Columbia Interior and assisting us in the development and initiation of a responsive research program.

Particularly helpful has been Northwood Pulp Ltd. of Prince George in providing advice, study areas, accommodation, and other assistance. Special thanks are due Messrs. C.O. Bardal and R.B. Dickens of that company for their interest and cooperation. We also thank the Foresters in charge of the Research and Reforestation Divisions and the District Foresters, Prince George and Prince Rupert Forest Districts, of the British Columbia Forest Service, and their staffs, for advice and assistance.

Valuable advice was received from several University of British Columbia faculty members.

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APPENDIX I

Current projects of the British Columbia Region, Canadian Forestry Service, which are relevant to regeneration of spruce/alpine fir types in the North Central Interior of British Columbia.

Projects related to planting of container-grown seedlings.

BC 087* - Field performance of container-grown seedlings in Interior forests. (E. Van Eerden).

BC 088* - Cultural techniques for the production of container seedlings. (E. Van Eerden).

BC 089 - Production and transportation of containerized seedlings. (J.M. Kinghorn).

BC 090 - Planting of containerized seedlings. (J.M. Kinghorn).

BC 091 - An economic analysis of alternative reforestation systems. (A.H. Vyse).

BC 929* - Mycorrhizal development of container-grown seedlings in Interior forests. (R.G. McMinn and E. Van Eerden).

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* Projects within the Project Group:
Regeneration of spruce/alpine fir types in British Columbia.

Other projects.

BC 015 - Cone production of Douglas fir, white spruce, alpine fir and other B. C. conifers. (S. Eis).

Subproject A: Development and morphology of buds of white spruce and true firs. Prediction of cone crops.

BC 913 - Growth and yield of pine and spruce in pure and mixed stands in the Interior of B. C. (S. Eis).

BC 022 - Ecology of spruce weevils. (L.H. McMullen).

BC 025 - Spruce beetle, Dendroctonus obesus (Mannerheim), in British Columbia. (E.D.A. Dyer).

BC 027 - Insects affecting seed production of trees in British Columbia. (A.F. Hedlin).

## APPENDIX II

Current* projects of the Research Division, B. C. Forest Service, which are relevant to regeneration of spruce/alpine fir types in the British Columbia Interior.

Plant Ecology

(Last reported in the 1970 Forest Research Review)

E.P. 553 - Ecological Classifications in the Interior Forest Regions. (J.W.C. Arlidge).

Objective (from 1967 F.R.R.): To develop, on an ecological basis, a classification of forest site types in the Interior forest regions, and to determine the characteristics of forest stands on these site types.

E.P. 618 - Cone Crop Periodicity in Spruce, Nelson Forest District. (C.F. Thompson).

Objectives: (1) To obtain comparable annual records of the relative magnitude of Englemann spruce cone crops, and to relate these to the weather. (2) To develop a satisfactory technique of counting cone crops.

E.P. 675 - Cone and Seed Maturity on White Spruce in the North Central Interior. (J. Revel).

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* As indicated in the Forest Research Review for the year ended March, 1970, and preceding issues.

Objectives: (1) To determine the pattern of cone and seed maturation in selected white spruce stands. (2) To find more reliable field indices for determining cone and seed maturity in the field.

Natural Regeneration

(Last reported in the 1969 Forest Research Review).

E.P. 653 - Seed Dispersal Study, Verdum Mountain. (D. Armit).

Objective: To investigate quality, quantity, and maturity of seed crops, seed-dispersal patterns, and some climatic influences.

Choice and Trial of Species

(Last reported in the 1970 Forest Research Review).

E.P.'s 646, 662, 672 and 683 - Effects of Altitudinal and Latitudinal Displacement of White and Engelmann Spruce Provenances: Prince George (646), Kamloops (662), Prince Rupert (672) and Nelson (683) Plantations. (J. Revel, M.B. Clark, D. Armit, and C.F. Thompson, respectively).

Objective: To record the performance of various provenances of white and Engelmann spruce.

E.P. 670 - Selection of White and Engelmann Spruce for Seed Orchards. (G. Kiss).

Objective: To produce genetically improved spruce seed from phenotypically superior trees selected in natural stands and propagated in seed orchards.

Nursery Practices

(Last reported in the 1969 Forest Research Review).

E.P. 655 - Fertilizer Applications for White Spruce at Red Rock Nursery.

(R. van den Driessche).

Objective: To determine suitable levels of fertilizer application for white spruce.

Direct Seeding

(Last reported in the 1970 Forest Research Review).

E.P. 677 - A Test of Spot-seeding Techniques and Season of Sowing.

(M.B. Clark).

Objectives: (1) To test the effectiveness of Panama "walking-stick" seeders with conventional hand-seeding of mattock-screefed spots. (2) To test the effect of season of sowing.

(Last reported in the 1969 Forest Research Review).

E.P. 638 - Seeding Trials in the Prince George Forest District. (J. Revel).

Objective: To explore seeding techniques suited to certain conditions found in the Prince George Forest District.

E.P. 650 - Direct Seeding after a Prescribed Burn, Verdun Mountain. (D. Armit).

Objective: To determine the effectiveness of prescribed burning and hand-screefing as preparations for spot seeding of Douglas fir, lodgepole pine, and white spruce.

E.P. 655 - Direct Seeding (1967) on "Mag" fire. (M.B. Clark).

Objective: To determine the feasibility and economics of direct seeding when limited to favourable site and seed-bed conditions.

(Last reported in the 1968 Forest Research Review).

E.P. 635 - Direct Seeding on Scarified Clear-cut Strips, Taltapin. (D. Armit).

Objective: To test the potential of spot seeding on machine-scarified sites to promote regeneration when natural crops fail.

<u>Planting</u>

(Last reported in the 1970 Forest Research Review).

E.P. 549 - Spacing Trials in the Prince George Forest District. (J. Revel).

Objective: To provide information on the growth and behaviour of trees planted at various spacings.

E.P. 626 - Engelmann Spruce Planting Trails. (C.F. Thompson).

Objective: To determine the length of the planting season for Engelmann spruce using bare-root stock and standard planting techniques.

E.P. 660 - Species and Spacing Trials in the Montane Transition Forest Zone. (J. Revel).

Objective (from 1969 F.R.R.): To determine the relative performance of lodgepole pine, Douglas fir, and white spruce at various spacings on a wide range of soil types.

E.P. 668 - Planting of White Spruce Throughout the Growing Season in the North Central Interior. (J. Revel).

Objective (from 1969 F.R.R.): To determine the feasibility of extending the planting period to the entire growing season.

E.P. 682 - Extended Planting Trials with Mudpack Stock in the Southern Interior. (M.B. Clark and C.F. Thompson).

Objective: To determine the relative survival rates of bare-root and mudpack spruce stock lifted in the normal spring season, cold-stored until required for planting throughout the spring and summer seasons.

E.P. 684 - Container, Mudpack, and bare-root Planting Trials in the Interior. (D. Gillespie, H. Coates, M.B. Clark, and C.F. Thompson).

Objective: To determine the relative survival of four types of stock when planted throughout the growing season.

(Last reported in the 1968 Forest Research Review).

E.P. 502 - Plantation Trials in the Prince Rupert Forest District. (D. Armit).

Objective: To compare the behaviour of 2 + 1 and 3 + 0 white spruce stock of the same provenance on a very bushy site near Topley Landing.

E.P. 661 - Engelmann Spruce Spacing Trials in the Kamloops Forest District. (M.B. Clark).

Objective: (None given).